Network, Network Position and the Deal Flow of Venture Capital Firms

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II

Content Overview

1 Introduction to the Topic .................................................................................................................................. 1
   1.1 Problem Definition and Objectives ........................................................................................................ 1
   1.2 Methodology and Structure of the Study ................................................................................................. 5

2 Definitions and Basic Concepts .................................................................................................................. 8
   2.1 Venture Capital ........................................................................................................................................ 8
   2.2 Deal Flow .............................................................................................................................................. 41
   2.3 Summary .............................................................................................................................................. 55

3 Theoretical Foundation ................................................................................................................................ 57
   3.1 Approach to Theory Selection ................................................................................................................ 57
   3.2 Social Network Analysis ....................................................................................................................... 68
   3.3 The Concept of Social Capital .............................................................................................................. 92
   3.4 Research Design .................................................................................................................................. 111
   3.5 Summary and Detailed Structure of the Research Design .................................................................. 144

4 Derivation of Hypotheses ............................................................................................................................. 146
   4.1 Hypotheses on the General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow ................................................................. 146
   4.2 Hypotheses on the Connection between Network Measures and Deal Flow ...................................... 152
   4.3 Summary of Hypotheses ....................................................................................................................... 161

5 Data Collection and Methodological Approach .......................................................................................... 162
   5.1 Data Collection .................................................................................................................................... 162
   5.2 Statistics in Social Network Analysis ................................................................................................... 183

6 Results of the Empirical Study .................................................................................................................... 192
   6.1 General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow ................................................................. 192
   6.2 Characterization of the Entire Network Structure .............................................................................. 193
   6.3 Connection between Network Position, Firm Attributes, and Deal Flow ........................................... 200

7 Discussion of the Results and Implications for Management and Research ............................................. 227
7.1 Discussion of the Results ................................................................. 227
7.2 Summary of the Results ................................................................. 265
7.3 Implications for the Management of Venture Capital Firms .......... 267
7.4 Implications for Research ............................................................... 271

8 Summary of the Study ...................................................................... 277

Appendix: Questionnaire of the Empirical Study ............................... 279
Bibliography ........................................................................................ 285
# Table of Contents

1 Introduction to the Topic ............................................................................................................ 1

1.1 Problem Definition and Objectives .................................................................................. 1

1.2 Methodology and Structure of the Study ........................................................................... 5

2 Definitions and Basic Concepts ................................................................................................. 8

2.1 Venture Capital .................................................................................................................. 8

2.1.1 Definition of the Term and Venture Capital as Method of Financing .......................... 8

2.1.2 Development and International Comparison of the German Venture Capital Market .................................................................................................................. 12

2.1.3 Venture Capital Firms and Portfolio Companies ....................................................... 20

2.1.3.1 Types of Venture Capital Providers ........................................................................ 20

2.1.3.2 Characteristics of Portfolio Companies ................................................................. 23

2.1.3.3 Investment Stages ..................................................................................................... 25

2.1.3.4 The Value Chain of Venture Capital Firms ............................................................ 29

2.1.4 Syndicated Venture Capital Investments ...................................................................... 34

2.1.4.1 Definition of Syndication ..................................................................................... 34

2.1.4.2 Lead-Investor and Co-Investor ............................................................................. 35

2.1.4.3 General Rationales for Syndication ..................................................................... 36

2.2 Deal Flow .......................................................................................................................... 41

2.2.1 Definition of Deal Flow ............................................................................................... 41

2.2.2 Quantity and Quality of Deal Flow ............................................................................. 43

2.2.3 Literature Review ......................................................................................................... 45

2.2.4 Generation of Deal Flow ............................................................................................. 48

2.2.4.1 Search Activities of Venture Capital Firms ............................................................ 48

2.2.4.2 Sources of Deal Flow ............................................................................................ 50

2.3 Summary ............................................................................................................................ 55

3 Theoretical Foundation ............................................................................................................ 57

3.1 Approach to Theory Selection .......................................................................................... 57

3.1.1 Theories Commonly Applied to Financial Markets ................................................... 57

3.1.2 Reasons for Abstaining from Frequently Applied Theories ........................................ 64

3.1.3 Requirements for the Theoretical Foundation for this Study ..................................... 67

3.2 Social Network Analysis .................................................................................................... 68

3.2.1 Economic Perspectives on Social Networks ............................................................... 68

3.2.2 Social Network Analysis as Method to Examine Relationships .................................. 71

3.2.3 Fundamental Concepts of Social Network Analysis .................................................. 73

3.2.3.1 Basic Terms ............................................................................................................. 73

3.2.3.2 Measurement and Collection of Network Data ......................................................... 75

3.2.4 History and Background of Social Network Analysis ............................................... 77

3.2.4.1 Sociometric Analysis and Graph Theory ................................................................. 77
3.2.4.2 Interpersonal Relations and Cliques ......................................................80
3.2.4.3 The Manchester Anthropologists .......................................................82
3.2.4.4 Synthesizing the Developments at Harvard University .......................83
3.2.5 Research Areas and Typology of Network Studies ...............................85
   3.2.5.1 Research Areas .............................................................................85
   3.2.5.2 Typology of Network Studies ......................................................88
3.3 The Concept of Social Capital ....................................................................92
   3.3.1 Description of Social Capital and Delineation to Other Forms of Capital .............................................................................................................93
   3.3.2 Dimensions and Definition of Social Capital ........................................95
3.3.3 Social Capital Theories .........................................................................98
   3.3.3.1 Information or the Theory on the Strength of Weak Ties ...............101
   3.3.3.2 Power through Structural Autonomy or the Structural Hole Theory .................................................................................................................103
   3.3.3.3 Power through Social Influence or the Significance of Strong Ties for Different Types of Actors .................................................................105
   3.3.3.4 Solidarity in Groups or the Strength of Strong Ties .................106
   3.3.3.5 Trust in the Prevalence of Norms ................................................106
3.3.4 Application of Social Capital Theories to the Deal Flow of Venture Capital Firms .................................................................................................107
3.4 Research Design ..........................................................................................111
   3.4.1 Description of the Basic Structure of the Research Model .................111
   3.4.2 Measurement of Deal Flow as Dependent Variables .........................114
      3.4.2.1 Deal Flow Quantity ................................................................114
      3.4.2.2 Deal Flow Quality ..................................................................115
   3.4.3 Measurement of the General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow ..............116
   3.4.4 Measures to Characterize the Entire Network Structure .....................117
      3.4.4.1 Components of a Network ......................................................118
      3.4.4.2 Density ....................................................................................119
      3.4.4.3 Transitivity .............................................................................120
      3.4.4.4 Clustering .............................................................................121
      3.4.4.5 Centrality .............................................................................122
   3.4.5 Network Measures as Independent Variables ....................................129
      3.4.5.1 Ego-Network Measures ..........................................................130
         3.4.5.1.1 Average Strength of Ties .................................................130
         3.4.5.1.2 Structural Hole Measures: Effective Size and Constraint ......................................................................................................................132
      3.4.5.2 Total Network Measures .........................................................137
         3.4.5.2.1 Betweenness Centrality .....................................................138
         3.4.5.2.2 Multiconnectivity ............................................................139
   3.4.6 Firm Attributes ....................................................................................143
3.5 Summary and Detailed Structure of the Research Design .........................144
4 Derivation of Hypotheses .............................................................................146
4.1 Hypotheses on the General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow ......................................................... 146

4.2 Hypotheses on the Connection between Network Measures and Deal Flow .... 152
   4.2.1 Ego-Network Measures ................................................................. 152
      4.2.1.1 Average Strength of Ties ....................................................... 152
      4.2.1.2 Effective Size .................................................................... 154
      4.2.1.3 Constraint ......................................................................... 156
   4.2.2 Total Network Measures ................................................................ 157
      4.2.2.1 Betweenness Centrality ...................................................... 157
      4.2.2.2 Multiconnectivity .............................................................. 158
   4.2.3 Role Analysis ................................................................................. 159

4.3 Summary of Hypotheses ......................................................................... 161

5 Data Collection and Methodological Approach ............................................ 162
   5.1 Data Collection ............................................................................... 162
      5.1.1 Data on Investments of Venture Capital Firms ................. 162
         5.1.1.1 Data Collection and Data Measurement .................. 162
         5.1.1.2 Definition of Network Boundaries ......................... 165
            5.1.1.2.1 Boundaries to Define the Actors ................ 165
            5.1.1.2.2 Boundaries to Define the Relationships .... 172
         5.1.1.3 Description of the Network Data Retrieved ............. 173
         5.1.1.4 Preparation of Data for Network Analysis .......... 178
      5.1.2 Data on the Deal Flow of Venture Capital Firms ............. 179
         5.1.2.1 Questionnaire as Data Collection Method ............ 179
         5.1.2.2 Data Collection Process .............................................. 181

5.2 Statistics in Social Network Analysis .................................................... 183
   5.2.1 Introductory Notes to Using Statistics in Social Network Analysis .... 183
   5.2.2 Overview of Statistical Methods and Selection of an Appropriate Method for this Study ................................................................. 185
   5.2.3 Multivariate Regression Analysis for Social Network Data ........... 187
      5.2.3.1 Estimation Technique and Significance Tests ............ 187
      5.2.3.2 Model Specification ......................................................... 188

6 Results of the Empirical Study .................................................................. 192
   6.1 General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow ................................................................. 192
   6.2 Characterization of the Entire Network Structure .................................. 193
      6.2.1 Components of the Network ............................................... 193
      6.2.2 Density ................................................................................ 195
      6.2.3 Transitivity .......................................................................... 197
      6.2.4 Clustering .......................................................................... 198
      6.2.5 Centrality .......................................................................... 199
   6.3 Connection between Network Position, Firm Attributes, and Deal Flow .... 200
      6.3.1 Descriptive Statistics for the Dependent Variables .......... 200
6.3.1.1 Deal Flow Quantity .................................................................201
6.3.1.2 Deal Flow Quality .................................................................203
6.3.2 Descriptive Statistics for the Independent Variables ...............205
6.3.2.1 Ego-Network Measures and Total Network Measures ........205
6.3.2.2 Firm Attributes ..................................................................208
6.3.2.3 Test for Multicollinearity ...................................................209
6.3.3 Connection between Independent Variables and Deal Flow Quantity..212
6.3.3.1 Effect of Firm Attributes and Ego-Network Measures on Deal Flow Quantity .................................................................212
6.3.3.2 Effect of Firm Attributes and Total Network Measures on Deal Flow Quantity .................................................................214
6.3.3.3 Robustness Checks on Deal Flow Quantity .........................215
6.3.4 Connection between Independent Variables and Deal Flow Quality....218
6.3.4.1 Effect of Firm Attributes and Ego-Network Measures on Deal Flow Quality .................................................................218
6.3.4.2 Effect of Firm Attributes and Total Network Measures on Deal Flow Quality .................................................................220
6.3.4.3 Robustness Checks on Deal Flow Quality ............................221
6.3.5 Role Analysis ............................................................................224
6.3.5.1 Segmentation of Venture Capital Firms...............................224
6.3.5.2 Effect of Roles on Deal Flow Quantity ..................................225
6.3.5.3 Effect of Roles on Deal Flow Quality ....................................226

7 Discussion of the Results and Implications for Management and Research ..........227
7.1 Discussion of the Results ..................................................................227
7.1.1 General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow .................................................................227
7.1.2 Connection between Independent Variables and Deal Flow Quantity..233
7.1.2.1 Effect of Firm Attributes and Ego-Network Measures on Deal Flow Quantity .................................................................233
7.1.2.2 Effect of Firm Attributes and Total Network Measures on Deal Flow Quantity .................................................................242
7.1.2.3 Comparison of the Effects of the Independent Variables on Deal Flow Quantity .................................................................245
7.1.3 Connection between Independent Variables and Deal Flow Quality....245
7.1.3.1 Effect of Firm Attributes and Ego-Network Measures on Deal Flow Quality .................................................................246
7.1.3.2 Effect of Firm Attributes and Total Network Measures on Deal Flow Quality .................................................................251
7.1.3.3 Comparison of the Effects of the Independent Variables on Deal Flow Quality .................................................................256
7.1.4 Comparison of the Effects of the Independent Variables on Deal Flow Quantity and Quality .................................................................257
7.1.5 Role Analysis ............................................................................259
7.1.5.1 Effect of Roles on Deal Flow Quantity ..................................259
7.1.5.2 Effect of Roles on Deal Flow Quality ....................................263
### Table of Figures

| Figure 1.1: | Structure of the study | 7 |
| Figure 2.1: | Overview of financing methods | 10 |
| Figure 2.2: | Functional principle of venture capital | 11 |
| Figure 2.3: | German venture capital market 1997-2004 | 15 |
| Figure 2.4: | Number of inquiries for venture capital and private equity in Germany | 16 |
| Figure 2.5: | European venture capital and private equity market, investments 2004 | 19 |
| Figure 2.6: | Overview of providers of venture capital | 20 |
| Figure 2.7: | Value-generating process of a VC | 30 |
| Figure 2.8: | Rationales for syndication | 37 |
| Figure 2.9: | Search strategies of VCs to generate deal flow | 48 |
| Figure 2.10: | Initiation of contact between VC and portfolio company | 52 |
| Figure 2.11: | Types of social science data and types of analysis | 72 |
| Figure 2.12: | Sociogram: The sociometric star | 78 |
| Figure 2.13: | Forbidden triad | 102 |
| Figure 2.14: | Structural holes and weak ties | 103 |
| Figure 2.15: | Categorization of social capital theories | 108 |
| Figure 2.16: | Basic structure of the research design | 113 |
| Figure 2.17: | Logic to measure deal flow quantity | 115 |
| Figure 2.18: | Example of connected and disconnected graph | 118 |
| Figure 2.19: | Star graph, circle graph, and line graph | 123 |
| Figure 2.20: | Example on effective size | 134 |
| Figure 2.21: | Example for constraint | 136 |
| Figure 2.22: | Extended example for constraint | 136 |
| Figure 2.23: | Positional roles of brokerage | 140 |
| Figure 2.24: | Matrix for the segmentation of VCs | 142 |
| Figure 2.25: | Detailed structure of the research model | 145 |
| Figure 4.1: | Two cases on tie strength | 153 |
| Figure 5.1: | Theoretical options for geographic focus of this study | 167 |
| Figure 5.2: | Format of dataset including investments and investors | 173 |
| Figure 5.3: | Data adjustments based on original data retrieved | 175 |
| Figure 5.4: | Number of venture capital providers with office(s) in Germany | 176 |
| Figure 5.5: | Investments under consideration of geographic location of investors | 177 |
| Figure 5.6: | One-mode investor-by-investor matrix as basis for the network analyses | 179 |
| Figure 6.1: | Allocation of VCs to industry-investment stage-matrix (N=88) | 224 |
| Figure 7.1: | Effective size for ego-networks of VC#043 vs. VC#067 | 237 |
| Figure 7.2: | Ego-networks for VC#095 and VC#225 | 239 |
| Figure 7.3: | Ego-network for VC#095 and ego-networks of its direct contacts | 240 |
| Figure 7.4: | Ego-network for VC#225 and ego-networks of its direct contacts | 240 |
| Figure 7.5: | Ego-network for VC#384 and VC#265 | 248 |
| Figure 7.6: | Ego-network for VC#071 and ego-networks of its direct contacts | 250 |
| Figure 7.7: | Ego-network for VC#095 and ego-networks of its direct contacts | 250 |
Figure 7.8: Examples on betweenness centrality.................................253
Figure 7.9: Examples on multiconnectivity........................................255
Figure 7.10: Roles not increasing deal flow quantity.........................260
Figure 7.11: Role increasing deal flow quantity..............................260
Figure 7.12: Role of coordinator .....................................................261
List of Tables

Table 2.1: Overview of investment stages ...........................................................28
Table 3.1: Overview of perspectives on social networks .....................................70
Table 3.2: Typology of network studies ...............................................................91
Table 3.3: Overview of forms of capital ...............................................................94
Table 3.4: Overview of dimensions of social capital .........................................96
Table 4.1: Hypotheses on the importance of the contact network .....................161
Table 4.2: Hypotheses on effects of network position on deal flow quantity/quality .................................................................................161
Table 5.1: Overview of empirical design of multivariate regression analysis ...191
Table 6.1: Descriptive statistics for measures A, B, C, A', B', C' (N=125) .........192
Table 6.2: Components and number of firms within components (N=234) .......194
Table 6.3: Descriptive statistics for number of investment opportunities (N=92) ...............................................................................................201
Table 6.4: Descriptive statistics for the deal flow quantity measure (N=92) .......202
Table 6.5: Descriptive statistics for the deal rate (N=92) ....................................203
Table 6.6: Descriptive statistics for the deal flow quality measure (N=92) .....204
Table 6.7: Descriptive statistics for ego-network/total network measures (N=92) ...............................................................................................205
Table 6.8: Descriptive statistics for firm attributes (N=92) .................................209
Table 6.9: Correlation matrix for firm attributes and network measures .........211
Table 6.10: Regression models for ego-network measures on deal flow quantity ..............................................................................................213
Table 6.11: Regression models for total network measures on deal flow quantity ..............................................................................................214
Table 6.12: Robustness check for 1998-2001 on deal flow quantity ............216
Table 6.13: Robustness check for 2002-2005 on deal flow quantity ...............216
Table 6.14: Robustness check for subsample of VCs on deal flow quantity ...217
Table 6.15: Regression models for ego-network measures on deal flow quality 219
Table 6.16: Regression models for total network measures on deal flow quality ..............................................................................................220
Table 6.17: Robustness check for 1998-2001 on deal flow quality .............222
Table 6.18: Robustness check for 2002-2005 on deal flow quality ...............222
Table 6.19: Robustness check for subsample of VCs on deal flow quality ....223
Table 6.20: Regression models for role measures on deal flow quantity .......225
Table 6.21: Regression models for role measures on deal flow quality .......226
Table 7.1: Descriptive statistics for deal flow sources (N=125) .....................229
Table 7.2: Hypotheses and results on the importance of the contact network ...232
Table 7.3: Regression model for 'coordinator' vs. 'gatekeeper' on deal flow quantity ..............................................................................................232
Table 7.4: Regression model for 'coordinator' vs. 'gatekeeper' on deal flow quality ..............................................................................................262
Table 7.5: Hypotheses and results on network measures and deal flow .......263
List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BVK</td>
<td>Bundesverband Deutscher Kapitalbeteiligungsgesellschaften - German Private Equity and Venture Capital Association e.V.</td>
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<tr>
<td>CAGR</td>
<td>Compound annual growth rate</td>
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<tr>
<td>EVCA</td>
<td>European Private Equity &amp; Venture Capital Association</td>
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<tr>
<td>GDP</td>
<td>Gross domestic product</td>
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<tr>
<td>IPO(s)</td>
<td>Initial public offering(s)</td>
</tr>
<tr>
<td>LBO(s)</td>
<td>Leveraged buyout(s)</td>
</tr>
<tr>
<td>MBO(s)</td>
<td>Management buyout(s)</td>
</tr>
<tr>
<td>MBI(s)</td>
<td>Management buyin(s)</td>
</tr>
<tr>
<td>PE(s)</td>
<td>Private equity firm(s)</td>
</tr>
<tr>
<td>QAP</td>
<td>Quadratic assignment procedure</td>
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<tr>
<td>VC(s)</td>
<td>Venture capital firm(s)</td>
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<tr>
<td>VIF</td>
<td>Variance Inflation Factor</td>
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<tr>
<td>vs.</td>
<td>versus</td>
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<tr>
<td>WFG</td>
<td>Deutsche Wagnisfinanzierungsgesellschaft</td>
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1 Introduction to the Topic

1.1 Problem Definition and Objectives

Entrepreneurial firms are an important driving power of the economy, inducing growth and innovation.\(^1\) Due to the high uncertainty that the financing of these firms entails, normally they are not funded by traditional banks, but rather by venture capital firms (VC(s)). The German venture capital market has experienced a steep upswing in the 1990's, especially from 1998 until 2001, and a significant downturn from 2001 until 2004. Remarkably, a significant portion of available funds of VCs is not invested and, in addition, this portion increased over the recent years.\(^2\) One major reason for funds not being invested is the challenge for VCs to identify promising investment opportunities they can invest in.\(^3\) Therefore, it is a vital element in the business model of VCs to have a constant stream of investment opportunities they can select from.\(^4\) This stream of investment opportunities is also denoted as the so-called deal flow, for which its quantity and quality can be distinguished. While the quantity of deal flow refers to the number of investment opportunities a VC can select from, the quality of deal flow relates to the question whether the investment opportunities satisfy the investment objectives and criteria of the VC.\(^5\)

One of the sources, from which a VC receives information on potential investment opportunities, is its contact network.\(^6\) The contact network comprises sources of information such as other VCs, universities or research centers, banks or investment banks, private contacts, and others. In terms of deal flow, contacts to other VCs might be

\(^1\) In academic and economic literature it is indisputable that a major part of new jobs are created by young and innovative companies, rather than by large and well-established firms. For the German market, see for example Gerke (1995), p. 11, Drukarczyk (1996), pp. 259-270, or Lessat et al. (1999), pp. 60 ff. For the US market also see Bygrave/Timmons (1992), p. 229; Wetzel (1986), pp. 87 ff.

\(^2\) See, for example, the development of the venture capital market as described in the yearbooks 1998-2005 of the German Private Equity and Venture Capital Association (BVK). The development of the German venture capital market will be described in detail further below. See section 2.1.2.


\(^5\) The study of Vater (2002) is one of the few that distinguishes between deal flow quantity and quality. See Vater (2002), p. 103 and pp. 140 ff.

Problem Definition and Objectives

important due to two reasons: First, VCs are the ones that most likely hear about potential investment opportunities in the market and might be willing to share this information. And second, VCs might be the ones that best know the investment criteria of their peers, so that investment opportunities that are received by referral from another VC can be expected to be of comparably high quality. If one VC refers a potential investment opportunity to another VC, most often, this happens in the form of an invitation to jointly invest in the project. Joint investments of two or more VCs are also denoted as syndicated investments. Based on syndicated investments, relationships between VCs are established, which can be mapped in a network. In this study, this network is denoted as syndication network. Consequently, the syndication network among VCs can be imagined to picture the relationships that exist between the firms.

As briefly introduced above, in practice, a significant portion of available funds of VCs is not invested, one reason for which is the challenge for VCs to identify promising investment opportunities (deal flow). While funds available in the German venture capital market increased from 7.6 EUR billion in 1997 to 45.0 EUR billion in 2004, the portion not invested augmented from 47.4% in 1997 to a peak of 55.1% in 2003, and still remained at a significant level of 54.9% in 2004. These numbers clearly indicate that the topic of deal flow is major challenge for practitioners, i.e., the management of VCs. Given, as briefly sketched above, that the contact network of VCs is important for them to generate deal flow, and given that, within that network, the contacts to other VCs might be a significant source of deal flow, the logical consequence is to systematically analyze the syndication network among VCs and to examine to what extent the network can explain differences in the deal flow of VCs. However, while the aspects referred to above lead to important challenges for the management of VCs, research on VCs and their deal flow seldom addresses these two aspects, i.e., the syndication network and the deal flow. Above all, studies that combine

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7 For now, the term 'project' is used as a synonym for an entrepreneurial firm the VC firm(s) intend to invest in.
8 See, for example, the study of Piskorski (2000).
9 See Williamson (1979b), p. 44 f.
these two areas and quantify the connection between the two topics are sparse.\textsuperscript{10} In their
study, Hochberg, Ljungqvist and Lu (2007) analyze the syndication network of VCs and
the connection to their economic performance as well as to the performance of their
portfolio companies.\textsuperscript{11} They find that better networked VCs, measured by centrality
measures, enjoy a better financial performance. Also, the portfolio companies of these
VCs show a better performance as measured by successful exits and their survival to
subsequent financing rounds. Regarding the topic of deal flow, the authors of the study
approximate the general existence of investment opportunities by using book-to-market
and price-earnings-multiples. Since multiples partially are driven by the specific market
situation, they also reflect the prevailing market mood. As further research topics the
authors identify the importance of personal relationships between managers in the
venture capital market, the costs that have to be incurred to gain favorable market
positions, or the question how a VC can form relationships with influential VCs in the
network.\textsuperscript{12} The paper of Hochberg, Ljungqvist and Lu (2007) represents a first important
step with respect to network research in the area of VCs.
Since deal flow is a basic prerequisite for the business model of VCs, the present study
builds on existing literature and extends it by specifically analyzing the connection
between the syndication network of VCs and their individual deal flow quantity and
quality. In order to achieve this, the objective of this study is two-fold: In step (a), which
can be understood as a starting point and justification for the second step, the importance
of the general contact network and of the syndication network is being measured. Step (b)
comprises the systematic analysis of the relationship structure of the VCs’ syndication
network, characterizing their individual positions within the network, and the
examination of the network positions’ effect on deal flow quantity and quality.
In order to accomplish goal (a), several measures will be determined that show the extent,
to which VCs in Germany make use of their general contact network (all sources within
\textsuperscript{10} Examples of studies that partially combine the two areas, are Bygrave (1987) or Piskorski (2000).
While Piskorski analyzes the syndication network of VCs, he only employs one network measure
(centrality). However, there are various other measures that capture different aspects of a VC's
relationship structure, which need to be taken into account.
\textsuperscript{11} See Hochberg/Ljungqvist/Lu (2007), pp. 261-263. The study appeared in two earlier versions as
working paper. See Hochberg/Ljungqvist/Lu (2004) and Hochberg/Ljungqvist/Lu (2005).
\textsuperscript{12} See Hochberg/Ljungqvist/Lu (2007), p. 296.
Problem Definition and Objectives

the contact network) and of their relationships to other VCs to generate deal flow quantity and quality. Goal (a) is to be understood as a verification of what has been found for other regions. Since empirical evidence is partially contradictory and not comprehensive for the German market with respect to deal flow quantity and quality, the analyses for goal (a) only represent the starting point of the empirical part of this study and the justification for performing the analyses to achieve goal (b).\(^{13}\)

With goal (a) being the starting point, the main focus of this study is therefore laid on achieving goal (b). By applying formal network analysis to the syndication network of VCs, in a first step, the structural characteristics of the entire network will be described.\(^ {14}\)

In a second step, and more importantly though, the position each VC holds within that network will be identified based on a comprehensive set of specific network measures. The secondary data on the VCs' network positions will then be linked to primary data on the quantity and quality of the deal flow of these firms, and it will be analyzed whether differences in network position can explain differences in deal flow quantity and quality.

In this context, not only the potential benefits for a VC based on its relationship structure vis-à-vis other individual VCs will be looked at, but also the potential benefits a VC has from representing links between different subgroups of VCs.

From a theoretical perspective, this study delivers a thorough examination of how VCs in the German venture capital market make use of their contact network, their contacts to other VCs, and how the relationship structure of VCs within the syndication network affects their deal flow quantity and quality. From a practical perspective, it will be derived, which network positions are beneficial for receiving a higher deal flow quantity and quality. Also, recommendations for VCs are deduced, laying out to whom they need to be connected to (through syndicated investments) and how, in turn, these contacts need to be connected, in order to increase deal flow quantity and quality.

\(^{13}\) As will be shown in later chapters, also for analysis (a), hypotheses will be derived in order for this study to comprehensively cover the topic.

\(^{14}\) From a technical perspective, this step is necessary to prepare the network data for further analyses. From a practical standpoint, this step makes sense in order to get a feeling for the overall structure of the entire network of syndication relationships.
1.2 Methodology and Structure of the Study

This study employs a research approach, which combines analytical deductions and theoretical arguments with empirical work: Based on theoretical explanations applied to the venture capital market and to the context of the syndication network, hypotheses will be derived. In the following, these hypotheses will be verified or falsified empirically. The hypotheses contain statements on how certain network properties will affect the quantity and quality of the deal flow of VCs. The potential relationship between network position and deal flow will be examined by multivariate regression analysis in multiple models. Thereby, this study clearly exceeds currently available research for the German venture capital market, but also goes beyond of what is available for other regions.

The study is structured into eight chapters. In chapter one, the problem definition and the objectives of the study are explained. In chapter two, some definitions and basic concepts are introduced. These refer to the venture capital market and to the characteristics of VCs, as well as to the topic of deal flow. In chapter three, the theoretical foundation for this study is laid out. Theories that are commonly applied to financial and capital markets do not sufficiently capture the potential effects of network positions for individual actors. Rather, social network analysis will be applied. Since social network analysis is a field of research, which is mainly unknown to the (economist) reader, some effort has to be spent on introducing this topic. Based on these explanations, specific theories from the social capital concept will be derived as theoretical foundation to analyze the VCs' network with respect to their deal flow. A detailed research design will be developed, building on the theoretical foundations.

Based on the theoretical explanations, in chapter four, hypotheses are derived with respect to two basic questions: First, in order to verify previous research in other regions for the German market, hypotheses are derived on the general importance of the contact network and of the contacts to other VCs for the generation of deal flow quantity and quality. As explained above, this first analysis is to be seen as the starting point and justification for the second part. Second, hypotheses are deduced on how certain network properties affect deal flow quantity and quality. This second part builds the main focus of the study, and again, it looks at how VCs benefit from their contacts to individual other VCs as well as at how VCs benefit from linking certain subgroups.
Chapter five explains the data collection process and lays out the methodological approach employed in this study. The method used to detect the potential connection between network position and deal flow quantity and quality is multivariate regression analysis. However, as will be explained in detail, in network analysis the standard statistical procedures can partially not be applied. Therefore, statistical methods have been developed that allow the application of statistical methods to the analysis of network structures.

While in chapter six the results of the empirical research are reported and described, in chapter seven, these results are discussed and practical implications for the management of VCs and for research are derived. In chapter eight, the study is summarized.

The structure of this study is presented in the overview below:
<table>
<thead>
<tr>
<th></th>
<th>Introduction:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Problem definition, objectives, and methodology of the study</td>
</tr>
<tr>
<td>2</td>
<td>Definitions and basic concepts: Venture capital market, VCs, syndicated investments and the deal flow of VCs</td>
</tr>
<tr>
<td>3</td>
<td>Theoretical foundation: Exclusion of traditional theories on financial markets, application of social network analysis and of social capital theory to the syndication network and deal flow of VC firms</td>
</tr>
<tr>
<td>4</td>
<td>Research design</td>
</tr>
<tr>
<td>5</td>
<td>Derivation of hypotheses: Hypotheses on the importance of the contact/syndication network for deal flow quantity and quality, hypotheses on the effect of network positions on deal flow quantity and quality</td>
</tr>
<tr>
<td>6</td>
<td>Data collection and methodological approach: Data collection process, use of statistics in network analysis, multivariate regression analysis</td>
</tr>
<tr>
<td>7</td>
<td>Empirical research: Importance of contact/syndication network for deal flow (goal (a)), analysis of VCs’ network position within syndication network (goal (b))</td>
</tr>
<tr>
<td>8</td>
<td>Summary of the study</td>
</tr>
</tbody>
</table>

Figure 1.1: Structure of the study

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15 Own illustration.
2 Definitions and Basic Concepts

As a foundation for the further discussion, some definitions and basic concepts regarding the topics of venture capital (section 2.1) and deal flow (section 2.2) have to be explained.

2.1 Venture Capital

2.1.1 Definition of the Term and Venture Capital as Method of Financing

The term 'venture capital' is derived from the English word 'venture', which is defined as "an undertaking involving chance, risk, or danger".\(^{16}\) This definition explicitly contains two meanings: On the one hand, it describes the negative aspect of risk and danger, on the other hand it describes the positive aspect of chance.\(^{17}\) Translations of the term 'venture capital' into German language are not satisfactory, since they either emphasize the aspect of risk ('Risikokapital', 'Wagniskapital') or chance ('Chancenkапital'), but they do not cover both. Therefore, also in German linguistic usage, the term 'venture capital' is well-established.\(^{18}\)

Basically, VCs invest funds of investors in the so-called portfolio companies, which are not yet mature enough to be publicly traded at the point in time when being financed by the VC. Typical business operations of VCs cover investments ranging from seed-, start-up-, and expansion-financing as well as buyouts (management buyouts (MBOs), management buyins (MBIs), leveraged buyouts (LBOs)) and turnaround-or mezzanine-financing. In Anglo-American linguistic usage, the expressions 'venture capital', '(leveraged) buyouts' and 'mezzanine-financing' are included in the superordinate term 'private equity'.\(^{19}\)

In German language, nowadays there is neither a uniform definition nor uniform usage of these terms. While some German authors use the terms analogously to the Anglo-


\(^{18}\) See Welpe (2004), pp. 17 f.

\(^{19}\) See Schefczyk (2004), pp. 17 f.
Definitions and Basic Concepts

American understanding mentioned above, both expressions, 'venture capital' and 'private equity' are often simply used as a synonym for the German word 'Kapitalbeteiligungsgesellschaft'. However, there seems to be a tendency that the term 'private equity' is used besides the term 'venture capital', with 'venture capital' describing investments relating to earlier financing stages and 'private equity' referring to later financing stages such as buyouts and mezzanine-financing. According to this understanding, the German Private Equity and Venture Capital Association (BVK) generally differentiates between venture capital (including seed-, start-up, expansion- and turnaround, replacement- and bridge financing) and private equity (buyouts including MBOs, MBIs, and LBOs). For the purpose of this study, this understanding of the terms is adopted. If used otherwise, explicit directions are provided.

In reference to financing methods and according to the classification of the BVK explained above, venture capital-financing represents a specific form of financing besides private equity-financing, of which further forms are MBOs, MBIs, and LBOs. Besides venture capital- and private equity-financing, funds can also be raised through the public capital market, which is then called public equity. Venture capital, private equity and public equity together constitute equity-financing, which is differentiated from debt-financing.

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21 For example, this understanding is represented in the name of the association of German 'Kapitalbeteiligungsgesellschaften', which, until 2002, was called 'Bundesverband Deutscher Kapitalbeteiligungsgesellschaften – German Venture Capital Association e.V.'. Here, the term 'venture capital' is used synonymously for the word 'Kapitalbeteiligung'. Since 2003, it renamed itself into 'Bundesverband Deutscher Kapitalbeteiligungsgesellschaften – German Private Equity and Venture Capital Association e.V.'. Here, the terms 'venture capital' and 'private equity' are used synonymously to the word 'Kapitalbeteiligungen'. Authors employing this understanding are among others Leopold/Frommann (1998), p. 8; Schefczyk (2004), p. 19.

22 See Schefczyk (2004), pp. 18 f. The different investment stages will also be explained in detail in section 2.1.3.3.


24 Another private equity-financing method is the so-called venture leasing. Further information on this are topic to be found in Kleiman (2001) or Lerner (2001).
Methods of financing

Equity financing

• Seed
• Start-up
• Expansion
• Turnaround/Replacement
• Bridge

Debt financing

• MBO
• MBI
• LBO

Private equity

• Public market for equity capital

Public equity

Figure 2.1: Overview of financing methods

Besides the formal classification of venture capital as financing method, the financing with venture capital is characterized by typical criteria:

**Equity financing:** Since venture capital formally belongs to equity capital, there is no pay back or interest liability for the portfolio company, reducing its risk of insolvency. Instead of equity capital, venture capitalists might also accept bonus shares or participation certificates, an investment without voting rights, or subordinated debt.

**Temporarily limited engagement:** Due to the fact that, in most cases, venture capitalists invest in order to maximize their return on investment, their primary goal is not to generate recurrent earnings through, for example, dividends. Rather, through disinvesting the investment after a certain period of time, they intend to benefit from the increased value of the business.

**Minority interest:** Typically, venture capital providers acquire minority stakes in their portfolio firms. Thereby, the portfolio company remains independent to some extent, and the founders retain the necessary power of decision.

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27 In this study, the term 'venture capitalist(s)' is used synonymously to 'VC(s)'.

28 For further objectives venture capital providers might focus on, see the types of VCs in section 2.1.3.1.
Control rights and co-determination rights: While the founder is formally independent in his decisions, usually, VCs are granted certain rights to control and co-determine important strategic decisions and decisions regarding the use of funds provided. Thereby, it is ensured that the portfolio company does not neglect the interest of the VC.

Management support: In order to secure the appreciation of value of the portfolio company, VCs also deliver non-financial support, i.e., they perform an advisory function in various areas such as topics concerning content, process, operative support, or collaboration in committees or boards.

However, despite the various possible forms of engagement of a venture capitalist vis-à-vis a portfolio company, the way a venture capital financing works, remains, which is illustrated below:

![Diagram of venture capital flow](attachment:image.png)

**Figure 2.2:** Functional principle of venture capital

VCs collect funds from (multiple) investors and spread them to multiple portfolio companies. In addition to financial support, managers of VCs also input their technical know-how and management expertise to support the management of the portfolio company. After exiting the investment(s), the funds flow back to the investors. Of course,

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30 In contrast to collecting funds from multiple investors, there can also be only one investor providing the entire amount. This is the case with captive VCs. Analogously, a VC might also invest in only one portfolio company, which is called a project-oriented investment. See also chapter 2.1.3.1.
in the case of successful exits, a premium gained through the exit flows back to the investors as well.

To better understand the investment behavior of VCs today, it is helpful to examine the development of the German venture capital market, and to also put the German market into comparison to its international counterparts.

2.1.2 Development and International Comparison of the German Venture Capital Market

The development of the German venture capital market started in the early 1960s with the foundation of relatively small VCs through private investors. During that time, a difficult fiscal and judicial business environment characterized the German capital market, paralleled by an adverse attitude and mentality of financiers vis-à-vis the foundation of young and innovative companies. These conditions prohibited a fast expansion of VCs as financial intermediaries in a qualitative and quantitative dimension. Another challenge was the lack of professional and (in high-tech industry) knowledgeable portfolio managers.

During the 1970s, first success stories of venture capital investments in the United States caused German politicians to react. After a long-winded political discussion, 27 banks founded the 'Deutsche Wagnisfinanzierungsgesellschaft (WFG)' in 1975. Predominant objective of the WFG was to economically promote scientific research findings in institutions and companies. Although some authors regard the WFG as origin of the

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31 For an overview of the various exit alternatives used by German VCs, see chapter 2.1.3.4.
32 As will be shown later on, the focus of this study is on VC investments in the German market. This will be explained in detail in section 5.1.1.2.
33 Examples for these early foundations were the 'Indufina-Frankfurt Industrie- und Finanzbeteiligungs-gesellschaft mbH & Co. KG' or the 'BONA-Kapitalbeteiligungs-GmbH'. For further details, see Schefczyk (2004), pp. 113 f; Heynen (1970), pp. 23-25.
35 See Leopold/Frommann (1998), p. 18. Leopold/Frommann also emphasize the importance of practical experience in this field of business.
German venture capital industry, the main focus of investments were medium-sized businesses. Not until the early 1980's, the real venture capital industry in Germany was born. Continuous information on success stories of venture capital investments in the United States and predictions of their micro-economic and macro-economic potential initiated a boom of VC foundations investing primarily in young and innovative businesses. With twice as many new foundations in the 1980's compared to the 1970's, the venture capital industry has experienced a steep upswing.

However, copying the American development to the German capital market proved to be difficult. On the one hand, this was due to the safety-oriented mentality and aversion as to innovations of managers. On the other hand, one major reason was the absence of the exit channel through an initial public offering (IPO). During the 1990's until the year 2000, one could witness a significant acceleration of the German venture capital market. Reasons for this recent development were changes in fiscal conditions, a stimulation of the market for equity capital investments through institutional investors as well as governmental support programs for innovation. Another main driver of the upward development of the venture capital industry was the opening of a new stock exchange segment in 1997 called the 'Neuer Markt', giving VCs the opportunity to exit investments through an IPO. While in 1995 only 36 IPOs occurred in all segments of the German stock exchange, already in 1999, the 'Neuer Markt' comprised of 147 firms.

After the boom period until 2000, from 2001 onwards the capital markets plummeted severely and a phase of consolidation began, which was characterized by low investment.

38 See Lessat et al. (1999), pp. 18 f.
40 A first governmental support program was the 'TOU' ('Förderung technologieorientierter Unternehmensgründungen'). This pilot project from 1983-1988 provided funding to young technology-oriented companies. In the 'BJTU' ('Beteiligungskapital für junge Technologieunternehmen'), VCs could receive funds from 1989-1994 to invest in young technology-oriented businesses. In 1995, the 'BTU' ('Beteiligungskapital für kleine Technologieunternehmen') started, providing funds for VCs that invest in small technology-oriented companies. See Lessat et al. (1999), p. 16. For a work on the significance of venture capital for innovation, see Roling (2001).
volumes and a difficult fund raising and exit environment. From its peak of approximately 8,500 points in March 2000, the NEMAX, i.e., the stock exchange index for the 'Neuer Markt' segment, came down to 359 points in February 2003, equivalent to a 95% decrease. As a consequence, the 'Neuer Markt' was abolished at the end of 2003.

In chapter one, it has been mentioned that one of the challenges for VCs today is to identify promising investment opportunities. This study shall help to improve this situation by analyzing how more and potentially promising deals can be identified. One of the preconditions to improve that situation is, of course, that VCs dispose of the necessary funds to invest. Looking at the development of the German venture capital market, it becomes obvious that the availability of funds is not the limiting factor. Actually, a large portion of available funds is not invested, as presented in figure 2.3 below.

Funds invested increased from 4.0 EUR billion in 1997 to 20.3 EUR billion in 2004 with a compound annual growth rate (CAGR) of 26.1%. Total funds available show an increase from 7.6 EUR billion in 1997 to 45.0 EUR billion in 2004 with a CAGR of 28.9%. What is important is that the share of funds not invested (of total funds available) increased from 47.4% in 1997 to 54.9% in 2004 (CAGR of 2.1%).

This development underlines two aspects: First, in line with previous explanations, the increase in the share of funds not invested is due to the restricted investment behavior of VCs after 2001. Second, and more important in the context of this study, it shows that the German venture capital market still has a considerable potential for investments. Reasons for this could be that either promising investment opportunities do simply not exist, or that they exist but that VCs are not able to identify them. This challenge VCs are facing is also reflected in the figures presented in figure 2.4.

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43 See the preface in BVK (2002).
44 The compound annual growth rate is calculated as the average year-over-year growth rate.
Figure 2.3: German venture capital market 1997-2004

The figures show a steep increase until 2001 (from 16,500 in 1997 to 90,500 in 2001) and a severe decrease can be recognized from 2001 until 2004, with the number of inquiries declining to 32,700. In contrast to the boom phase until 2001, the time afterwards is characterized by fewer inquiries and with increasing funds available, which results in the phenomenon of "too much money chasing too few deals". In such a situation, identifying promising investment opportunities (deal flow) becomes even more important for VCs.

The present study shall contribute to analyzing and developing options to improve the way how to think about generating deal flow.

From a macro-economic perspective, the necessity to improve the VCs' ability to access or identify investment opportunities also becomes obvious when considering the development of the investments into the various financing stages, as presented in figure 2.5. Before 1997, investments of German VCs are characterized by a rather conservative investment behavior, represented by a considerable share of expansion financing (47.6% in 1997). Fueled by the market upswing from 1997 until 2000, the comparatively riskier seed- and start-up financing experienced a steep increase from a share of 15.1% in 1997 to 34.7% in 2000.

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47 This phenomenon has been described by Kaplan/Stein (1993), p. 313; Gompers/Lerner (2000), p. 282.
Even stronger than the increase was the decline after the year 2000, with the share dropping to 9.4% in 2004. At the same time, since 2000 the share of MBO/MBI/LBO

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investments rose significantly. This evolution nicely reflects the change in investment behavior by German VCs, shifting the investment focus to early-stage investments during 1997 to 2000, and to later-stage investments after 2000.

Based on these figures and based on the initial statement in this study, i.e., that entrepreneurial firms are an important driving power of the economy, it becomes obvious that the financing stages 'seed/start-up' and also 'expansion' need to be developed. One approach is to help VCs improve the ways to identify promising investment opportunities.

In order to get a feeling for the size of the German venture capital market in an international context, in the following it is related to the European and the US market. As shown in the following figure, in a European comparison of investments, the UK claims 51.7% of total investments of 36,921 EUR millions in 2004, followed by France (14.2%), Germany (10.2%), Spain (5.3%), the Netherlands (4.5%), Sweden (4.4%), and Italy (4.0%). The rest (5.7%) is represented by other European countries. In terms of the total market, i.e., the capital under management (invested funds), nearly the same picture is drawn. Of the total invested funds of 156.1 EUR billion, the UK accounts for 59.8 EUR billion, followed by France (25.5 EUR billion), Germany (20.3 EUR billion), Italy (12.4 EUR billion), and the Netherlands (9.0 EUR billion).

In comparison to the European market, the US market for venture capital and private equity is about 1.3 times as large (capital under management in the US of 209.9 EUR billion compared to 156.1 EUR billion in Europe). Regarding investments in 2004, Europe accounts for 36.9 EUR billion whereas the US accounts for 16.9 EUR billion. With respect to the gross domestic product (GDP), it appears that investments in Europe stand for approximately 0.35% of the GDP whereas in the US this value equals approximately 0.18%. However, total funds invested in the US account for approximately

49 Not shown in the figure, the predominant driver of this development were investments in LBOs. See BVK (2001), p.73; BVK (2005c), p. 7.


51 See BVK (2005e), p. 12. Data is provided in US $ (invested funds of 260.7 US $ billion and investments of 20.993 US $ billion) and has been converted by the author with the US $-EUR average interbank rate for 2004 (1 US $ = 0.8051 EUR). Source for the interbank rates was www.oanda.com.
2.2% of the GDP, while in Europe this value only equals approximately 1.5%, and for Germany approximately 0.9%.\footnote{The values in comparison to the GDP are own calculations based on the investment volume and the volume of invested funds for Germany, Europe, and the US (sources given above). For GDP values see World Bank (2005).}

![Figure 2.6: European venture capital and private equity market, investments 2004\footnote{Source: EVCA yearbook 2005.}]

Especially in comparison to the US market, it appears that the venture capital market in Germany is underdeveloped. Again, significant funds exists, that need to be activated, and one way to help this be done is to find ways how VCs can identify more and promising investment opportunities, which is the goal of this study.

To get an understanding of the firms being active in the venture capital market and of their investments, i.e., portfolio companies, these will be elaborated on in the next section.
2.1.3 Venture Capital Firms and Portfolio Companies

2.1.3.1 Types of Venture Capital Providers

As illustrated in figure 2.2, VCs act as intermediaries between capital providers and seekers of venture capital. They can be differentiated according to various criteria, such as the ownership structure, according to their degree of specialization regarding industries or the phases of a company’s lifecycle they invest in, or the degree of management support provided. However, while these classifications are partially not free of overlaps, it can be distinguished whether there exists a direct or indirect investment contract between capital providers and capital seekers. This systematic is illustrated in the figure below:

![Figure 2.7: Overview of providers of venture capital](image)

In the former case, capital provider and capital seeker directly enter an investment contract. Capital providers of direct investments are wealthy private investors, which are denoted as the so-called business angels.

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54 The different investment stages will be explained in section 2.1.3.3. Also in this study, an analysis will be performed based on the classification of VCs into a 2x2-matrix with one dimension referring to the industry focus, and the other dimension being the focus on investment stages. See sections 3.4.5.3 and 6.3.5.1.

55 For detailed discussion on the specialization of VCs, see Sorenson/Stuart (2001), pp. 1562 ff.; Norton/Tenenbaum (1993), pp. 431ff. Further information, for example, on management support provided, see Zider (1999), p. 46; Fredrikson et al. (1990), pp. 503-505; Gifford (1997), pp. 459 ff.

56 For example, publicly held VCs may virtually act like a privately held VC.

57 For further information on details of investment contracts, see Schefczyk (2004), p. 27 and pp. 46-56.


59 For an excellent overview of and study on the informal venture capital market in Germany, see Brettel (2004). On a comparison of business angels and VCs and the Scandinavian market, see, for example,
In the case of indirect investments, VCs act as intermediaries between the original capital providers and portfolio companies. This is also referred to as formal venture capital. According to the definition of the BVK, in independent VCs, no shareholder owns more than 20% of the shares, in semi-captive firms at least one owner holds between 20% and 50% of the shares, and in captive firms one owner accounts for more than 50% of the company's shares.

Independent VCs actively raise funds from multiple investors such as pension funds, industrial firms, insurance companies, or banks. These capital providers regard their investment as one of many investment alternatives with the objective to maximize the return on investment. However, independent of their investors, these VCs can autonomously decide upon their investments, the reason for which they are called 'pure' intermediaries. 'Impure' intermediaries can be grouped into captive and semi-captive VCs. Captive VCs comprise legally independent subsidiaries of industrial firms or of financial institutions. Investment decisions are not made independently from the parent company, since this is the exclusive provider of funds. Normally, members of the parent company and of the
captive VC together come to an investment decision. Corporate VCs often invest not only to maximize the financial return, but also due to strategic reasons. These include, for example, access to new and innovative technologies and resources, access to distribution channels, or the chance to win the young company as a future business partner. In addition, often the results of scientific research done for and by start-ups are of special interest for larger corporations.

In contrast to captive VCs, funds raised in semi-captive VCs originally come from multiple investors. As in captive VCs, decisions are made by an advisory council, to which managers of the VC and of the capital-providing firms belong. However, in most cases, the maximization of financial return is the primary objective. One particular kind of semi-captive firms are governmentally-funded VCs. In most cases, shareholders of these firms are governmental authorities that do not primarily invest in order to maximize the return on investment but to support and promote the economy, often with a regional focus. Therefore, these companies also perform an economic-political mission.

Besides through indirect investments, venture capital can be directly transferred from a wealthy private investor (business angel) to the portfolio company without interposing an intermediary from the standardized or formal venture capital market. Business Angels invest their private capital as equity capital in young, innovative businesses. Although this type of investments is not new, business angels and their investments have received

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64 See Zemke (1995), p. 85. Sometimes, according to Zemke (1995), the term 'captive VC' solely refers to financial institutions. However, since both, VCs of industrial firms and of financial institutions, are owned by the parent company by the majority (more than 50% of the company's shares), both forms are included into 'Captives' for the purpose of this study.

65 See Schefczyk (2004), p. 71. For further literature on this topic, see Gompers/Lerner (1999); Maula/Autio/Murray (2005); Siegel/Siegel/Macmillan (1988); Hagleitner (2000); Ollig (2001).


69 For an excellent overview of the informal venture capital market in Germany, see Brettel (2004). Also see Brettel/Jaugey/Rost (2000).

70 Examples of firms, that have meanwhile developed into large international companies, are Ford and the former Mannesmann. Henry Ford and the Mannesmann family have both been supported by business angels. Also, Christoph Columbus has been financed by private investors, who participated in the risk of a loss as well as in potential goods. See Leopold/Frommann (1998), p. 8; Gaston (1989), p. 2; Tschammer-Osten (1996), pp. 718 f.
significant attention in academic literature over the last 25 years. Business angels differ significantly from formal investors with respect to investment motives, invested volumes, stages of investment and expectations regarding the return on investment. They prefer to invest in very early stages of a business, especially with a focus on start-ups with innovating technologies.  

Often, the primary objective is not to maximize the return on their investment but to participate in the founding and development of a business or technology, enjoying the fun they gain from helping the founders. Since business angels are often wealthy individuals with an entrepreneurial or management background, they are able to support the founders with their know-how and expertise. However, for the purpose of this study, it is abstracted from the group of business angels, so that the focus is laid on the formal venture capital market.

2.1.3.2 Characteristics of Portfolio Companies

In order to get a common understanding of companies qualifying for a financing with venture capital, it is necessary to consider both, the needs of the potential portfolio company and the requirements of the venture capital provider. As to the requirements of the VC, one predominant demand becomes obvious, i.e., the growth potential of the young business. VCs typically intend to exit their investments after a certain period of time, which is approximately 5-10 years. Therefore, a precondition is that during this time period, the portfolio company's value needs to increase significantly in order for the venture capitalist to be a profitable exit opportunity. In academic literature though, there is no general definition of what exactly a growth company is. Rather, a


72 These business angels are called 'entrepreneurial angels'. Besides these, there are also 'virgin angels', 'latent angels', 'income-seeking-angels', and 'corporate angels'. For details on this classification of business angels, see Stevenson/Coveney (1994), pp. 5 ff.


74 A possible categorization is provided by Bygrave (1997) and Timmons (1999). They group growth firms into three categories: Lifestyle ventures characterized by low growth potential, high-potential-ventures showing very high growth potential, and middle-market-ventures described by a growth potential somewhere in the middle between the other two. See Bygrave (1997), pp. 185 f.; Timmons (1999), pp. 420 f. In contrast to Bygrave, Timmons calls the third group 'foundation firms'.
growth company can be described based on its needs and further aspects characterizing them.

A potential categorization is provided by Bygrave (1997) and Timmons (1999), who group young growth firms into three categories: Lifestyle-ventures, high-potential-ventures, and middle-market-ventures. Lifestyle ventures are characterized by low growth potential, high-potential-ventures by very high growth potential, and middle-market-ventures are assigned somewhere in-between lifestyle ventures and high-potential-ventures with respect to their growth potential.\(^75\)

With respect to the needs of the portfolio company, two aspects are characteristic. First, due to the fact that in most cases the possibility of self-financing out of cash-flows is not feasible, the young firm requires an external financing. However, neither a financing with debt capital nor with equity capital through the public capital market is feasible.\(^76\) Second, the management of the firm is often comprised of the founders of the business, who have specific technological knowledge. They (and also their business model) frequently do not have a proven track record of management performance and need significant support in managing their firm due to a lack of managerial expertise. This can be provided by the VC.\(^77\)

Besides these two basic characteristics of venture capital-financed firms, potential portfolio companies often intend to achieve fulfillment of three further conditions regarding their cooperation with a VC: First, if possible, they prefer minority stakes held by venture capitalists in order not to lose their independence. In addition, of course, the founders would like to benefit most from economic success.\(^78\) Second, portfolio companies prefer to have the possibility to retain potential profits, primarily in order to achieve and secure a solid financial basis.\(^79\) Third, potential portfolio companies intend to

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\(^75\) See Bygrave (1997), pp. 185 ff.; Timmons (1999), pp. 420 ff. In contrast to Bygrave, Timmons calls the third group 'foundation firms'.


\(^77\) See Gompers/Lerner (1999), p. 128; Achleitner/Bassen (2001), pp. 9 ff. As to the track record, note that, for example, companies that were listed at the Neuer Markt in 2000, have existed for approximately 5 years. See Achleitner (2000), p. 248.


initially receive temporarily unlimited financing. However, often, founders are also interested in certain rights to buy back the shares from the VC.\footnote{See Arnold (1989), pp. 211 ff. An early buy back of the shares is often restricted to the existence of specific reasons, which have been defined beforehand, or to potentially long cancellation periods. See Schefczyk (2004), p. 37.}

As mentioned above, potentially promising young businesses VCs invest in can be in various stages of a company's lifecycle. Based on the phase of the lifecycle the portfolio company is in, various investment stages can be differentiated. Because this study will focus on some of them but not on all,\footnote{Which of the investment stages are focused on will be explained in detail in section 5.1.1.2.} the various investment stages are explained in the following section to get a common understanding.

### 2.1.3.3 Investment Stages

Although there is partially no consistent classification of the investment stages a VC can invest in, German literature basically has adopted a differentiation into eight stages:\footnote{This categorization is also used by the BVK. See BVK (2005c), pp. 35-36.}

**Seed:** This first stage is characterized by the promotion of the original product idea or proposal of the potential founders of the venture business to-be. Main focus is put on the development of the business model and a first prototype. By primarily investing in research and development activities, utilizable results are to be achieved.\footnote{See Rams/Remmen (1999), pp. 687 ff. Also see Wupperfeld (1994).} Major challenges during this phase are the balanced and sustainable evaluation of the product idea and of the market environment as well as the extent of the management support needed.\footnote{See Schefczyk (2004), pp. 41-42; Frommann (1991), p. 733.} All activities during this stage aim at preparing the venture for its official foundation.

**Start-up:** This stage refers to financing of venture business' foundation. The required capital is employed for initial marketing efforts as well as the preparation of production.\footnote{See Beyel (1987), p. 658.} At this point in time, the newly-founded firm has not yet started or recently begun to sell its products or services on the market. Establishing trust to the involved venture capital
producers and the recruiting of qualified personnel represent major challenges during this stage.\footnote{See Schefczyk (2004), pp. 41-42; Frommann (1991), p. 733.} By taking up personal loans, receiving financial support from governmentally-funded loan programs, or by establishing cooperations to other businesses in related industries, entrepreneurs may significantly incite VCs and thereby compensate for potential deficiencies, for example regarding the business plan.\footnote{See Nevermann/Falk (1986), p. 74. Sometimes, the terms 'first stage', 'second stage', and so on, are used in literature as well. See Leopold (1993), p. 356. However, since these expressions are partially also used for the expansion stage (see Weitnauer (2001), pp. 10-11.), they are not applied here.}

**Expansion:** Some authors, for example Rams and Remmen (1999), Leopold (1993), or Weitnauer (2001)\footnote{See Rams/Remmen (1999), pp. 687-691; Leopold (1993), pp. 345 ff.; Weitnauer (2001), pp. 10-11.} refer to the terms 'first stage', 'second stage', and so on. Due to this inconsistency with respect to other literature, the more concrete terminology as given, for example, in Schefczyk (2004), Frommann (1991), or the BVK is adopted. During this stage, investments are directed to expand the production of the business, which finds itself approximately at the break-even-point. Emphasis is put on product modifications and product differentiation as well as on the increase of the company's market share. Major challenges are the establishment of an image and positioning in the market as well as the raising of debt capital. Despite a strong interest of VCs in seed-, start-up-, and expansion-financings during the period from 1997 until 2000, the investment focus has shifted to later stages in recent years.\footnote{Also see the development of the (German) venture capital market in chapter 2.1.2. See also Nevermann/Falk (1986), pp. 79-80; Schmidtke (1985), pp. 136 ff.}

**Bridge:** In bridge financings, funds invested are employed to prepare or 'bridge' the time period until the disinvestment of the VC. Above all, these financings help to set up the venture business to be taken public in an IPO or to promote the growth of the company, resulting in an improved positioning vis-à-vis an industrial investor in a trade sale.\footnote{See Nevermann/Falk (1986), pp. 79-80; Schmidtke (1985), pp. 136 ff.} Challenges regarding the organizational structure and processes as well as a strengthened competition on product markets are critical factors during this phase. Often, bridge financings are provided by the banks accompanying the IPO in the form of the so-called
mezzanine capital, being an intermediate form of capital in-between equity and debt capital.  

**MBO/MBI:** The MBO or MBI refer to the takeover of a company by the internal (MBO) or external (MBI) management. In MBO/MBI transactions, often the lack of financial resources and cohesion of the management team represent particular challenges. In an MBO/MBI the management holds at least 10% of the company's shares.

**LBO:** In an LBO, investors take over the company while the management does not hold more than 10% of the company's shares. In an LBO, the company takes on a significant amount of debt, which should be paid back over a comparably short period of time.

**Replacement Capital:** This form of financing refers to the acquisition of company shares from an existing shareholder, i.e., from an existing equity capital investor.

**Turnaround:** In a turnaround financing, a company receives funds after having overcome significant economic difficulties, for example a downturn in sales. At this point in time, the investment aims at promoting the economic constitution of the company.

A condensed illustration of these investment stages is given in table 2.1.

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91 For a discussion of financing with mezzanine capital, see, for example, Gereth/Schulte (1992); Golland (1999).


93 See Frommann (1993), pp. 444-446.

94 See BVK (2005c), p. 36.


While the so-called 'early stage' comprises the seed- and start-up stages, bridge financings as well as MBO/MBI transactions are considered to be 'late stage' financings. Expansion stage financings are classified to be in-between early stage and late stage investments. Although increasingly being offered by VCs, LBOs and replacement capital are, by its definition, not strictly allocated to venture capital financings. The comparably large late stage financings are also referred to as private equity. Turnaround financings represent a special case of financings by VCs. However, they cannot be integrated into this chronological development of investment stages.

So far, a common understanding has been established as to the types of firms being active in the venture capital market, the characteristics of the portfolio companies, and the

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98 For an explanation of the different uses of the terms 'venture capital' and 'private equity', also see chapter 2.1.1.

various investment stages a VC can invest in. In addition, what is important to understand, is the value-generating process of a VC. Since this study will analyze the deal flow of VCs, and since deal flow is one part of that value-generating process, it is helpful to put that part into the bigger picture of the entire value chain.

2.1.3.4 The Value Chain of Venture Capital Firms

The value-generating process of a VC can be divided into pre- and post-investment activities, comprising six stages as presented in figure 2.8.

With respect to the first stage of the business model, communicating the investment strategy vis-à-vis potential investors and acquiring funds are the main activities. Since captive and semi-captive VCs receive the funds from their single or a few investors, this stage of the value-added process is mainly performed by independent VCs. At the beginning of the value-generating process, the venture capitalist aims to convince potential capital providers of an investment in the VC. However, this stage of the process should simply satisfy the need to acquire funds for investments at a later point in time.

In the next phase, 'deal flow', the focus of activities is the identification of potential investment opportunities and the gaining of access to information about these firms. To generate deal flow, there are generally two possible ways a VC can follow. First, the venture capitalist can engage in direct marketing activities, for example, participate in conferences or seminars, or issue advertisements or articles in industry magazines. Secondly, the VC may use its contact network comprising private contacts such as family and friends or professional contacts such as other VCs, banks, consultants, investment clubs, etc. Since the present study focuses on this stage of the value chain, i.e., on the analysis of the deal flow of VCs, a more detailed description and analysis will be provided in section 2.2. However, looking at the stages of the value chain of VCs, here it should already be noted that, besides the acquisition of funds, the generation of deal flow constitutes a central prerequisite for the business model to function.

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### Pre-investment activities
- **Acquisition of capital**
  - Communication of investment strategy
  - Acquisition of funds
- **Deal Flow**
  - Identification and contacting of potential portfolio companies
  - Access to information about potential portfolio companies
  - Eventually first contact
- **Screening and Due Diligence**
  - First check
  - Pre-screening to check business concept and key parameters
  - Eventually detailed analysis
  - Eventually letter of intent
- **Negotiation of investment and contracting**
  - Negotiations of key determinants of investment
  - Eventually closing of deal by contracting

### Post-investment activities
- **Management support**
  - Support by consulting on operative and strategic questions
  - Securing of interests of capital providers through controlling and monitoring
- **Exit/Disinvestment**
  - Complete or partial disinvestment

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**Figure 2.8: Value-generating process of a VC**

After the deal flow has been generated, the due diligence is mostly organized as a multi-staged process, which results of two conflicting aspects: On the one hand side, a detailed analysis of the potential portfolio company is necessary to comprehensively evaluate the investment and to assess the often high uncertainty implicit in newly-founded businesses. On the other hand, this detailed analysis is costly and is therefore only feasible and reasonable in cases, for which there is also a high probability that an investment will actually be made. The multi-staged process is divided into three basic steps.\textsuperscript{104} In a first one, the VC performs a first check upon reception of the investment opportunity, i.e., whether the business concept and key parameters of the potential portfolio firm are in line with its overall investment strategy and objectives. In case of a positive evaluation, in a second step the venture capitalist conducts a preliminary screening.\textsuperscript{105} Again, in case of a positive evaluation, a more detailed due diligence follows, including meetings with the entrepreneur, on-site-visits, and an analysis eventually supported by external consultants such as lawyers, auditors, etc.\textsuperscript{106} If the venture capitalist comes to a positive result, a so-called letter of intent concludes the due diligence phase.\textsuperscript{107}

In a next phase, key determinants of a potential investment are negotiated between the VC(s) and the portfolio company. The key determinants include the investment conditions, the prices of the shares, a company valuation, and the final capital requirements of the potential portfolio firm. In case of successful negotiations, the deal is closed.\textsuperscript{108}

Following the closing of the deal, post-investment activities in the form of management support begin. Besides providing the necessary capital, VCs also provide non-financial support, with which they intend to achieve two basic objectives: First, they try to secure and increase the value of the investment (capital gain). Second, they aim at minimizing the risk of insolvency by constantly providing management support and by controlling


\textsuperscript{105} Key parameters include an evaluation of the management team, product, market, revenue, profitability, etc. Eventually, further documents are requested from the potential portfolio firm. See Stuart/Abetti (1990), pp. 151 ff.; Schefczyk (2004), p. 45. At the same time it is checked whether there is a potential conflict of interest to other portfolio firms. For a discussion on this aspect, see Bygrave et al. (1998).

\textsuperscript{106} See Tyebjee/Bruno (1984), pp. 1053 f.


\textsuperscript{108} For further details and discussions of this stage of the value-generating process, see Wupperfeld (1996), pp. 58 ff.; Schröder (1992), pp. 194 ff.; Cimbal (1995), pp. 149 ff.
and monitoring the development of the portfolio company. Providing non-financial support therefore represents an important means of securing and influencing the success of the venture business.\footnote{See Wupperfeld (1996), p. 60; Schefczyk (2004), p. 54. For the importance of non-financial support as means of influencing the success of the venture, see Fredriksen et al. (1990), pp. 258-261; Cable/Shane (1997), pp. 145-156.}

The final stage of the value chain of a VC is the exit or disinvestment, for which five potential exit options can be differentiated:\footnote{See Schefczyk (2004), pp. 57-60. For further detailed descriptions of exit alternatives, see Schröder (1992), pp. 251-266; Cimbal (1995), pp. 173-191.}

\textit{Trade sale:} The portfolio company is sold to an industrial investor. Normally, the buyer is a well-established, comparably large firm, operating in the same or related industry. There are several advantages to trade sales: Firstly, buyers often invest for strategic rather than profitability reasons, resulting in the fact that also portfolio firms with moderate growth and profitability expectations can be sold. Secondly, transactions can be closed fairly quickly due to the low number of involved parties and due to the fact that often, portfolio companies are easily identifiable in the market, resulting in low search costs for the investor.

\textit{Buy back:} The company's shares are bought back by existing shareholders. A commonly occurring challenge with buy backs is that existing shareholders often do not dispose of the necessary financial resources to finance the deal. Since buy back transactions often yield comparably low profits for the VC, the latter do not prefer this exit option. However, governmentally-funded VCs frequently use this exit channel.\footnote{See Schröder (1992), p. 262.}

\textit{Secondary purchase:} In a secondary purchase, the venture business is sold to another VC or to a financial institution. For this exit option, usually the agreement of the portfolio company is required. However, this exit option is not used very frequently.\footnote{See Schefczyk (2004), pp. 57 f.}

\textit{Going public:} The shares of the portfolio company are sold at the stock exchange by taking the company public. This exit channel is regarded as the most interesting possibility since it may provide the venture business with significant cash funds. Often, this channel is simultaneously used to increase the company's share capital. Despite these
advantages, taking a company public also means significant reporting and publicity requirements regarding, for example, costs and risks of the venture business. While this exit option was very lucrative, especially in the time period from 1997 to 2000, since then chances for a profitable IPO have reduced significantly. Liquidation: Usually, this exit option refers to a total loss of the investment. Due to an unexpected aberration, the liquidation is effected as a depreciation within the VC.

As has been explained, deal flow, i.e., the identification of potentially promising investment opportunities, is a fundamental phase in the value chain of VCs. One of the sources, from which a VC receives information on potential investment opportunities, is its contact network. The contact network comprises sources of information such as other VCs, universities or research centers, banks or investment banks, private contacts, and others. As to the source 'other VCs', most often, if one VC refers a potential investment opportunity to another VC, this happens in the form of an invitation to jointly invest in the project. Joint investments of two or more VCs are also denoted as syndicated investments.

Because one of the goals of this study is to closely examine the VCs' position within the syndication network, several concepts as to the aspect of syndication need to be explained. First, the term 'syndication' will be defined. Second, it will be referred to the roles of the so-called lead-investor and co-investor within a syndicated investment. And third, the general rationales why VCs syndicate at all will be described.

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113 Regarding disinvested investments, the share of IPO peaked in 1999, representing 17.4% of the total volume. From then onwards until 2004, this percentage declined to 5.9%. See the BVK statistics and yearbooks 1998-2005.

2.1.4 Syndicated Venture Capital Investments

2.1.4.1 Definition of Syndication

The term syndication refers to the combination of multiple parties in a syndicate, while the term syndicate can have different meanings. Firstly, it describes "... a loose association of racketeers in control of organized crime." Secondly, it denotes a very strict form of a price cartel. Thirdly, and in line with the original French term 'syndic', it refers to a combination of companies or persons to carry out some commercial undertaking or, even more precisely, "... a group of persons or concerns who combine to carry out a particular transaction."

From an economic viewpoint, the concept of syndication is applied in a variety of contexts such as in the area of investment banking or in the insurance industry. For example, Wilson (1968) defines the term as "... a group of individual decision-makers who must make a common decision under uncertainty, and who, as a result, will receive jointly a payoff to be shared among them." According to this definition, in a financing context, multiple capital providers may commonly make a decision on an investment or financing while sharing potential profits or losses resulting from the undertaking.

Regarding venture capital investments, the term 'syndication' therefore refers to the common investment of multiple venture capitalists in a portfolio company. In literature and also in this study the terms 'syndication' and 'co-investment' are used synonymously.

115 The etymologic origin of the word syndicate is a combination of the Greek words 'syn', meaning 'together', and 'dike', meaning 'judgement' or 'justice'. Together they form the word 'syndikos', describing a 'public advocate'. See Harper (2001): Online Etymology Dictionary, date of access: October 14, 2005.
119 See Wilson (1968), pp. 119 f.
investment in a portfolio company combined with a collaboration during the investment period and a sharing of potential profits or losses when disinvesting.\textsuperscript{122} There are multiple ways how the situation of co-investments can develop. For example, it could be that the VCs under consideration commonly decide whether to invest or not. In another case, one VC may invest alone in an early stage, inviting one or more VCs to join the investment at a later stage. However, some authors do not regard the latter case as syndication because their very narrow definition of syndication involves that VCs have to make a common decision on an investment.\textsuperscript{123} Still, with respect to the generation of deal flow, the offer of a VC to join an investment of course also represents an investment opportunity (deal flow for the invited VC), even if the original VC has already invested at an earlier point in time. Therefore, for the purpose of this study, a broader definition of syndication is adopted, also regarding investments as syndicated, in which one or more VC(s) invests first, inviting one or more further VC(s) at a later point in time. Along these lines goes a more recent definition of Brander, Amit and Antweiler (2002), defining syndication as either two or more VCs sharing a particular round of financing, or different VCs investing in a portfolio company at different points in time.\textsuperscript{124}

2.1.4.2  \textit{Lead-Investor and Co-Investor}

In case of syndicated investments, usually one VC acts as the so-called lead investor, the others as co-investors. The lead investor plays a vital role in the development of the business, especially in the early stages of a company. Weitnauer (2001) distinguishes between the formal and the material function of a lead investor.\textsuperscript{125} Regarding the formal role, which is particularly important in cases, in which the young business intends to take up a governmentally-funded loan, a lead investor is often required as a condition of the governmental support program. In this context, the lead investor is required to invest at


\textsuperscript{124} See Brander/Amit/Antweiler (2002), p. 424.

\textsuperscript{125} See Weitnauer (2001), pp. 251 f.
least as much as the provider of public funds. Furthermore, the lead investor has to control and report to the public funds provider on a regular basis.\(^\text{126}\) As to the material role, the lead investor usually provides a significant share of the capital needed and also performs most of the management support.\(^\text{127}\) In addition, the lead investor also represents the young business and, based on the standing of the venture capitalist in the capital markets, stands for its creditworthiness.\(^\text{128}\) Besides providing a significant part of the necessary capital and besides fulfilling the condition for governmental support programs, the lead investor might also make use of its contact network, deliver specific know-how, and act as a sparring partner for the management of the portfolio firm.\(^\text{129}\) Due to these reasons, the choice of an adequate lead investor often is crucial for the success of the newly-founded business.

2.1.4.3 General Rationales for Syndication

The phenomenon of syndication and syndicated venture capital investments has attracted growing interest in scientific studies mainly within the past two decades.\(^\text{130}\) The general question is why venture capitalists syndicate investments at all. When deciding whether to co-invest with other investors, VCs have to trade off the potential benefits from syndicating with the costs incurred through the syndication.\(^\text{131}\) Costs incurred are two-fold, i.e., on the one hand, profits gained from the investment have to be shared among

\(^{126}\) In this context, Weitnauer (2001) indicates the lead investor to be playing two roles. On the one hand, she invested a significant amount in the portfolio company; on the other hand, she has to report to the public funds provider about the economic status of the portfolio company. See Weitnauer (2001), p. 251.

\(^{127}\) The lead investor usually provides a larger share of equity capital compared to co-investors. See Wright/Lockett (2003), p. 2090. Furthermore, the lead investor spends more time supporting the portfolio company than the co-investors. For a further discussion, also see Gorman/Sahlman (1989); Freear/Sohl/Wetzel (1990); Elango et al. (1995).


\(^{129}\) See Weitnauer (2001), pp. 254-257.


\(^{131}\) See, for example, Brander/Amit/Antweiler (2002), pp. 425 ff.
the investors involved. On the other hand, syndication also implies costs for coordinating the investment effort with other venture capitalists. Consequently, VCs only enter a co-investment in the case that the expected benefits outweigh the expected costs.

In literature, there is no generally accepted classification for the rationales of syndication. Categorizations include linking the motives to financial theory and the resource exchange theory, or, whether the positive aspects of syndication occur on the level of the single investment or of the entire portfolio. Since within this study, not the syndicated investments themselves but the potential connection between deal flow and the network structure of venture capitalists is analyzed based on syndicated investments, a more intuitive and simple categorization of the motives for syndication is helpful. Based on this, the rationales for syndication are distinguished based on whether they primarily stem from gaining a benefit or from mitigating a risk or hazard. This systematic is illustrated in figure 2.9.

![Figure 2.9: Rationales for syndication](image)

Rationales for syndication stemming from the primary objective to mitigate risks or hazards are the following:

*Portfolio diversification:* According to the traditional explanation based on finance theory, VCs might syndicate investments to share financial risk and thereby diversify their investment portfolio. The risk of an investment in a portfolio company is comprised of a market component (systematic risk) and a firm-specific component (non-

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132 For a detailed discussion of this categorization, see Lockett/Wright (2001), pp. 376 ff.
133 See Nathusius (2005), pp. 75 ff.
134 Own illustration.
systematic risk). Since the systematic risk cannot be reduced by the venture capitalist, the rationale might be to hold a well-diversified portfolio of investments and thereby reduce the non-systematic risk.\textsuperscript{136}

\textit{Prevention of competition:} Another rationale for syndication is prevention of competition, also named collusion. On the one hand, VCs are competitors on the market, searching for attractive investment opportunities. On the other hand, they also act as providers of information and capital to each other.\textsuperscript{137} Especially in times, when potential investment opportunities are scarce,\textsuperscript{138} banding together instead of competing represents a feasible strategy. By banding together, VCs prevent the situation of competition and may also significantly enhance their bargaining power vis-à-vis business founders.\textsuperscript{139}

Rationales for syndication that are \textit{primarily} based on the objective to gain benefits are the following:

\textit{Capital constraints:} Syndication might also arise due to capital constraints. There are two basic explanations why a VC might offer an (attractive) investment opportunity to other VCs. Firstly, in case that the venture capitalist does not have sufficient financial resources at hand to exclusively finance the venture business, syndication might be the only way how the VC can participate in that deal.\textsuperscript{140} Secondly, investors of VCs such as institutional investors often prescribe that the VC may only invest a certain percentage, for example up to 10\% or 15\%, of the entire investment volume in a single portfolio company in order to ensure portfolio diversification. If the capital requirements of the venture business exceed this given limit, syndication might again be the only way that the VC can invest.\textsuperscript{141}

\textsuperscript{136} A precondition for reducing non-systematic risk by diversification is that the investments do not co-vary. See Brealey/Myers (2000), pp. 166-169.

\textsuperscript{137} See Bygrave (1988), p. 137.

\textsuperscript{138} See also Lockett/Wright (2001), pp. 378 f.


\textsuperscript{140} See Brander/Amit/Antweiler (2002), pp. 426 f.

Reciprocation of deal flow: Deal flow, i.e., the list of potentially promising investment opportunities is a highly valued intangible resource for VCs. Although also the quality of these opportunities is of significant importance, a venture capitalist aims to be in a position, in which he has access to and competes for a wide supply of potential deals. Deal flow becomes even more important to a VC in times when "...too much money is chasing too few deals", i.e., when the availability of funds is high and there is strong competition for deals among VCs. Reciprocity generally refers to the mutual exchange of resources between at least two parties, i.e., if A offers resources to B, A expects to be offered the same or similar resources from B at a later point in time. If B does not reciprocate A's offer, a further resource exchange between A and B in future is unlikely. By syndicating in and out deals with one another, venture capitalists share the pool of available investment opportunities. Therefore, the relationship between venture capitalists is two-way. When syndicating out a deal, the lead investor creates the expectation that this behavior will be reciprocated by the invited VC in the future. Reciprocating deals may result in the fact that "...deal flow can be maintained even when an individual VC may not be the originator of the deal."

Investment evaluation (selection hypothesis): Without referring to venture capital investments or any other finance-related topics, Sah and Stiglitz (1986) propose a general model of organizational design. They argue that in a hierarchical organization, investments only proceed if several independent observers agree. Furthermore, decisions that are made by many observers are superior to ones made by only one party. Lerner (1994) applies this selection hypothesis to the decision making process of VCs.

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143 For a detailed discussion on the quantity and quality of deal flow, see section 2.2.2.
144 Gompers/Lerner (2000), p. 282. See also Kaplan/Stein (1993), pp. 313 f. For a further discussion, see also section 2.2.3.
145 See Piskorski (2000), p. 4. In this context, Bygrave explained that, in the US market, reciprocity is a mechanism that is expected to be existent. See Bygrave (1987), p. 141.
According to the selection hypothesis, multiple VCs may evaluate investment opportunities more effectively than a single VC would do. This is due to the fact that "...each learns something from the other's evaluation"\textsuperscript{149} and that "Venture capitalists prefer syndicating most deals for a simple reason – it means that they have a chance to check out their thinking against other knowledgeable sources".\textsuperscript{150}

\textit{Management support (value-added hypothesis):} In contrast to the selection hypothesis that applies to the pre-investment stage or ex-ante decision making, the value-added hypothesis refers to the post-investment stage or ex-post decision making.\textsuperscript{151} Deviating from the function as a financial intermediary, a VC can also be regarded as a collection of resources.\textsuperscript{152} Resources are "...anything which could be thought of as a strength or weakness of a given firm",\textsuperscript{153} i.e., tangible and intangible assets such as machines or specific technological know-how or management skills. Since different VCs have different resources and therefore different skills, one venture capitalist might not be able to provide all specific skills that are needed for the portfolio company. One possibility to solve this problem is to engage external industry experts, another one is to invite other VCs to syndicate and bring their skills to the table.\textsuperscript{154}

\textit{Window-dressing:} One possibility to improve the return at the end of an investment period is to 'window dress'. Lakonishok et al. (1991) suggest that pension fund managers behave in that way in order to adjust their portfolios at the end of a period, i.e., they buy firms whose shares have appreciated and sell the underperforming stocks. The underlying objective of this strategy is to impress sponsors to be in a better position for raising funds in the future.\textsuperscript{155} Lerner (1994) claims that venture capital funds act in the same way.\textsuperscript{156}

\textsuperscript{149} Brander/Amit/Antweiler (2002), p. 424.
\textsuperscript{150} Lerner (1994), p. 17.
\textsuperscript{151} See Lockett/Wright (2001), p. 378.
\textsuperscript{152} See Manigart et al. (2002), p. 4. The value-added perspective is there also named as resource-based perspective.
\textsuperscript{154} See Lockett/Wright (2001), p. 378.
\textsuperscript{156} See Lerner (1994), p. 17.
order to earn publicity, VCs may make investments in late financing rounds of attractive firms, although much of the value appreciation might already have occurred and therefore, financial returns are comparably low. Still, this behavior "...allows them to represent themselves in marketing documents as investors in these firms".157 Along the same lines, young VCs might have incentives to 'grandstand'. That is, they aim to signal their ability to potential investors, either by taking a portfolio firm public prematurely, or by syndicating with well-known venture capitalists in later financing rounds.158

In this chapter 2.1, a common understanding was established as to the development and current state of the German venture capital market. Also, venture capital as method of financing has been explained as well as the types of VC and the characteristics of portfolio companies. In addition, syndicated investments have been defined and the various rationales of VCs to syndicate have been laid out.

Since the deal flow of VCs is an integral part of the analysis within the present study, some basic thoughts on this topic are provided in the following sections. These include the definition of the term, explanations regarding the quantity and quality of deal flow, a short literature review, as well as aspects regarding the generation of deal flow.

### 2.2 Deal Flow

#### 2.2.1 Definition of Deal Flow

As briefly mentioned in section 2.1.3.4 and besides the acquisition of funds, generating deal flow constitutes a basic prerequisite for the business model of a VC to function.159 This is expressed in the figurative descriptions of deal flow of, for example, Betsch, Groh and Schmidt (2000) and Lockett and Wright (2001):

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• Deal flow is a foundation for the business activities of venture capital firms. (Betsch/Groh/Schmidt (2000))\textsuperscript{160}

• "Another important intangible resource that is highly valued by venture capitalists is deal flow." (Lockett/Wright (2001))\textsuperscript{161}

Although there are other circumscriptions such as the description of deal flow as an indicator of the market acceptance of the services provided by the VC,\textsuperscript{162} more narrow definitions of the term are fairly consistent in literature:

• "...finding suitable projects to invest in..." (Coutarelli (1977))\textsuperscript{163}

• "The process by which deals enter into consideration as investment prospects, ..." (Tyebjee/Bruno (1984))\textsuperscript{164}

• Stream of investment opportunities (Brettel/Jaugey/Rost (2000))\textsuperscript{165}

• Attempt of VCs to identify and contact potential portfolio companies (Vater 2002)\textsuperscript{166}

As becomes obvious, there are only slight differences between these definitions. Therefore, for the purpose of this study, deal flow should be understood according to the definitions provided by Tyebjee and Bruno (1984) and Brettel, Jaugey and Rost (2000), i.e., as the process by which deals enter into consideration of the VC, resulting in the flow of investment opportunities a VC can select from.\textsuperscript{167}

\textsuperscript{160} See Betsch/Groh/Schmidt (2000), p. 118.
\textsuperscript{161} Lockett/Wright (2001), p. 378.
\textsuperscript{163} Coutarelli (1977), p. 61.
\textsuperscript{164} Tyebjee/Bruno (1984), p. 1051.
\textsuperscript{165} See Brettel/Jaugey/Rost (2000), p. 129. The authors refer to the stream of investment opportunities presented to a business angel. Although business angels are not the focus of this study, the definition provided for deal flow is adopted also in the context of VCs.
2.2.2 Quantity and Quality of Deal Flow

In the deal flow phase of the value chain, VCs try to identify and contact potential portfolio companies. When regarding the deal rate, which varies between 1% and 10%, the conflicting area between quantity and quality of deal flow becomes obvious. On the one hand, VCs have to try to identify and contact as many potential portfolio companies as possible to secure a certain flow of investment opportunities and to be able to select those projects that meet their investment objectives best. On the other hand, however, searching potential portfolio companies, initiating a contact to them and screening their investment proposal represents transaction costs and therefore is a costly undertaking for the VC. Consequently, the VCs attempt to minimize these costs by identifying and contacting only those potential portfolio companies, for which there is a high probability of an actual investment. In other words, the lower the quality of investment opportunities received, the higher the rejection rate and the more investment opportunities have to be identified and potentially contacted to realize a certain deal rate. Conversely, the higher the quality of the investment opportunities received, the less need exists for a quantitatively high deal flow.

An important question is how quantity and quality of deal flow can be measured. As performed in various studies, the quantity of deal flow is simply measured as the number of investment opportunities coming to the attention of a VC in a certain period of time, and before any selection is made. In contrast, there are several ways how to measure deal flow quality and it needs to be elaborated on this point in more detail to select the appropriate way for the present study. In academic literature on the venture capital industry and the deal flow of VCs, there is a lack of empirical studies that differentiate between the quantity and especially the quality of deal flow.

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168 Deal rate is defined as the proportion of investment opportunities actually invested in, of all originally received investment opportunities.


170 For the different forms of transaction costs, see Picot (1982), pp. 270 f.


of deal flow. Only in a few studies this attempt has been made. The measures that have been used, measure deal flow quality as the percentage of investment opportunities that remain after the various stages of the value chain of VCs. That means, it is being measured what percentage of the initially received investment opportunities remain after the initial screening, after the detailed due diligence, etc. However, the studies of Schröder (1992) and Vater (2002), for example, differ regarding at what stage of the value chain the deal flow quality is being measured. While Schröder proposes the percentage of investment opportunities actually invested in (deal rate), Vater argues that the deal rate is affected by several other factors such as the detailed due diligence, the negotiations on the investment terms, etc. Therefore, as proxy for deal flow quality, Vater measures the percentage of investment opportunities remaining after the initial screening by the VC. Although these ways of measuring deal flow quality are conceptually similar (measuring deal flow quality based on the percentage of investment opportunities remaining after the various stages of the value chain), from the author's perspective they differ significantly and not both ways are regarded suitable for the purpose of this study. When measuring deal flow quality as proposed by Vater, a relatively high percentage results. These high results seem logical in the sense that the initial screening of investment opportunities only takes a venture capitalist a few minutes, in which he decides whether to look at a business plan in more detail or whether to reject it immediately. Another reason why this way of measuring deal flow quality does not seem suitable is the huge difference between the remaining percentages, i.e., after the

173 See the studies of Schröder (1992) and Vater (2002) for the German market, see Fried/Hisrich (1994) for the US market.
174 One could also imagine further measures for deal flow quality, such as the number of successful exits a VC has done. However, from the point in time that an investment is entered until the exit, many more factors might have influenced the success of the young business. The most 'direct' way of measuring deal flow quality is therefore to look at the number of investment opportunities that a VCs invests in.
177 In his study, Vater finds percentages for different segments of VCs ranging from 31.2% to 50.6%. See Vater (2002), p. 153.
178 For example, Hall and Hofer found that VCs very rapidly make a go/no-go decision on business plans. See Hall/Hofer (1993), p. 25. This point could also be verified in interviews and conversations with venture capitalists that have been performed for this study. Independent from each other, several venture capitalists explained that the initial screening of one business plan hardly takes them more than 5-10 minutes.
initial screening and after the final investment decision has been made. While after the initial screening the percentage ranges between approximately 30-50%, this number decreases to approximately 1-10% for the percentage of investment opportunities actually invested in. Therefore, from the author's perspective, measuring the percentage of investment opportunities remaining after the initial screening can only be a very rough indicator for deal flow quality.

In contrast to the argumentation in Vater (2002), in the present study it is argued that because other factors can lead to the rejection of business plans, the actual quality of deal flow is better reflected in the final deal rate itself. From the author's perspective, this is the measure that indicates best, in what percentage of the initially received investment opportunities a VC is willing to invest. Therefore, this approach is followed in this study.

2.2.3 Literature Review

Based on existing academic literature, there are several topics that have been analyzed with respect to the deal flow of formal and informal venture capital providers. Since there is no existing categorization of this body of literature, it has been grouped topic-wise. These groups include the competition for deal flow, syndication and deal flow, and the sources of deal flow including the importance of networks. Most research relates to the latter part of the groups mentioned, i.e., to the sources of deal flow and the importance of networks to generate it. However, it will be shown, that there exist significant gaps with respect to the systematic analysis of the network and its impact on the deal flow of VCs.

One area that has been analyzed by researchers in the venture capital and private equity arena is the competition for deal flow. A key aspect identified and examined is the so-called 'money chasing deals' phenomenon. It holds that, given that there is a certain number of potential investment opportunities available, if too much money is available among VCs, this amount has to be distributed across the same number of investment

\[^{179}\text{In his study, Vater measures a deal rate of between 2.1\%-3.3\%, while Schröder measures between 1.6\% and 10\%. See Vater (2002), p. 153; Schröder (1992), p. 162.}\]

\[^{180}\text{The topic of deal flow has not been touched intensively in academic research so far. See also Mason/Harrison (1999), p. 28.}\]
opportunities. Consequently, the competition for the potential deals gets more intensive. In a similar vein, the effect of variances in the supply of and in the demand for investment opportunities on the behavior of VCs has been analyzed. It could be shown that changing size of supply of and demand for investment opportunities have an influence on (a) the valuation of investment opportunities by VCs, (b) the time invested by VCs to search for and screen investment opportunities, (c) the negotiation power of entrepreneurs vis-à-vis VCs, and (d) the cautiousness of venture capital managers to invest when competition for deal flow gets intensive.

Another area that has (so far comparably sparsely) been covered is the connection between syndication among VCs and their deal flow. As described in the section on the rationales for syndication, one motive to syndicate deals is to increase the deal flow through reciprocation of investment offers. A number of studies have analyzed this argument, showing that one of the motives for VCs to syndicate is the expectation that giving out invitations to other firms to join investments will be reciprocated in the future. For example, for the German market, Jungwirth and Moog (2004) find that specialist VCs (firms that specialize in certain industries or investment stages) syndicate in order to get access to deals, while generalist firms (firms that have standard knowledge in financing start-up firms) syndicate to get access to specific know-how. For the UK market, Lockett and Wright found that, for VCs investing in earlier financing stages, the syndication motive to get access to information in terms of deal flow is highly relevant, while for firms investing in later stages, the motive of spreading financial risk is more important. In a study on the European venture capital market, Manigart et al. (2002) find that, although the spreading of financial risk is an important motive for VCs, access to deal flow is an important motive for young VCs and for specialized firms. Another finding in this study is that young VCs seek to build central positions in the syndication

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182 See the studies of Inderst/Müller (2004) and Ljungqvist/Richardson (2003).
184 See Lockett/Wright (2001), p. 375. In this context, also see the related studies of Lockett/Wright (1999), Wright/Lockett (2002), and Wright/Lockett (2003).
network.\textsuperscript{185} In the same vein, for the US venture capital market, Bygrave found that sharing of information is a more important motive for syndication than the spreading of financial risk is. Especially the access to promising investment opportunities is a key driver for firms to connect.\textsuperscript{186}

A third area, in which research has been performed, addresses the sources of deal flow and the importance of networks. In this regard, several studies have been performed for the informal and formal venture capital market. Since the results of these studies are described in detail further below,\textsuperscript{187} it is abstained from elaborating in detail on them at this point. To briefly summarize, there are three conclusions based on these studies: First, the contact network of VCs seems to be an important source to generate deal flow quantity. Second, there is weak empirical evidence for the German market that the network might also be important for deal flow quality. Third, the role of the contacts to other VCs for deal flow quantity and quality has empirically not been examined sufficiently.

Based on previous research in the context of the VCs' contact network and deal flow, there is an obvious demand to systematically analyze the contact and syndication network of VCs and to try to link these areas to the quantity and quality of deal flow. The present study aims at closing these gaps.

In order to better understand the characteristics of a VC's deal flow, this aspect will be discussed in more detail in the next section.

\textsuperscript{185} See Manigart et al. (2002), p. 4. This finding is consistent with the findings in the study of Piskorski, who shows that centrally positioned firms have access to more investment opportunities. However, the study of Piskorski does not further analyze the difference between quantity and quality of investment opportunities and also only refers to one measure (centrality) to characterize a network position. See Piskorski (2000), p. 4. However, there are several other measures, as will be discussed later, that imply benefits in terms of deal flow quantity and quality.


\textsuperscript{187} See section 2.2.4.2.
2.2.4 Generation of Deal Flow

2.2.4.1 Search Activities of Venture Capital Firms

In several empirical studies, researchers have examined the search activities and search strategies of VCs in order to generate deal flow.\textsuperscript{188} Although partially denoted with different terms, there is a consistent view of the activities a VC can engage in to generate deal flow.

As presented in figure 2.10, VCs can follow two basic search strategies, a passive one and an active one.\textsuperscript{189}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{search_strategies.png}
\caption{Search strategies of VCs to generate deal flow\textsuperscript{190}}
\end{figure}

\begin{itemize}
\item \textit{Direct marketing activities:}
  \begin{itemize}
  \item Presentations at conferences, seminars, etc.
  \item Participation in industry fairs, roundtables, etc.
  \item Advertising
  \item Publication of articles
  \item Other marketing activities
  \end{itemize}
\item \textit{Indirect activities (establishment/maintenance of network contacts):}
  \begin{itemize}
  \item Family members
  \item Friends
  \item Other VCs
  \item Traditional banks/investment banks
  \item Consultants, lawyers, auditors
  \item Matching services
  \item Technology institutes of universities
  \item Other professional contacts
  \end{itemize}
\item \textit{Initiation of contact through portfolio company}
\end{itemize}


With respect to the passive search behavior, the venture capitalist basically waits for the entrepreneurs to contact him. However, in this case both, quantity and quality of deal flow are left to chance. Consequently, it seems intuitively reasonable that VCs actively engage in the search for attractive investment opportunities. Coutarelli (1977) argues that, due to three reasons, "[it] is incumbent on the venture capitalist to try actively to identify projects he should consider investing in."\(^{191}\) Firstly, the classic model of supply and demand only functions in perfect market conditions, which is not the case for both, the market for investment opportunities and, from the entrepreneur's perspective, for the market for venture capital. Secondly, the deal rate of venture capitalists is very low, i.e., the percentage of projects invested in of all investment opportunities considered. Thirdly, the funding of innovation tends to be cyclical. According to Coutarelli (1977), in a boom phase, entrepreneurs tend to regard higher risks as justifiable, the viability and also the quality of investment proposals tend to become more questionable. Consequently, the venture capitalist will face more difficulties in identifying potentially attractive deals. Conversely, in a recession, entrepreneurs may become more conservative and it is up to the VC to identify interesting projects to potentially invest in. Due to these reasons, "…it is important to develop project flow systematically…"\(^{192}\) in order to actively influence the quantity and quality of deal flow.

Regarding the active search strategies it can further be differentiated between a direct and an indirect approach.\(^{193}\) The direct approach includes activities that increase the entrepreneur's awareness of the venture capitalist's existence. These activities include presentations at conferences or seminars, participation in industry fairs and roundtable discussions, advertising or publication of articles in magazines, etc. However, Coutarelli (1977) stresses that, although in the long run, direct activities tend to have positive effects, the overall quality of investment opportunities generated through this way is extremely poor.\(^{194}\) This conclusion appears to be reasonable because, although the above

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191 Coutarelli (1977), p. 64.
mentioned direct marketing activities increase the entrepreneurs' awareness of the VC and also might transport the VC's investment objective into the market, it is still up to the potential entrepreneurs to initiate a contact to the venture capitalist. Furthermore, also those entrepreneurs will apply for funding, the business plans of whom do not meet the investment objectives. This can be due to the fact that either within the direct marketing activities the VCs was not able to communicate the objectives clear enough or that potential entrepreneurs simply disregard the investment objectives in the hope to still be approved for funding. Therefore, direct marketing activities seem to be limited means to effectively control for the quantity and quality of deal flow.

Regarding the indirect approach of active search activities, the venture capitalist uses his contact network comprised of personal or private contacts as well as professional contacts. Personal or private contacts include family members or friends. Professional contacts include connections to other VCs, traditional banks or investment banks, consultants, lawyers, auditors, matching services, or for example, technology institutes of universities.\textsuperscript{195} Already at this point it becomes clear that it cannot always be precisely differentiated between the roles of single persons in ones network since one person can be both, for example, a personal friend and an employee of another VC. Due to the significance of the contact network of venture capitalists as a source of deal flow, this topic will be examined in detail in the next section.

2.2.4.2 Sources of Deal Flow

As can be derived from figure 2.10, there are various sources of deal flow. In academic literature, there are several studies that examine the sources of deal flow in both market segments, for informal and formal venture capital. For both areas, attempts have been made to structure the sources of deal flow.

For the field of informal venture capital, for example Mason and Harrison (1994) and Brettel, Jaugey and Rost (2000) group the deal flow sources into informal sources, formal sources, and organized sources.\textsuperscript{196} Informal sources include business associates, active


Definitions and Basic Concepts

personal search, and entrepreneurs. Formal sources include VCs, consultants, lawyers, auditors, etc. Organized sources comprise matching services, business brokers, and newspapers. Another structuring provided by Kelly and Hay (2000) differentiates between business associates and friends as one source of deal flow, and professional intermediaries such as lawyers, consultants, or matching services as a second source of deal flow.\footnote{See Kelly/Hay (2000), p. 185.}

In the area of formal venture capital, usually a general structuring differentiates between cold calls, active search, and referrals.\footnote{See for example the studies of Tyebjee/Bruno (1984), Steier/Greenwood (1995), Betsch/Groh/Schmidt (2000).} In a further specification, the referrals, i.e., the contact network, are usually split up into various groups of potential referrers such as other VCs, lawyers, consultants, matching services, etc. Independent of whether it is in the area of informal or formal venture capital, a significant result is that an intermediary, who is part of the contact network, often refers the deals or investment opportunities to the business angel or venture capitalist.\footnote{See further below for a detailed description of the results of several empirical studies in the area of informal and formal venture capital.}

To illustrate the importance of the contact network as source of deal flow, the basic question to pose is: How does a contact between a potential portfolio company or investment opportunity and the VC come about? Or, in other words, how does a VC become cognizant of a potential investment opportunity? The structure that is used in this study is derived based on this question and is illustrated in figure 2.11. The figure looks similar to the previous one. This, of course, is due to the fact that both, the search activities and the initiation of a contact between a VC and a portfolio company are based on the same sources of information. Still, thinking about how the contact comes about helps to recognize the importance of the contact network:
A contact can either be initiated directly or indirectly through an intermediary, also called referrer. In the case of direct initiation, the venture capitalist and the entrepreneur either already know each other personally or they do not. In the latter case, either the potential entrepreneur or the venture capitalist has gathered information and decides to address the other party, also known as cold call. In the case of an indirect initiation of the contact, the referrer can either be a private or a professional contact of the venture capitalist. The important aspect to notice is that, except for the situation of a cold call, all other options fall into what is called the contact network of the VC. In a next step it is therefore important to clearly differentiate between the various potential referrers within the contact network.

In contrast to business angels, for whom business associates and friends are a major source of deal flow, for VCs most investment opportunities come from referrers out of

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200 Own illustration.
201 For example based on visits at conferences, roundtable discussions, publications from the VC, etc.
202 For the US market, Freear/Sohl/Wetzel (1994) found that approximately 50% of the investment opportunities received were referred to the business angel by either a business associate or a friend. For the US market, see also Fiet (1995a) and Fiet (1995b). For the UK market, Mason/Harrison (1994) basically confirm the results, finding that approximately 60% of the business angels participating in the survey named business associates as deal flow source and 49% of the business angels also named
the professional contact network. For the US market, for example, Wells (1974) found that 61% of the proposals the VCs received were generated through professional contacts. More than half of these referrers were other VCs.\textsuperscript{203} Tyebjee and Bruno (1984) found that 65% of the investment opportunities received stemmed from referrals and more than half of them come from professional contacts such as other VCs,\textsuperscript{204} banks, or investment brokers.\textsuperscript{205} Fried and Hisrich (1994) confirmed these findings showing that, although VCs receive many cold calls, they seldom invest in them. In their study, 18 venture capitalists provided information on investments, and most of the projects that were funded come by referral.\textsuperscript{206} For the German venture capital market, Jugel (2001) found that, for generating deal flow, the contact network is most important, delivering approximately 46% of the investment opportunities.\textsuperscript{207} Vater (2002) analyzed German VCs and PEs and found that 54% of the investment opportunities come by referral.\textsuperscript{208} As regards the importance of other VCs as source of deal flow quantity, Vater comes to contradictory results. On the one hand, he finds that, on average, only approximately 7% of the investment opportunities received came from another VC. On the other hand, he found that, when asked, VCs answered that they regard other VCs as an important source for deal flow quantity.\textsuperscript{209} As regards deal flow quality, Vater finds that the source 'other VCs' also supports deal flow quality. However, there are several reasons why this result cannot be applied to the context of this study, i.e., to the VCs syndication network considered in this study: First, the measure for deal flow quality that is used by Vater (as presented above), is different from the one used in the present study and is considered not

\textsuperscript{203} See Wells (1974), p. 57.

\textsuperscript{204} In most of the cases, in which the investment opportunity came from another VC, it was an offer to syndicate an investment. See Tyebjee/Bruno (1984), p. 1055. See also the preliminary results of the study in Tyebjee/Bruno (1981), p. 310.


\textsuperscript{206} See Fried/Hisrich (1994), pp. 31 f.

\textsuperscript{207} In his study, Jugel (2001) does not further differentiate between single types of referrers. Still, the high significance of the network as source of deal flow becomes obvious. See Jugel (2001), p. 39.

\textsuperscript{208} See Vater (2002), p. 144.

to be suitable to appropriately reflect the deal flow quality for the VCs under consideration. Second, quite a large part of the firms analyzed by Vater were PEs that focus on the buyout segment of the market for private equity, for which the process to generate deal flow is different from the one for VCs focusing on the earlier financing stages.\textsuperscript{210} Anticipating later explanations, since buyout investments will be excluded in the present study, the Vater's result regarding deal flow quality cannot be applied to the present study. Third, the study of Vater is based on data gathered in interviews before 1998, while this study (anticipating later explanations) is based on data gathered from 1998-2005.\textsuperscript{211} Therefore, in the present study it is vital to analyze the importance of other VCs as source of deal flow quantity and quality and thereby significantly enhance the understanding of the importance of contacts among VCs to generate deal flow quantity and quality.

The rationales of a venture capitalist for cultivating his contact network are two-fold. Firstly, "...referred deals are more likely to pass through the generic screen, if the VC has confidence in the referrer's judgment."\textsuperscript{212} Secondly, deals, which have been referred to the VC via a referrer, tend to be of comparably higher quality, i.e., these investment opportunities have a greater chance to successfully make it through the due diligence process. This is due to the fact that contacts of the VCs usually have knowledge about their investment preferences and therefore tend to refer to the venture capitalist only those deals that have a high chance of meeting the VC's requirements.\textsuperscript{213} This is also the reason why venture capitalists invest a considerable amount of their resources into the establishment and the maintenance of their contact network.\textsuperscript{214}

Due to the high significance of the contact network as a source of deal flow and with the VCs' syndication network (contacts only among VCs) potentially playing an important

\textsuperscript{210} One-third of the firms analyzed are buyout-focused firms. PEs focusing on the buyout segment receive a large part of their deal flow from investment banks, accounting for nearly half of the investment opportunities received. See Vater (2002), pp. 82 ff. and p. 144. See also Deloitte&Touche (2002), p. 6.

\textsuperscript{211} Which investment stages and which time period will be looked at will be explained in section 5.1.1.2.

\textsuperscript{212} Fried/Hisrich (1994), p. 32.


\textsuperscript{214} Wells (1974) already showed that VCs dedicate approximately 40% of their time to the maintenance of their network contacts. See Wells (1974), p. 44.
role within this network, one goal of this study is to analyze their importance regarding the generation of deal flow quantity and quality. As explained in section one, the second goal of the present study is to analyze each VC's position within the syndication network and to link this analysis to the VC's deal flow quantity and quality. In order to perform this second analysis, methods from the rapidly emerging field of network analysis will be used. Because the (economist) reader is normally not deeply familiar with this topic, a thorough introduction is required, following in the next section.

2.3 Summary

Venture capital has been presented as a method of financing for entrepreneurial firms. While the venture capital market in Germany experienced a steep upswing from 1998 until 2001, it experienced a significant downturn from 2001 until 2004. During the phase of the sharp increase, the volume invested in entrepreneurial firms as well as the number of portfolio companies financed inclined significantly. In the period after 2001 then, VCs became more reluctant to invest and nowadays, a significant portion of available funds is not invested but still waiting to be. For example, in 2004, of the available funds of 45.0 EUR billion in the German venture capital market, a portion of 54.9% is not invested. However, since it is above all the small firms that induce growth and innovation in the nation's economy, their financing is crucial, not only on a micro-economic level but also from a macro-economic perspective. One of the challenges for VCs to alleviate that situation is to identify promising investment opportunities, i.e., to generate deal flow. Deal flow has been explained to have two dimensions, described as deal flow quantity and deal flow quality. While VCs receive investment opportunities from many sources, it has been shown that their contact network is vital for the generation of deal flow. Among the sources within the contact network, the source 'other VCs' might play a significant role, also relating to the rationale for syndication deals denoted as deal flow reciprocation.

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215 Also, of course, on a worldwide scale.
However, in academic research, the link between the VCs’ contact network and syndication network and their deal flow has not yet been analyzed sufficiently and systematically. Therefore, this significant gap shall be addressed with this study.
3  Theoretical Foundation

In this chapter, the theoretical foundation for this study will be developed. The approach to the selection of an appropriate theory is first to examine which theories are commonly applied to financial markets (section 3.1.1). Next, it will be explained why these theoretical concepts do not properly suit the purpose of this study (section 3.1.2). Following, the requirements for a theoretical foundation for the present study will be derived (3.1.3). The remainder of this chapter is dedicated to highlight in a detailed way the methods of social network analysis (section 3.2) and the concept and theories of social capital (section 3.3). Furthermore, an appropriate research design will be developed (section 3.4). The chapter closes with a summary (section 3.5).

3.1  Approach to Theory Selection

3.1.1  Theories Commonly Applied to Financial Markets

In academic literature, there are many theoretical concepts that are frequently applied to financial markets. It would certainly go beyond the scope of this study to explain all of them in a detailed way. Still, within this section, three major fields of financial theories are highlighted, including the neo-classical perspective on financial markets, a behavioral approach, as well as the theories of the so-called new institutional economics. Each of these areas will be sketched briefly in the following.

In a traditional view, financial or capital markets are theoretically analyzed based on neo-classical theories of finance, in which future cash flows of equity or fixed income securities are valued to derive a present value.\(^{216}\) The underlying assumptions refer to perfect or efficient capital markets:\(^{217}\)

\(^{216}\) See Brealey/Myers (2000), pp. 16 ff. For a detailed review on the valuation of fixed income securities, see also Bodie/Kane/Marcus (1999), pp. 399 ff.

Approach to Theory Selection

- Market participants are rational and they are utility maximizers.\textsuperscript{218}
- All securities on the market are arbitrarily divisible.\textsuperscript{219}
- There are no transaction costs, i.e., transaction costs are zero.
- Market participants have all and the same information, i.e., information is immediately accessible for all market participants.\textsuperscript{220}

Theories that evolved based on these basic assumptions are the theory of Modigliani and Miller regarding the value additivity and the irrelevance of the choice of capital structure,\textsuperscript{221} the theory on informational efficiency by Grossmann and Stiglitz,\textsuperscript{222} the separation theorem by Tobin,\textsuperscript{223} and the Capital Asset Pricing Model (CAPM).\textsuperscript{224}

A younger field of research on financial markets, mainly developed in the US, is represented by the so-called behavioral finance.\textsuperscript{225} This line of research emerged due to the fact that several phenomena observed in financial markets cannot be explained by the neo-classical perspective alone. These phenomena refer to anomalies that are contradictory to, for example, the neo-classical argument of information efficiency. The anomalies include, for example, the observation that companies that are to be included in a stock index, experience an incline in its share price shortly before being included in the index.\textsuperscript{226}

\textsuperscript{218} In neo-classical theories of finance, investors seek to maximize their return given varying risk preferences. Non-monetary measures are not incorporated into the utility maximization. See Brealey/Myers (2000), pp. 187 ff.

\textsuperscript{219} See Modigliani/Miller (1958), p. 266.

\textsuperscript{220} There are various forms of market efficiency or informational efficiency. The most common differentiation was pioneered by Fama (1970), referring to a weak form, semi-strong form, and strong form of information. See Fama (1970), pp. 389 ff.

\textsuperscript{221} See Modigliani/Miller (1958), pp. 266 ff. The fundamental statement holds that the value of a company is unaffected by its capital structure, i.e., the debt-equity-ratio.

\textsuperscript{222} See Grossman/Stiglitz (1976), pp. 246 ff.

\textsuperscript{223} See Tobin (1958), pp. 65 ff.

\textsuperscript{224} For the development of the CAPM, see the seminal works of Treynor (1961), Sharpe (1964), and Lintner (1965).

\textsuperscript{225} For this area, see for example the works of Kahneman/Tversky (1979), Kahneman/Slovic/Tversky (1982), De Long et al. (1990), Shleifer/Vishny (1997b), Rabin (1998), Kahneman/Tversky (2000), Shleifer (2000), Barberis/Thaler (2003).

\textsuperscript{226} See for example Harris/Gurel (1986), Shleifer (1986), Wurgler/Zhuravskaya (2002).
In contrast to the neo-classical approach, behavioral finance incorporates psychological and sociological aspects to explain the partially irrational behavior of market participants. The concept is based on two major building blocks, i.e., limits to arbitrage and psychology.\(^{227}\) Limits to arbitrage refers to the argument “…that it can be difficult for rational traders to undo the dislocations caused by less rational traders…”\(^{228}\) Psychology relates to experimental evidence from the field of cognitive psychology, stating that traders act irrationally based on their beliefs and their preferences. Abstaining from going into too much detail on this field of research,\(^{229}\) in essence, behavioral finance does not assume market participants to always act in a rational way. Rather, due to imperfect capital markets and due to limited cognitive capacity, humans act irrationally. In consequence, this leads to market participants making mistakes in perceiving and processing information, and in making decisions based on the information perceived. These irrational behavior is based on mental mechanisms also referred to as heuristics, i.e., behavioral patterns.\(^{230}\) For example, one of these heuristics is denoted as the so-called anchoring: When people are asked to form an estimate on a certain number, they often start with an initial, possibly arbitrary, value and then adjust it. However, empirical evidence shows that people heavily ‘anchor’ on this initial value and thereby form estimates in an irrational way.\(^{231}\)

Another well-established field of theory refers to the so-called new institutional economics.\(^{232}\) New institutional economics is a broader framework basically comprised of three theoretical concepts: Property rights theory, principal agent theory, and transaction cost theory.\(^{233}\) The principal agent theory is a core framework in information economics. It

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\(^{227}\) For further literature on the topic of limits of arbitrage, see for example De Long et al. (1990) or Shleifer/Vishny (1997b). For further literature on psychological aspects, see for example Kahneman/Slovic/Tversky (1982), Camerer (1995), or Rabin (1998).

\(^{228}\) Barberis/Thaler (2003), p. 1052.

\(^{229}\) Further below it will be shown that the approach of behavioral finance is not well suited to be applied in the context of this study.

\(^{230}\) See for example Goldberg/von Nitzsch (1999), pp. 49 ff.

\(^{231}\) See Barberis/Thaler (2003), p. 1066.

\(^{232}\) See for example Williamson (1979b), p. 233.

\(^{233}\) See for example Picot/Bortenlänger/Röhrl (1997), p. 108.
builds on the property rights theory since it refers to the delegation of decision rights from the principal to the agent and can be defined as “[...] a contract under which one or more persons (the principal(s)) engage another person (the agent) to perform some service on their behalf, which involves delegating some decision making authority to the agent.” 234

The separation of ownership and control as well as the fact that both parties are assumed to be utility maximizers generate the agency problem. 235 Instead of acting in the best interest of the principal, the agent may prefer to maximize his private wealth. 236

While the principal agent theory focuses on conflicts arising from asymmetric information between the principal and the agent, the transaction cost theory elaborates on institutions, which aim at rationalizing exchange, information, and communication processes. 237 Since in this study, the syndication network of VCs is intended to be analyzed, and since transaction cost theory is a concept that could serve as a basis for analyzing networks, it has to be looked at in more detail to decide whether it could also serve as theoretical basis for the present study.

The transaction cost theory has originally been pioneered by Coase (1937) 238 and has later been refined by Williamson. 239 In this approach, specifically, two institutions, markets and hierarchies, are examined regarding the question, why specific transactions are executed on the market while others are executed within organizations. 240 The elements under consideration are single transactions, which can either be the physical transfer as an "…exchange of goods or services from one party to another" 241 or, in a

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234 Jensen/Meckling (1976), p. 308.


239 In this context, see the seminal works of Williamson (1985). In this context, see also further works of Williamson to this topic: Williamson (1975), Williamson (1979a), Williamson (1979b), Williamson (1981a), Williamson (1981b), Williamson (1984), Williamson (1989), Williamson (1990).

240 This refers to the classic 'make-or-buy' decision.

juridical context, the transfer of certain rights.\textsuperscript{242} The efficiency criterion is the sum of the production and transaction cost, the basis on which transaction cost theory compares the alternative institutional arrangements markets and hierarchies, i.e., organizations. Consequently, the institutional arrangement is supposed to be more efficient, for which production and transaction costs are lower.\textsuperscript{243}

Based on the transaction cost theory, an organization has a 'right' to exist if it is able to solve the tasks and problems of coordination internally for lower costs than would be possible compared to the same transaction if executed involving an external partner on the market.\textsuperscript{244} Influencing factors for transaction costs are the so-called human factors, i.e., assumptions on human behavior, and environmental factors. Human factors refer to the human's bounded rationality due to imperfect information and limited information processing capacity as well as to opportunistic behavior.\textsuperscript{245} Environmental factors include the factor specificity, and the uncertainty and frequency of the transaction.\textsuperscript{246} Factor specificity refers to investments in assets, in human capital, and in the production site. On the one hand side, the more specific the investments, the lower the production costs. On the other side, specific transactions, which are executed on the market, may lead to a situation with significant asymmetric information between the transaction parties, i.e., one of the parties can potentially exploit the fact of having more information than the other, finally leading to higher transaction costs.\textsuperscript{247} On the one hand side, uncertainty refers to the conditions of the transaction. On the other hand, it refers to uncertainty regarding the behavior of the other party, i.e., uncertainty with respect to a potentially opportunistic behavior. In both ways, transaction costs increase due to the need to gather more information on the transaction partner upfront, and due to ex-post amendments of the contracts or conditions of the transaction. Finally, the more frequent a transaction

\textsuperscript{242} See Commons (1931), p. 648.

\textsuperscript{243} See Ebers/Gotsch (1999), pp. 225-227. Furthermore, it is differentiated between ex-ante and ex-post transaction costs. Ex-ante transaction costs are those that occur prior to closing the contract. Ex-post transaction costs are comprised of three categories: Control costs to ensure that contracts are fulfilled, costs to solve (legal) conflicts, and costs arising due to ex-post changes of the contract. In this context, see Williamson (1985), p. 22.

\textsuperscript{244} See Picot/Reichwald/Wigand (1996), p. 41.


\textsuperscript{247} See Picot/Reichwald/Wigand (1996), pp. 43-44.
occurs, the lower the production and transaction costs, representing reasons to organize a transaction within an organization.\textsuperscript{248}

Based on the above explanations, the economic institution \textit{market} is characterized by independent actors, who spontaneously execute single transactions. These transactions are coordinated by the price mechanism and rights and obligations are fixed in contracts. Access to the market is open for all actors, and laws of various kinds control for situations of conflicts or fraud.\textsuperscript{249}

In contrast to the market, the economic institution \textit{hierarchy} refers to organizations or companies that are structured into hierarchical levels and departments. Despite modern management concepts regarding employee-oriented management styles, the organization functions based on formal rules to which the employees adhere when signing the employment contract. Situations of conflict can be solved by authoritarian instruction of a supervisor.\textsuperscript{250}

However, in both cases, markets and hierarchies, it is questionable whether these two extreme and ideal forms are suitable to describe the relevant situation in reality. In the case of real markets, transactions can usually not be executed without being embedded in institutions and some form of formal rules.\textsuperscript{251} This means, that partners to a transaction need to show a minimum of cooperative behavior, institutional arrangements such as contract law must be in place, and the involved parties need to be willing to adhere to these rules.\textsuperscript{252}

\textsuperscript{248} See Williamson (1985), pp. 281 ff.

\textsuperscript{249} See Weyer (2000), pp. 5-7.


\textsuperscript{251} See Granovetter (1985), pp. 482 ff. In this paper, Granovetter refers to the dispute of the so-called undersocialized view and the oversocialized view underlying opposing theories. On the one hand, the new institutional economics tend to view actors, i.e., individuals or companies, as undersocialized since transactions are executed without any human or social contact between the parties being taken into account. In this context, see also Hirschman (1982), p. 1473. On the other hand, the oversocialized perspective prefers a point of view in which market participants are seen as human beings that have relations and underlie behavioral constraints. In this context, see the early works of Piore (1975) and Phelps Brown (1977). On the topic of under-/oversocialized view with respect to VCs and entrepreneurs, see Shane/Cable (2002).

In the case of hierarchies such as organizations, it is questionable whether a modern company can be described as simple hierarchical structure or whether the informal, internal relationships and networks are not also a factor that accounts for the success of the firms.\(^{253}\)

Transaction cost theory also provides a third form of institutional coordination, which is a hybrid one, situated somewhere along the continuum between the endpoints (market and hierarchy). This form of coordination is also referred to as network. Some authors view networks as being part of the continuum,\(^{254}\) others denote networks as a form of coordination having its own quality, excluding the gradual transition to the endpoints of the continuum.\(^{255}\)

The essence here is that, although 'market' and 'hierarchy' are used as reference points in both perspectives, networks constitute a form of coordination with an own character, joining elements of markets and hierarchical structures: Networks combine the flexibility of market transactions with the efficiency and security provided by organizational structures.\(^{256}\) This leads to two advantages that networks deliver:

- They reduce the uncertainty regarding the behavior of other actors.
- They enable an organization to produce a higher output.

While the theories explained above are commonly applied in analyses of financial markets, for several reasons it is abstained from applying them as theoretical foundation in the present study. These reasons are described in detail in the following section.

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\(^{254}\) Authors that represent this line of thought are, for example, Sydow (1992) or Schneider/Kenis (1996).

\(^{255}\) In this context, for example see the works of Powell (1990) or Willke (1995).

3.1.2 Reasons for Abstaining from Frequently Applied Theories

With respect to the neo-classical perspective, and looking at the venture capital market and the market for investment opportunities VCs can invest in, it becomes obvious that the assumptions of the neo-classical finance theories are not fulfilled. Information on potential investment opportunities is not freely and immediately available to all market participants. Quite the opposite, this information is unequally distributed among market participants and, since it is private and potentially valuable information, it might not be transmitted deliberately.

Although market participants are utility maximizers, the utility function might also incorporate non-monetary elements, which is to a large extent not conformable to neo-classical theories. This becomes obvious based on the discussion on the rationales for syndicating venture capital investments. One example in this context is the expected reciprocation of deal flow.

Often, the VCs engage in early stage investments, i.e., they invest in a financing phase, in which the risk of the investments theoretically can hardly be assessed. Taking this thought one step further, not only for the case of early stage investments but also in later financing stages, the risk profiles of portfolio companies are difficult to evaluate. The value of equity and especially the question why the search for equity capital frequently constitutes a challenge for potential portfolio companies, cannot be explained based on the neo-classical finance theory.

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257 In his work on the informal venture capital market, i.e., on business angels, Brettel (2004) also shows that the neo-classical assumptions do not hold. Although in his work applied to the case of business angels, parts of the line of argumentation are also valid for the formal venture capital market, finally leading to the same result, namely that the neo-classical theories provide an insufficient basis in the context of the study.

258 On the topic of the sharing and the transmission of knowledge, see also Hansen (1999), Cross et al. (2001), Tsai (2001), Borgatti/Cross (2003), Mauta/Autio/Murray (2003), Aalbers/Dolfsma/Koppius (2004).

259 See section 2.1.4.3.


261 See Schefczyk (2004), p. 134. In his work on informal venture capital providers, Brettel (2004) adds two further arguments why the neo-classical perspective is not a useful theoretical foundation for the analysis of the market under consideration. First, securities in the informal venture capital industry are only theoretically divisible. In practice, however, high costs have to be incurred to achieve separation. Here, the author refers to the costs that have to be incurred for notaries. For the purpose of this study, i.e., the formal venture capital market, this argument might not weigh as much as it does in the informal counterpart. This is assumed because in the formal venture capital market, investments are frequently syndicated, i.e., securities are separated. Second, Brettel (2004) argues that the separation theorem does
Based on these arguments it could be shown that, for the formal venture capital market, the underlying assumptions of neo-classical finance theories are not fulfilled. Therefore, this traditional perspective on financial markets is not employed as a theoretical basis within this study.

In contrast to the neo-classical theories of finance, the behavioral approach is able to incorporate psychological and sociological aspects into explaining phenomena observed in financial markets. However, for one simple reason, also the behavioral finance perspective does not seem to provide a solid theoretical foundation in the context of this study: The focus of this work is to examine the VCs’ syndication network by characterizing the individual VC’s network position and drawing conclusions on their deal flow. Behavioral finance, however, is more tailored to explain phenomena occurring on the stock market (stock price movements, behavior of traders), rather than explaining network structures in general, apart from the specific case under consideration (structure of the syndication network). Moreover, based on the approach of behavioral finance it would not be possible to draw conclusions with respect to the deal flow of VCs. Therefore, it is abstained from applying this approach as theoretical foundation to the present study.

With respect to the framework of the new institutional economics, the transaction cost approach is the concept that could theoretically be employed as basis for a study on networks. Although representatives of the transaction cost approach would place the syndication network of VCs on the continuum between markets and hierarchies, the question arises whether transaction cost theory is a suitable approach for the purpose of this study. In the following it will be explained what exactly needs to be analyzed regarding the VCs' syndication network, and it will be checked whether the transaction cost approach is a suitable theoretical foundation to achieve this goal.

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not hold, i.e., investment plans and financing are not separated in early stage investments. Instead, single and specific investments are financed. Again, for the formal venture capital market this argument might not apply to the full extent, since venture capital firms also invest in later stage companies that have been in business for several years. Here, it is assumed, that not only single and specific investments are being financed but that portfolio companies also receive funds that they then can invest in several projects. For the original arguments, see Brettel (2004), pp. 100-101.
In industrial or market systems, firms are in contact with each other to exchange goods or services. These systems can be viewed as relationship networks, i.e., relationships the firms have among each other. To establish and further develop these relationships, firms have to invest time and effort. Furthermore, based on these relationships, firms are dependent on each other and possibilities to change counterparts are to some extent constrained. Therefore, although it is a market system the firms are active in, it is not solely the price mechanism that coordinates the firms' activities. Rather, coordination is either achieved through joint planning activities or through power one firm exerts over another.

At this point, a concept is briefly introduced (social network analysis), that will later be explained in detail and from which the theoretical foundation (social capital theory) will be derived. This is being done to show that the transaction cost approach does not seem to be a suitable theory as basis for this study.

An important idea in order to assess the potential benefits and constraints for a single firm is the network position that the focal firm occupies. The position of a firm within a network provides information on the potential ability of that firm to access external resources, i.e., resources the firm itself does not possess. In the context of this study, an example of such resources is information on potential investment opportunities. This is exactly one goal of this study, i.e., to analyze the VCs' network position within the syndication network and to derive statements about the benefits (in terms of deal flow quantity and quality) the VCs have due to their network position.

Based on these explanations it becomes obvious that the transaction cost theory is not a suitable concept to achieve this goal. Although, as stated above, the network of VCs can

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262 For the network in the venture capital market, see also the works and analyses of Lerner (1994), Gorman/Sahlman (1989), Sahlman (1990), and Hsu (2004).
263 See Owen-Smith/Powell (2004), p. 5.
266 Besides the network position of the single firms, also the structure of the entire network is important. This will be explained in detail further below. See also Owen-Smith/Powell (2004), p. 5.
269 The goal referred to is goal (b), as explained in chapter one.
probably be allocated on the continuum between the endpoints 'market' and 'hierarchy', the transaction cost approach does not deliver adequate methods, with which a network of relationships can be analyzed and that explain the benefits of single network positions. Besides this, another reason for not applying transaction cost theory is that it reverses the logic of social network analysis. Social network analysis holds that network structures and the embeddedness of actors within a network structure (at least co-) determine the actors' economic performance. However, transaction cost theory states quite the opposite, i.e., that economic performance is the driver of individual behavior.\textsuperscript{270} Furthermore, transaction cost theory is criticized regarding the quantification of transaction costs. Although attempts have been made in a general context,\textsuperscript{271} especially in the context of venture capital investments it appears impossible to accurately quantify the transaction costs.\textsuperscript{272} Due to these reasons, the transaction cost approach is not further pursued as a theoretical foundation for this study.

3.1.3 Requirements for the Theoretical Foundation for this Study

Given the arguments above and based on the characteristics of the market for venture capital investments, a theoretical framework needs to be found that accepts bounded rationality and imperfect capital markets or imperfect information as underlying conditions. Furthermore, in order to be able to analyze the network of VCs and particularly their position within the network with regard to their deal flow, a theoretical foundation accounting for the concept of networks seems desirable. In addition, the theory needs to be able to deliver methods and theoretical concepts capable of examining the relationships among individual actors while at the same time being able to explain the benefits of networks as a whole. Therefore, the concept of social network analysis and the theories of social capital are applied, which will be elaborated on in detail in the following sections.

\textsuperscript{270} See Borgatti/Foster (2003), p. 995.
\textsuperscript{272} See Brettel (2004), p. 103.
3.2 Social Network Analysis

In this section (3.2), first, two different perspectives on social networks are explained, of which one will be adopted in this study (section 3.2.1). Second, it will be shown that social network analysis is the appropriate method to examine relationships among actors (section 3.2.2). Third, some necessary vocabulary of social network analysis and information on the measurement and collection of network data are provided (section 3.2.3). Fourth, in order to better understand the today's discussion on social network analysis, a section on the history and background follows (section 3.2.4). These steps are necessary in order to have a common understanding of the basics of social network analysis. Then, in section 3.2.5, it will be explained to which research areas social network analysis has been applied, and a typology of network studies will be used to derive that social capital is the appropriate theoretical foundation for this study.

3.2.1 Economic Perspectives on Social Networks

There are two perspectives how social networks are looked at in economic research. One perspective is to classify social networks as form of coordination, i.e., in the sense of inter-organizational networks. Inter-organizational networks view social networks as a target-oriented form of coordination among actors, i.e., it focuses on the faithful cooperation of actors. This perspective is also denoted as sociological institutionalism, and its underlyings root in the allocation of networks on the continuum between market and hierarchy. In this approach, it is not the position of actors within the network or the structure of the network that is analyzed. Instead, qualitative methods are used to examine for example, strategic networks, regional networks, policy networks, or innovation networks.

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273 Examples of studies, in which this perspective has been applied are the works of Powell (1990), Sydow (1992), or Willke (1995).


275 For discussions on strategic and regional networks, see Piore/Sabel (1985), Nohria/Eccles (1992) or Sydow (1992); for policy networks see Atkinson/Coleman (1989) or Dunn/Perl (1994); for innovation networks see also the debate on open versus closed networks, since innovation networks are closely related to the topics of knowledge sharing, see Coleman (1988), Putnam (1995) and Granovetter (1973), Burt (1992).
From the second perspective, social networks can be understood as networks of relationships. This perspective does not compete with the previous one explained. Rather, it should be regarded as a complementary one, i.e., both perspectives look at the same phenomenon but focus on different aspects. In this approach, the structure of the entire network, the positions of the individual actors within the network, or the content of the relationships between actors are examined based on quantitative methods. An example for this approach would be to characterize the structural position of actor(s) in a network. In addition, social network analysis offers theoretical concepts that serve as basis for the derivation of hypotheses on the actors' abilities to benefit from their structural position in the network. An example would be that actors being centrally positioned within the network or actors building a bridge between otherwise disconnected subgroups might have more influence on others, compared to actors that hold positions in the periphery of the network.

These thoughts are summarized in an overview presented in table 3.1:

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277 In this context, see also the works of Schenk (1984), Pappi (1987), Scott (1988), Trezzini (1988).


279 A significant part of the theoretical discussion in the field of social networks refers to the benefits and constraints of closed or cohesive network structures versus open network structures. For seminal works in the context of closed networks, see Coleman (1988) or Putnam (1995); for works in the context of open networks, see Granovetter (1973) or Burt (1992). At this point of the study, this representation is deliberately simplified in order to present a short overview. Further below, these opposing views and theories are discussed in detail.

280 See Wasserman/Faust (1994), pp. 169 ff. and pp. 198 ff. These thoughts refer to the structural hole theory, which will be explained further below. See for example Burt (1992).
Social Network Analysis

<table>
<thead>
<tr>
<th>Perspective</th>
<th>• Social network analysis</th>
<th>• (Inter-) Organizational networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension</td>
<td>• Method of analysis</td>
<td>• Form of coordination</td>
</tr>
<tr>
<td>Nature of measurement</td>
<td>• Quantitative analysis of network structure</td>
<td>• Qualitative description of type of network and form of cooperation</td>
</tr>
<tr>
<td>Objects of analysis</td>
<td>• Position of actors within the network</td>
<td>• Form of cooperation within the network</td>
</tr>
<tr>
<td></td>
<td>• Structure and sub-structures of entire network</td>
<td>• Types of networks</td>
</tr>
<tr>
<td></td>
<td>• Resulting opportunities and constraints for actors</td>
<td>• Description of purpose of cooperation</td>
</tr>
<tr>
<td>Examples</td>
<td>• Relationship networks (individual persons, companies, states, etc.)</td>
<td>• Strategic networks</td>
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<tr>
<td></td>
<td></td>
<td>• Regional networks</td>
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<tr>
<td></td>
<td></td>
<td>• Policy networks</td>
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<tr>
<td></td>
<td></td>
<td>• Innovation networks</td>
</tr>
</tbody>
</table>

Table 3.1: Overview of perspectives on social networks

In these two perspectives, the difference between sociological institutionalism and sociological network analysis becomes obvious: Sociological institutionalism views networks as a form of efficient coordination of action, which is in place if transactions are not effectuated on the market or within an organization. In contrast, the sociological network analysis perspective does not necessarily regard markets, organizations, or networks as an efficient form of coordination. Also, the stringent assumption that humans behave in an opportunistic manner, as is assumed within the institutional perspective, does not exist in formal network analysis. Actually, it is not the form of coordination or opportunistic behavior that formal network analysis is interested in. Rather, a network is defined in a formal or neutral way, describing it as set of nodes (actors) that are connected by lines (relationships). The striking advantage of social (formal) network analysis is that the social structure, which is to be analyzed, is not classified ex-ante as form of coordination, i.e., market, hierarchy, or network. Rather, by the instruments of formal network analysis, competitive social structures such as markets as well as hierarchies or networks can be examined. What is of interest in social network analysis, is

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282 This, of course, also relates to the field of new institutional economics, therefore the term sociological institutionalism exists.
284 An explanation of basic terms used in social network analysis follows in section 3.2.3.
the underlying structure of relationships and the resulting positive or negative implications for the actors. 285

Since one goal of this study is to analyze the individual VCs' position within the syndication network, the perspective presented first will be adopted, which views social networks as networks of relationships.

3.2.2 Social Network Analysis as Method to Examine Relationships

In general, the term 'network' denotes social structures or systems, which can be illustrated as a graph. Simplistically, a graph consists of points, and edges connecting the points. Just some examples for networks from practice are road networks, computer networks, or social networks. 286 In social networks, the points within a graph can correspond to individual persons, groups of persons, institutions, organizations, or even countries. 287 In this case, the connections between the points represent the relations or ties between the persons, groups, or organizations. These relations or ties can take various forms, for example, friendship, kinship, or the exchange of resources such as information. When analyzing the social network among actors such as the syndication network of VCs, it is decisive, which kind of data is to be looked at. In social sciences, there are basically three types of data, i.e., attribute data, relational data, and ideational data. 288 Attribute data refers to the behavior, opinions, and attitudes of persons or the unit of analysis. Attributes are measured as the values of particular variables such as education, income, or occupation. The methods that are appropriate to analyze attribute data are those of variable analysis. Ideational data describes, for example motives, meanings, or definitions. This kind of data is analyzed by typological analysis. Relational data refers to the contacts, ties, and connections, which relate one point in the graph with other points. This kind of data therefore does not describe the properties of the points, i.e., persons, groups, or organizations, but of systems of points. As Scott (2000) explains, "…these

relations connect pairs of agents into larger relational systems.” The methods that are appropriate to analyze relational data are those of social network analysis. An overview of the before-mentioned types of social science data and types of corresponding analyses is presented in figure 3.1.

<table>
<thead>
<tr>
<th>Type of data</th>
<th>Examples</th>
<th>Type of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attribute data</td>
<td>Behavior, opinions, attitudes</td>
<td>Variable analysis</td>
</tr>
<tr>
<td>Ideational data</td>
<td>Motives, meanings, definitions</td>
<td>Typological analysis</td>
</tr>
<tr>
<td>Relational data</td>
<td>Contacts, ties, connections</td>
<td>Social network analysis</td>
</tr>
</tbody>
</table>

Figure 3.1: Types of social science data and types of analysis

Social network analysis is a fairly complex scientific area, with a very extensive and partially confusing profusion of methods and models provided in social sciences and economic literature. The reason for this is that social network analysis developed based on research in diverse scientific strands or disciplines such as sociology, psychology, anthropology, and mathematics. Strands of research of these areas "...intersected with one another in a complex and fascinating history, sometimes fusing and other times diverging on to their separate paths." 

In order for the reader to get a better understanding of this extensive research field, a view on the history and background of social network analysis will follow (section 3.2.4). Before though, some fundamental vocabulary and concepts need to be explained.

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290 Own illustration according to Scott (2000), p. 3.
3.2.3 Fundamental Concepts of Social Network Analysis

3.2.3.1 Basic Terms

The following explanations on basic terms used in social network analysis are taken from the textbook of Wasserman and Faust, which is on the methods and applications of social network analysis and which is frequently referred to in academic research.292

**Actor:** As introduced above, social network analysis focuses on the connections or linkages among social entities and on the implications these connections have. In social network terminology, these social entities are referred to as actors. Generally, actors can be individual people, groups of people, subgroups, organizations, or collectives such as communities or even nations. In network analysis, the actor, whose network connections are analyzed, is denoted as 'ego', while the actors, ego is directly connected to, are denoted as 'alters'.

**Relational tie:** The connections between the actors are called 'social ties' or 'relational ties'. Relational ties can be of various types, however, the defining criterion is that it establishes a connection between a pair of actors. Examples for types of social ties are friendship or liking among people, transfer of resources as is the case with business interactions, affiliation such as jointly attending social events, behavioral interactions such as talking to each other or sending messages, or biological connections such as kinship.

**Dyad, triad:** A dyad refers to a pair of actors and the possible tie or ties between them. Most frequently being the unit for statistical analysis of networks, dyadic analysis concentrates on the properties of the relational tie(s) between two actors, such as reciprocity or strength. In contrast to dyads, triads refer to a subset of three actors and the tie(s) among them. Many social network analyses focused on triads, especially the ones referring to balance theory or transitivity.293

292 See Wasserman/Faust (1994).
293 Explanations on balance theory will follow in section 3.2.4.1. Transitivity describes the situation that if actor A likes actor B, and if actor B likes actor C, then, in the long run, actor A also tends to like actor C. For an early discussion of the idea of transitivity, see also Rapoport (1953a), Rapoport (1953b),
Ego-network and total network: The term ego-network, also denoted as neighborhood, refers to the network a focal actor has. That means, included in the ego-network are the ties of ego to his direct alters as well as the ties among these alters. Therefore, when calculating network measures based on the ego-network, only the above mentioned relationships are included. In contrast, the term total or entire network refers to all actors and their relationships in the network. Measures, which are calculated based on the total network, therefore include all actors and all relationships.294

Subgroup and group: Subgroups are defined as any subset of actors such as dyads, triads, or larger subsets and the existing ties among them. Although identifying and studying subgroups of social networks has been an important aspect, the specification of the group of actors itself, which should be analyzed, is at the heart of social network analysis. A group can be defined as "...the collection of all actors on which ties are to be measured".295 Based on conceptual, theoretical, or empirical criteria, the boundaries of the group under consideration have to be drawn, resulting in a finite set of actors of whom the ties are analyzed.

Structural and composition variables: It can be differentiated between two types of variables that occur in network data, i.e., structural and composition variables. Structural variables are measured on dyads, i.e., pairs of actors. Examples are business transactions, trade between nations, or friendship relations. In contrast, composition variables are measured on the level of individual actors. Examples are geographical location, gender, race, etc.296

Mode: The term 'mode' refers to a specific set of entities, on which structural variables are measured. One-mode networks therefore refer to a single set of actors, on which

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Theoretical Foundation

structural variables are measured. In case of two-mode networks, there are two sets of actors, on which structural variables are measured. An example could be the measurement of transactions between one set of actors consisting of corporations, and another set of actors consisting of non-profit corporations.\footnote{See Marsden (2005), pp. 8 f.; Wasserman/Faust (1994), p. 29. In addition to the types of networks explained above, Wasserman/Faust (1994) also mention another type, the so-called 'affiliation network'. These networks are two-mode although they only have one set of actors. The second mode within this network is a set of events, which actors attend (for example a club or organization). For a further discussion of these types of networks, see Wasserman/Faust (1994), p. 30.}

\textit{Social network:} Based on the explanations above, a social network shall be defined as a "…finite set or sets of actors and the relation or relations defined on them".\footnote{Wasserman/Faust (1994), p. 20. See also Weyer (2000), p. 11 and p. 36.}

3.2.3.2 \textit{Measurement and Collection of Network Data}

\textit{Measurement:} In terms of measurement of network data, three aspects require attention, which are the unit of observation, the modeling unit, and the quantification of the relations. The unit of observation refers to the entity, on which measurements are collected, i.e., the individual actor, a pair of actors, the relational tie(s), or events.\footnote{See Wasserman/Faust (1994), p. 43.} For the purpose of this study, the unit of observation is the individual VC and the ties to other VCs within the network.

The so-called modeling unit refers to the level, at which network data is presented. This can be the actor, the dyad or triad, a subgroup, the set of actors, or the entire network.\footnote{See Wasserman/Faust (1994), p. 44.} The choice of the modeling unit depends on the kind of analysis intended. If, for example, it should be studied, whether there are subsets of actors, in which the actors interact more frequently with each other, the relevant modeling unit would be the subgroup. Therefore, which modeling unit is the relevant one, is dependent upon the network measure or network property under consideration.

Regarding the quantification of the relations, it is important to understand two basic dimensions, which are the directionality and the numeration.\footnote{See Scott (2000), pp. 47 f.} Relational data can either
be directed or undirected. In the case of a directional relation, the "…tie between a pair of actors has an origin and a destination; that is, the tie is directed from one actor in the pair to the other actor in a pair".302 In the case of an undirected relation, the tie does not have an origin and a destination, which means that the two actors of the pair are just connected. In the case of syndicated venture capital investments, an undirected relation exists if two or more VCs jointly invest in a portfolio company. If, in addition to this, information existed on which VC invited the other firms to join an investment, a directionality of the relation could also be shown.

The second important dimension regarding the quantification of relational data is its numeration, which can either be binary, i.e., dichotomous, or valued. If it is binary, information only exists on whether a relation between two actors is present or absent. In the case of syndicated venture capital investments this means that either two firms have or have not jointly invested in a deal. With valued relations, statements can also be made about the strength, frequency, or intensity of the relation.303 For example, if two VCs frequently invest in projects together, the relation between these two actors is supposed to be stronger or more intense compared to the case, in which they have only invested once.

Collection: The collection of social network data can be performed in many ways. The most commonly used are questionnaires, interviews, experiments, observations, and archival records.304 To collect information on the relations between actors, who are individual people, most often questionnaires, interviews, observations, and experiments are applied.305 To collect data on syndicated venture capital investments and thereby on relational ties between VCs, a database, i.e., archival records containing information on joint investments, is most appropriate and will be used. In addition, as is common in

302 Wasserman/Faust (1994), p. 44.
304 There are also several other techniques to gather information on relations between actors such as the small world technique or the ego-centered technique. However, since these techniques are used for very specific social study designs, which are not relevant for the purpose of this study, they are just mentioned but not explained in further detail. For a further discussion, see for example Burt (1984) for ego-centered, Milgram (1967) and Korte/Milgram (1970) for the small world technique.
305 For a detailed discussion of these techniques, see Wasserman/Faust (1994), pp. 45-54.
social science studies, a questionnaire will be used to gather further information on composition variables, for example, such as the quantity and quality of the deal flow of the VCs under consideration.

3.2.4 History and Background of Social Network Analysis

Present-day social network analysis has its roots in basically three main traditions: Firstly, sociometric analysts working on small groups from the middle of the 1920's onwards, developing and employing the concept of graph theory; secondly, researchers from Harvard University, who, in the 1930's, explored the formation of cliques and patterns of interpersonal relations; thirdly, anthropologists from the University of Manchester, who, while building on results from the sociometric analysts and the Harvard researchers, examined the structure of community relations, and village and tribal communities from the 1950's onwards. Later, during the 1960's and 1970's, again Harvard researchers (mainly Harrison White and his associates, who continued his work), brought together these three main traditions and forged contemporary social network analysis. These four steps in the historic development towards social network analysis are described in the following.

3.2.4.1 Sociometric Analysis and Graph Theory

Sociometric analysis dates back to a tradition in psychology, called 'Gestalt theory', which is mainly associated with the work of Köhler (1925). Gestalt theory basically deals with organized patterns or conceptual schemes of the human mind, through which thoughts and perceptions are structured. Also, Gestalt theory "...emphasizes the influence of group organization and its associated social climate on individual perceptions."
Jacob Moreno, one of the leading Gestalt theorists, examined the psychological well-being of individuals, which is related to the structural features of the group, the individual is part of. Moreno named this 'social configuration', being the result of the relations people are involved in. Moreno displayed the formal properties of these social configurations in a so-called sociogram, which is a systematic way to illustrate a network of relations. An example of one of Moreno's sociograms is given in figure 3.2:

![Figure 3.2: Sociogram: The sociometric star](image)

The sociogram allowed researchers to identify for example leaders or isolated individuals in a social network, to show the channels through which individuals could influence each other, or through which information could flow, or even to examine asymmetry or reciprocity of relations. For example, in the sociogram illustrated, person A receives choices from all other persons, but only gives choices to persons B and C. A is therefore a person of comparably great popularity and leadership.

Approximately at the same time, Lewin examined the structural properties of groups, which are described as elements within a field of relations. The focus of the so-called 'field theory' was therefore to investigate the group and its environment in a system of relations based on mathematical techniques. As in a sociogram and from a topological point of view, the social field consists of points that are connected by lines, which create

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311 See the famous work of Moreno (1934).
315 See the work of Lewin (1936), and later also Lewin (1951).
paths. These paths not only connect the points, but patterns of paths may also divide the social field into separate regions, i.e., into a social structure, in which paths run within specific regions of the social structure but not between these regions. The boundaries imposed by the course of the paths also have implications on the opportunities people have, for example, to communicate or move through the social field.316

Later, in the 1950's, Cartwright and the mathematician Harary, built on Lewin's strand of research of mathematical models of group relations. They were the first to apply graph theory to group behavior.317 Graph theory was pioneered by König in 1936 in Germany, however, due to the political situation in Germany at that time, only through a republishing of the book in 1953 in the US, the concept found its way into a broader scientific usage.318 Using Lewin's and Moreno's insights on group structure and group behavior, Cartwright and Harary (1956) illustrated groups as a collection of points that are connected by lines, which was the fundamental insight of Moreno.319 Graph theory also refers to a collection of points connected by lines. Due to several reasons, graph theory is a useful tool to analyze social networks. Firstly, structured properties of social networks can be defined by a set of useful vocabulary.320 Secondly, graph theory is based on mathematical concepts to measure these structural properties. Thirdly, based on the vocabulary and the mathematics, graph theory allows researchers to deduce testable statements about the social structure and its implications for the actors.321 Based on the sociometric and graph theoretic findings, Cartwright and Harary were working on concepts to decompose a social structure into subgroups. They made use of a theory first developed by Fritz Heider in 1946, called the cognitive balance theory.322 This theory refers to cognitive psychology and to attitudes and perceptions of individuals. The theory basically states that, if a person's beliefs are unbalanced, a state of psychological stress will cause internal pressure, resulting in the fact that the person will change some of the

317 See the works of Harary/Norman (1953), Bavelas (1950), or Cartwright/Zander (1953).
320 How the structural properties can be measured will be explained in sections 3.4.4 and 3.4.5.
sentiments (liking, disliking) or the relationship (proximity, membership). In the case that a set of beliefs is equally positive or negative, cognitive balance exists. Unbalanced beliefs produce imbalances that are not sustainable. As Heider formulates, "[a] balanced configuration exists if the attitudes […] are similar."\textsuperscript{323} For example, if person A likes person B, and person B likes person C, a balance can only be reached if person A also likes person C. Cartwright and Harary picked up this concept, applying it to triadic structures, i.e., to groups of three individuals.\textsuperscript{324} The researchers proposed that complex social structures are built from simple structures, and more precisely, complex social structures are built from overlapping triads.\textsuperscript{325} By analyzing these triads, or threesomes, they argued, also complex social structures can be analyzed. One of the most important findings, for example, was that any balanced graph, whether complex or not, can be dissected into two subgroups. Within each subgroup, relations are positive, i.e., individuals like each other, however, the relation between the subgroups is negative.\textsuperscript{326} Based on these findings, a lot of work has been done to identify techniques to decompose any balanced or unbalanced graph or social structure since the identification of subgroups might bring significant features of the social network to daylight.\textsuperscript{327}

3.2.4.2 Interpersonal Relations and Cliques

Parallel to the work being done in the sociometric and graph theoretic field, Harvard researchers investigated interpersonal relations and subgroups of social networks, called cliques, during the 1930's and 1940's. These researchers were concerned with techniques to decompose the social structure of any social system into subgroups. Major proponents in this area were W. Lloyd Warner and Elton Mayo.\textsuperscript{328}

\textsuperscript{323} Heider (1946), p. 107.

\textsuperscript{324} The analysis of dyads, i.e., two individuals, and triads, dates back to Simmel (1908).


\textsuperscript{326} For this, also see the studies of Davis (1967) and Holland/Leinhardt (1978).

\textsuperscript{327} See Wasserman/Faust (1994), p. 15. For a further discussion of the discovery of decomposition techniques, also see the study of Davis (1966).

\textsuperscript{328} Predecessors or academic mentors of Warner and Mayo were Radcliffe-Brown and Durkheim, who worked in Australia and whose thoughts were picked up developed further by Warner and Mayo. See Scott (2000), p. 16.
Theoretical Foundation

During the 1930's, Mayo performed an anthropological study of workers in a bank wiring room of the Hawthorne electrical factory in Chicago, observing the workgroup behavior, recording the relationships in the form of a sociogram. Although the Hawthorne study was the first to use a sociogram to describe the relations between people in a real setting, the researchers did not use their records for sociometric analysis.  

Also during the 1930's, Warner, whose work strongly built on thoughts of Radcliffe-Brown and Durkheim, emphasized aspects such as cohesion, reciprocity, stability, and integration in his study of social structures. Closely related to the vocabulary Moreno used, Warner argued that social groups consist of subgroups or, how he termed them, 'cliques'.  

Although there were other studies also referring to cliques or subgroups during that time, it was not until the early 1950's that Homans picked up the work of Mayo, Warner, and also of other researchers. While also Warner used simple matrices to display social interaction, Homans was the first to make use of matrix rearrangements to decompose subgroups in social structures. Although matrices will also be described in a later section, it is useful to present the basic idea at this point. Until that point in time, relations between individuals have been illustrated in a sociogram, however, they can also be displayed in matrix form. In a so-called sociomatrix or adjacency matrix, the rows and columns represent the individual persons in identical order. Basically, if a relation exists between two individuals, a '1' is noted as the respective element in the matrix, a '0' in case that no relation exists. One can easily imagine that a sociomatrix for many individuals and their relations presents a confusing picture of 1's and 0's and it might be difficult to recognize any pattern. Homans, however, had the idea to rearrange the sequence of the indivuals within the rows and columns until a pattern of relations becomes visible through blocks of 1's and 0's. This development, i.e., the attempt to decompose a social network into its subgroups, was an important step in social network analysis.

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329 The researchers used the form of a sociogram without actually being aware of the development made by Jacob Moreno. See also the report of the Hawthorne studies by Roethlisberger/Dickson (1939), pp. 500 ff.
331 See Warner/Lunt (1941), p. 32.
332 For example, one of the studies, Homans also made use of, was the one of Davis/Gardner/Gardner (1941).
334 This is a very simplifying description but sufficient for the purpose of the study at this point. See also Wasserman/Faust (1994), p. 80 and pp. 150 ff.
3.2.4.3 The Manchester Anthropologists

The third main tradition of social network analysis were the Manchester anthropologists, mainly John Barnes, Clyde Mitchell, and Elizabeth Bott. Influenced even stronger by Radcliffe-Brown than the Harvard researchers, the leading scientist in Manchester, Max Gluckman, instructed his associates not to emphasize cohesion and integration, but to emphasize conflict and change in their studies of small interpersonal communities. The researchers regarded social structures as networks of relations and successfully combined techniques of network analysis with sociological concepts in the early 1950's.\textsuperscript{335}

Focusing on the work that had been done in the sociometric field, Barnes and Bott more rigorously and analytically applied the idea of a social network, which, until then, had more been used in a metaphorical sense. However, inspired by a work of Nadel in 1957,\textsuperscript{336} Mitchell referred to graph theory, which is, as stated above, a basic mathematical concept in sociometric analysis of social structures. More precisely, he described a social network as ";...personal links individuals have with a set of people and the links these people have in turn among themselves."\textsuperscript{337} According to Mitchell, actions between the individuals incorporate both, the transfer of information and the transfer of goods or services. Furthermore, and also of special importance for this study, Mitchell argues that, in order to do actual research on social networks, it is necessary to select a particular aspect, i.e., a certain part, of the social network under consideration. This is due to the fact that the entire network with all its relations, is, in most cases, simply too large.\textsuperscript{338} For the network analysis in this study, therefore, of all kinds of relationships a VC and its employees have, the selected part of the network is the syndication network, representing the contacts that VCs have among each other.\textsuperscript{339}

Mitchell applied two basic forms of concepts to interpersonal relations. On the one hand, there are concepts that describe the quality of relations such as reciprocity, intensity, or

\textsuperscript{336} See the work of Nadel (1957). Nadel was influenced by the previously mentioned researchers Köhler and Lewin.
\textsuperscript{337} Mitchell (1969), p. 10.
\textsuperscript{339} The entire network of a VC would incorporate all contacts the employees have, i.e., private contacts to friends or family members as well as professional contacts to consultants, lawyers, and others.
durability of the relations. On the other hand, there are concepts taken from graph theory that describe interpersonal relations such as density or reachability.\textsuperscript{340}

In their work, Mitchell, Barnes, Bott, and most of the other Manchester researchers focused on so-called ego-centered networks, i.e., the social network relations of all kinds of one individual. These informal, interpersonal relations included friendship ties, work relations, political relations, etc. of one individual. However, what was not the focus of attention was to analyze "…the global properties of social networks in all fields of social life…".\textsuperscript{341} This strand of analysis was picked up by Harrison White and his associates at Harvard University, who, mainly in the 1960's and 1970's, brought together the three main traditions of social network analysis. This fourth step in the development towards contemporary social network analysis will be described in the following.

3.2.4.4 Synthesizing the Developments at Harvard University

Through their work, Harrison White and his associates have made significant progress in social network analysis as a method of structural analysis of social networks. The researchers mainly focused on two mathematical strands. One was the development of a scaling technique, which allows to illustrate social relations as social distances. The other, and even more important, was the focus on algebraic models to express the notion of social role or position of individuals in a social network.\textsuperscript{342} Many researchers in subsequent years have centered their attention on the concepts of position or role.\textsuperscript{343}

A milestone that made social network analysis popular in American sociology was an article of Mark Granovetter in 1973 called 'The strength of weak ties'.\textsuperscript{344} It inspired researchers also of other scientific areas to apply social network analysis to all kinds of phenomena, one of which are, for example, corporate interlocks. Granovetter studied the channels through which individuals receive information on job opportunities. He found

\begin{itemize}
\item \textsuperscript{340} See Mitchell (1969), pp. 24 ff.
\item \textsuperscript{341} Scott (2000), p. 33.
\item \textsuperscript{342} See, for example, the work of Lorrain/White (1971).
\item \textsuperscript{343} For the concept of position, see, for example, Burt (1976), Faust (1988), or Borgatti/Everett (1992). For the concept of role, see, for example, White/Reitz (1983), White/Reitz (1989), Winship/Mandel (1983), or Breiger/Pattison (1986).
\item \textsuperscript{344} See Granovetter (1973).
\end{itemize}
that people did very little active search for job opportunities, but that most of the latter were communicated to them through work related contacts. More precisely, it were those contacts that were not close friends or people in the same occupation as the person looking for a job, but it were mostly just acquaintances. Granovetter made his conclusions based on an information diffusion model: People, who have information on job opportunities, pass it on to their direct contacts, who, in turn, pass it on to their direct contacts, and so on. That way, information flows through the social network, attenuating at each step as it flows through the various links within the network. Therefore, people in the network, who are positioned in a great social distance from the source, are unlikely to receive accurate information on the job opportunity or they do not receive the information at all. Therefore, Granovetter concluded that the position of a person's contacts within the network structure is highly important in order to receive information that flows through the network.

Based on these findings, Granovetter derived his famous argument about the 'strength of weak ties'. Strong ties are relations to people one knows well or with whom one interacts frequently. However, due to the frequent interaction, these contacts show the tendency to have the same information, i.e., there is very little novel information coming from strong ties. In contrast, weak ties are relations to people, who are not close friends but rather acquaintances, i.e., people in different work situations or people to whom one has less frequent contact. Granovetter found that it were the weak ties that are most important for the reception of novel information.

Some researchers argue that social network analysis also represents a basis for the development of a formal theory, instead of just formal concepts or methods. Some

345 See Granovetter (1973), pp. 1371 f.
349 See, for example, the work of Barnes/Harary (1983).
authors promote, for example, an exchange theoretical view, others focus on the sociological perspective based on just the relational aspects. Despite these advances, social network analysis "...is not a specific body of formal or substantive social theory" in itself, but rather provides a set of very useful concepts and methods, based on mathematical and graph theoretic techniques, to analyze the structural properties of social networks.

In the following section, it will be shown, first, to which research areas social network analysis has been applied (section 3.2.5.1). Since this field is very extensive, second, network studies will be categorized and based on this categorization, the theoretical foundation for this study will be derived (section 3.2.5.2).

3.2.5 Research Areas and Typology of Network Studies

3.2.5.1 Research Areas

Since the beginning of the 1970's, the number of research studies in the field of social network analysis has grown tremendously. Therefore, in academic literature, it is commonly described as challenging to get an overview of the methods, applications, and theories behind social network analysis. However, in order to better understand the research of this study, it is helpful to structure this section as follows: First, a literature review provides an overview of the main research areas, in which social network analysis has been applied. Although these areas are partially overlapping and intertwined, from the author's perspective this step is helpful in order to better understand the methods and

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350 See, for example, Cook (1977), Cook (1982), Emerson (1962), Emerson (1964), or Cook/Whitmeyer (1992).
351 See, for example, Emirbayer/Goodwin (1994) or Emirbayer (1997).
354 From the author's experience with user and discussion forums in the social network research arena, topics range from the analysis of economic outcomes for firms in a network, to the analysis of terrorist networks, to the analysis of relationships between countries, to the analysis of the passes between players in a basketball game. Although the latter is certainly not the mostly used area, however, it demonstrates the wide range of topics social network analysis is applied to. See, for example, the analysis of relations among countries including the US, Europe, and the countries in the mideast region, under http://www.orgnet.com/mideast.html.
theories applied in this study. Second, it is explained in what dimensions network studies differ and how they can be categorized. Based on this categorization, the focus on social capital theory will be derived. Third, the concept of social capital including its underlying theories is specified as theoretical foundation of this study.

One area that has experienced the most significant growth in network research is the topic of social capital. Social capital can, very generally, be described as referring to the value of relationships. The concept of social capital builds on explaining benefits for individual actors based on their network position. Studies in this area relate an actor's ties to a wide range of outcomes such as mobility, individual performance, entrepreneurship, power, individual creativity, or many others. Seminal works in this area are the ones of Granovetter (1973), Burt (1992), Coleman (1990), and Putnam (1995), which reflect two theoretical strands in the social capital arena. Granovetter and Burt propose that weak ties and the lack of ties of others are the characteristics that determine positive outcomes for actors. In contrast, Coleman and Putnam propose that it is the strong ties and dense networks that determine positive outcomes. Besides these seminal works that shaped this main research stream in social network analysis, there is a vast body of literature in this area, the mentioning of which would go beyond the scope of this study.

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358 See the studies of Brass (1984) or Kilduff/Krackhardt (1994).
359 See the study of Perry-Smith/Shalley (2003).
360 These are just some examples. For good overviews, see Portes (1998) or Lin (2001).
361 Which Burt denotes as the so-called structural holes. See, for example, Burt (1992), pp. 18 ff.
362 Granovetter developed the so-called 'strength of weak ties' theory, see Granovetter (1973). Burt developed the so-called 'structural hole theory', see Burt (1992).
363 See the works of Coleman (1988), Coleman (1990), and Putnam (1995).
364 Further characteristic studies include, for example, the ones of Portes/Sensenbrenner (1993), Gulati/Westphal (1999), or Gargiulo/Benassi (2000).
Another area that experienced significant growth is the topic of embeddedness. Again induced by a seminal work of Granovetter, in this field, economic actions are described as necessarily embedded in a larger social context. The argument here is that ties, which are well embedded in the larger social system of relationships yield performance benefits, for example, that close and exclusive relationships drive economic outcomes. Applications include a wide range of topics such as the analysis of the effect of embeddedness in the field of client relationships, purchasing decisions of individuals, cost of capital, market entry in foreign markets by international consulting firms, or economic geography. As becomes obvious, the areas of social capital and embeddedness are closely intertwined because they both look at relationships and their potential effect on economic outcomes for individual actors.

In a somewhat different vein, social network research has also been applied to areas such as board interlocks, joint ventures and strategic alliances, or social cognition. Board interlocks describe the situation that companies are connected in the sense that the same person(s) sit(s) on the boards of both firms. In this context, especially the causes of board interlocks as well as the informational aspects of board interlocks have been focused on. Network research on joint ventures and strategic alliances refer to topics

365 See Granovetter (1985). See also Granovetter's review on how social structure impacts economic outcomes, see Granovetter (2005).
366 See Granovetter (1985), pp. 481 f. For an overview on conceptions for embeddedness, see also Dacin/Ventresca/Beal (1999).
367 In this field see, for example, the works of Uzzi (1996), Uzzi (1997), Uzzi (1999), or Gulati/Gargiulo (1999). On economic outcomes in the form of occupational status of individuals, see De Graaf/Flap (1988).
368 See the study of Baker/Faulkner/Fisher (1998).
369 See the study of DiMaggio/Louch (1998).
370 See the study of Uzzi (1999).
372 See the review of Mizruchi (1996).
373 See the studies of Pfeffer (1972), Palmer (1983), or Zajac (1988).
374 See the studies of Davis (1991), Haunschild (1993), or Gulati/Westphal (1999).
375 An overview of network studies in inter-organizational network research is to be found in Aldrich/Whetten (1981). For a network study on strategic alliances in high-technology industries, see Stuart (1998).
such as firm valuation, innovation, or organizational learning. Social cognition refers to how actors perceive their network. This strand of research is concerned with the implications (for research) of actors not being able to accurately report on their network contacts. This topic also includes the notion of how actors develop the perception they have of the network.

Another area of network research relates to the question how, for example, proximity, amount of interaction, or similarity in the beliefs among actors is interrelated with affective ties. An important case within this strand of research is the so-called homophily theory, which relates to the tendency of actors to interact with those that are of their kind. The saying 'birds of a feather flock together' probably best describes this phenomenon.

As becomes obvious, there is a manifold body of academic literature that uses the models, methods, and theories of social network analysis. A categorization of network research helps to get a better understanding in what dimensions network studies differ. Based on this categorization, the theoretical foundation (social capital) will be derived.

### 3.2.5.2 Typology of Network Studies

Studies that appear in network research can be examined along four dimensions, which include the direction of causality, the levels of analysis, the explanatory goals, and the explanatory mechanisms. The first two are more methodological, the latter two are more substantive and will be used to derive a typology to classify network studies.

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379 This area of research goes back to the discussion on informant accuracy. See, for example, Bernard et al. (1984).
381 For an overview on this area, see Kilduff/Corley (2000).
382 For this strand of research, see, for example, McPherson/Smith-Lovin/Cook (2001).
383 In network literature, little effort has been done to systematically categorize existing research. Approaches include, for example, those of Lin (1999a) or Borgatti/Foster (2003). For the purpose of this study, the approach of Borgatti/Foster is adopted.
Direction of causality basically refers to the question whether studies are about the causes or consequences of network structures, or, in other terms, whether network measures serve as dependent or independent variables in the analysis. The levels of analysis refer to the aspect whether network measures are calculated for individual actors or pairs of them, for subgroups, or for the entire network. More important for the development of a typology of network studies are the latter two dimensions, i.e., explanatory goals and explanatory mechanisms, which relate to the consequences of network structures. Both dimensions contain two characteristics each, so that a 2x2-table can be established.

Explanatory goals include the two characteristics 'performance' and 'homogeneity'. Basically, the goal of a network study can either be to explain the benefits of a network position and opportunities for the actor that result from his network position. Or, the goal can be to explain how certain things such as practices or attitudes diffuse through a social system and how the network structure changes the attitudes of actors. To make this point more explicit, there are basically two kinds of network studies with respect to the goals of studies: One kind focuses on social capital and strives to explain differences in outcome based on network positions. Examples are the studies of Burt (1992) on promotions based on network positions or the study of Gargiulo and Benassi (2000), who show that managers with cohesive networks are less flexible than managers with networks rich in structural holes. The other kind focuses on diffusion, social influence, and social attitudes, and seeks to explain homogeneity among actor beliefs or attitudes as function of the actors' network ties. Examples are the studies of Erickson (1988) on attribute formation, Friedkin and Johnsen (1999) on social influence, and Davis (1991) on diffusion.

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384 This aspect relates to the so-called 'micro-vs.-macro' debate in social network research. Many network analysts argue that social network analysis is a method that holds the potential to bridge the gap between analysis on the micro-level (individual actors) and analysis on the macro-level (entire social systems such as companies, states, etc.). For early discussions on this topic, see for example Parsons (1937) for the macro-perspective, and Homans (1972) or Hummel/Opp (1972) for the micro-perspective. See also the works on micro-macro-models of Coleman (1986) and Burt (1982).

385 See Borgatti/Foster (2003), pp. 1001-1004, and see further below.


387 The notion of diffusion has attracted a large number of researchers. For example, for a model of diffusion in heterogeneous social networks, see Buskens/Yamaguchi (1999).
Explanatory mechanisms refer to the difference (in network studies), how the function of ties are viewed. The so-called structuralist view focuses on the structure or configuration of an actor's network ties (topology) and on the benefits that the actors have due to their network position. In contrast, the so-called connectionist view focuses on the resources controlled by others, and thereby on the question, whom one has to contact to get access to specific resources.\footnote{See Borgatti/Foster (2003), p. 1002.} Examples for the structuralist view are the works of Burt (1992) and Coleman (1988), examples for the connectionist view are the works of Lin (2001) and De Graaf and Flap (1988).

However, that these two seemingly opposing views are intertwined, becomes obvious in the following debate in academic research: Burt explains in his seminal work that the debate is about the 'who' (connectionist) and the 'how' (structuralist).\footnote{See Burt (1992), pp. 11-13.} That is, the connectionist view focuses on whom one reaches to get specific resources, while the structuralist view is about how (structure) one reaches another actor. The reason why Burt favors the structuralist over the connectionist view is that, as he argues, the network position and structure of the ego-network of an actor implicitly "...indicates the volume of resources held by the player and the volume to which the player is connected."\footnote{Burt (1992), p. 13.} However, Borgatti and Foster (2003) argue that, although Burt puts himself into the structuralist camp, his network measures combine both arguments, structuralist and connectionist.\footnote{Burt has developed network measures such as 'effective size' or 'constraint'. Without elaborating on them at this point in the study, they are explained in detail in section 3.4.5.1.2.} This is due to the fact that an actor's relationship structure also determines to whom this actor is connected to.\footnote{See Borgatti/Foster (2003), p. 1003.}

Neglecting this debate, a 2x2-table can be derived to categorize network studies, which is presented below:
The two axes of the table reflect the two dimensions, i.e., explanatory goals and explanatory mechanisms. The goal of a network study (horizontal axis) can either be to explain performance or to explain diffusion in terms of social homogeneity. The explanatory mechanisms (vertical axis) can either be the structuralist view, i.e., referring to benefits for actors based on network position, or it can be the connectionist view, under which the focus is on the resources that flows through the ties.

The resulting four quadrants, reflecting different types of network studies, are denoted as structural capital, social access to resources, environmental shaping, and contagion. Network studies of the type 'structural capital' explain the benefits of actors based on their network positions. Actors are seen as agents who are able to extract gains based on their network position. Studies of the type 'social access to resources' focus on the success of actors as a function of resources controlled by other actors. Studies of the types 'environmental shaping' and 'contagion' explain how, for example, actors' attitudes, beliefs, or culture become similar (homogenous) based on network structure (structuralist) or based on whom they are in contact with (connectionist).

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394 See, for example, the studies of Brass/Burkhardt (1993), Powell/Koput/Smith-Doerr (1996), Burt (1992), Burt (2004), or Coleman (1988).
395 Although Burt sees himself as structuralist, the argument explained is strongly related to Burt's argument regarding the constraint of actors. The measure of constraint will be explained in section 3.4.5.1.2.
Based on this typology, it directly becomes obvious that the explanatory goal of this study, i.e., explaining the quantity and quality of deal flow based on the VCs' network position, is clearly in the social capital area of network research. However, as explained above, some network measures combine the structuralist and the connectionist arguments. Applied to the VCs' syndication network, while both perspectives are important, i.e., the network position itself as well as the resources controlled by others (in the form of information on potential investment opportunities), it is not vital to formally delineate the two perspectives. What is more important though, are the single network measures used that capture different aspects of an actor's position in the network. These measures will be explained in sections 3.4.4 and 3.4.5. In a next step, however, the concept of social capital needs to be explained because from this concept, single theories will be derived as theoretical foundation of this study.

### 3.3 The Concept of Social Capital

An important concept to grasp the connection between social structures or systems and the action or behavior of individuals is the concept of social capital. With the help of this concept, qualities in the sense of opportunities and constraints for single actors, for groups of actors, or for the entire social structure can be detected. Therefore, this concept is also an instrument to analyze the embeddedness of actors and the social structures that actors are embedded in. To begin with, some fundamental thoughts of the concept will be described, and social capital as form of capital will be delineated to other forms of capital (section 3.3.1). Then, the dimensions of social capital are explained and the term will be defined (section 3.3.2). Following, the underlying theories of social capital are explained (section 3.3.3). Next, the theoretical concepts will be applied to the VCs' syndication network.

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396 The delineation between the two perspectives will implicitly be made by the selection of the network measures. 'Effective size', for example, is a measure that also draws on connectionist arguments, while the measure 'constraint' refers to the structuralist argument. However, for the purpose of this study it is not important to delineate between structuralist or connectionist. Important is, what aspect of an actor's network position the single network measures capture. For example: 'Effective size' captures the extent to which an actor has non-redundant contacts.

397 This view is consistent with many works of scientists that have contributed to the discussion on social capital. See among others Bourdieu (1983); Bourdieu (1986); Coleman (1986); Coleman (1988); Coleman (1990); Lin (1982); Lin/Dumin (1986); Lin (1999a); Lin (1999b); Portes (1998); Putnam (1993a); Putnam (1993b); Putnam (1995).

Theoretical Foundation

syndication network and specific theories from the social capital concept will be selected that help in achieving the goals of the study (section 3.3.4).

3.3.1 Description of Social Capital and Delineation to Other Forms of Capital

In modern sociology, the term 'social capital' has first been coined by Bourdieu (1983), who compares social capital to cultural and economic capital. While Bourdieu mainly focused on cultural capital, a number of scientists highlighted the concept of social capital in more detail and developed this approach over time. One of the first of these scientists was Coleman, who sees two aspects at the core of the social capital concept: First, social capital is inherent in the structure of relations between and among actors and thereby, social capital is determined by the social structure. Second, just like other forms of capital such as physical capital or human capital, social capital is productive because it facilitates the actions of certain actors, "...making possible the achievement of certain ends that in its absence [i.e., the absence of social capital] would not be possible". Based on these thoughts, Coleman argues that social capital is defined by its function. To make this point more comprehensible, Coleman compares the concept social capital to the physical object, or concept 'chair': Just like the concept 'chair' identifies physical objects by their function, social capital identifies aspects inherent in the social structure.

399 See Bourdieu (1983), pp. 183 ff. The term social capital initially appeared in community studies, highlighting the importance of strong personal relationships or ties as basis for trust and cooperation in the communities. In this context, see also Jacobs (1965). The focus was not only laid on communities or societies as a whole, but also on the benefit of individuals. See Loury (1977) on the resources inherent in family relations and their benefits for the young child.

400 See Bourdieu (1983), pp. 183 ff.; Bourdieu (1986), pp. 243-248. Bourdieu describes cultural capital as set of symbols, values, and meanings that the dominating class recognizes and internalizes as their own. Through education, these artifacts are indoctrinated in society, i.e., to the dominated class. While mostly captured by the dominant class through transmission over generations, also the dominated class can invest in acquiring cultural capital, which may enable them to generate returns from this investment. See Bourdieu (1986), pp. 243 ff.

401 See Coleman (1988); Coleman (1990); Portes/Sensenbrenner (1993); Portes (1998); Putnam (1993a); Putnam (1993b); Putnam (1995); Lin (1999a).

402 For the early works on human capital theory, see Johnson (1960), Schultz (1961), Becker ((1964)1993).

by their function. That is, what social capital identifies "...is the value of these aspects [...] to actors as resources that they can use to achieve their interests".  

As mentioned above, in contrast to physical and human capital, which are located either in physical objects such as tools and machines or in individuals, social capital is inherent in social structures of relations. Therefore, ownership of social capital is limited for the individual actors. Consequently, social capital is not fungible and can also not be transferred from one actor to another. In addition, physical capital and human capital are created by investments in either tools or machines in the case of physical capital, or, as in the case of human capital, by investments in education, i.e., the acquisition of certain technical skills, abilities, or knowledge. In contrast, the production of social capital comes about through the development and changes in relations among actors. Therefore, the production of social capital happens unconsciously. Nevertheless can actors try to optimize their social capital in a strategic sense by establishing and developing relations within the social structure.

The above thoughts are summarized in table 3.3:

<table>
<thead>
<tr>
<th></th>
<th>Physical capital</th>
<th>Human capital</th>
<th>Social capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Tools, machines,</td>
<td>Technical skills and knowledge of</td>
<td>Aspects inherent in social structure (relations among actors)</td>
</tr>
<tr>
<td></td>
<td>productive equipment</td>
<td>individuals</td>
<td></td>
</tr>
<tr>
<td>Productivity of capital achieved through</td>
<td>...use of tools and</td>
<td>...application of technical skills</td>
<td>...aspects inherent in social structure enabling</td>
</tr>
<tr>
<td></td>
<td>machines for production</td>
<td>and knowledge in working context</td>
<td>actions otherwise not possible (access to resources,</td>
</tr>
<tr>
<td></td>
<td>process</td>
<td></td>
<td>solidarity in groups, etc.)</td>
</tr>
<tr>
<td>Ownership</td>
<td>Owned by individual</td>
<td>Owned by individual</td>
<td>Ownership limited for individual</td>
</tr>
<tr>
<td>Transferability/fungibility</td>
<td>Transferrable, fungible</td>
<td>Transferrable, fungible</td>
<td>Limited transferrability and fungibility</td>
</tr>
<tr>
<td>Tangibility</td>
<td>Tangible</td>
<td>Less tangible</td>
<td>Intangible</td>
</tr>
</tbody>
</table>

Table 3.3: Overview of forms of capital

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In order to further understand of what dimensions the concept of social capital is comprised of, these will be explained next, and social capital will be defined in a way that helps in achieving the goals of the study.

3.3.2 Dimensions and Definition of Social Capital

Although in the previous chapters a focus has been laid on the formal part of network analysis and on the structure of social networks, it is also important to understand the various dimensions of the concept of social capital. As Putnam (1995) highlights in his seminal work on the supposedly declining stock of social capital in the US, social capital is not a uni-dimensional concept. Rather, Putnam suggests to clarify the dimensions of this concept.409 Social capital can be clustered along three dimensions: A structural dimension, a relational dimension, and a cognitive dimension.410

The structural dimension refers to the embeddedness of actors in a social system, an idea that has been mentioned in previous sections already. Again, this dimension looks at the properties of the network of single actors as well as of groups of actors, or at the structure of the entire network. In other words, the structure of links between and among actors is examined.411

The relational dimension of social capital refers to the type of relationship actors have developed with each other. Granovetter (1992) denotes this aspect of social capital as relational embeddedness.412 In contrast to the structural dimension, it is not the structure of the relationships or of connections between actors that is focused on. Rather, it is an attempt to grasp the underlying basis of the relations. Key aspects that have been


410 See Nahapiet/Ghoshal (1998), pp. 243-244. Nahapiet/Ghoshal describe that, although the dimensions can be separated analytically, many of the features are interrelated to some extent. For the purpose of this study and to provide an overview of social capital to the reader, at this point the interrelations are neglected.

411 Compared to the following two dimensions (relational, cognitive), the aforementioned connectionist view soonest would fall into this dimension (structural), because it examines to whom an actor would have to be connected to, in order to access specific resources. Thereby, this perspective also looks at the structure of the relationships. Refer back to section 3.2.5.2.

considered in this context are trust and trustworthiness, norms and sanctions, obligations and expectations, and identity and identification.  

The third cluster of social capital relates to a dimension Nahapiet and Ghoshal (1998) denote as cognitive. Examples for facets of the cognitive dimension are shared languages, codes, and narratives. This cognitive dimension therefore "...refers to those resources providing shared representations, interpretations, and systems of meaning among parties".

An overview of the dimensions of social capital is presented in table 3.4:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Social capital</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Structural</td>
</tr>
</tbody>
</table>
| Focus       | • Properties of social structure  
              • Embeddedness of actors within social structure  
              • Kind of relationships people have developed with each other  
              • Resources providing shared representations, interpretations, and systems of meanings |
| Measures/Elements | • Size/degree, density, centrality, constraint, closeness, betweenness, etc.  
                      • Trust, trustworthiness, norms, sanctions, expectations, obligations  
                      • Shared languages, codes, and narratives |

Table 3.4: Overview of dimensions of social capital

Based on these forms or dimensions of social capital and based on the fact that in scientific literature the various dimensions have been examined in various contexts, it is understandable that many definitions for the term 'social capital' have appeared. In definitions used, scientists put a focus on one of the dimensions explained above, depending on the context of their study. Although it is not possible to provide all definitions that have appeared, some examples are provided below:

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413 For trust and trustworthiness, see the works of Putnam (1993b) or Fukuyama (1995); for norms and sanctions, see Coleman (1990) or Putnam (1995); for obligations and expectations, see Granovetter (1985), Coleman (1990), or Burt (1992); for identity and identification, see Hakansson/Snehota (1995). On the topic of measuring trust, see Glaeser et al. (2000)


415 Own illustration based on Nahapiet/Ghoshal (1998), pp. 243-244.
• Coleman (1988) focuses on the structural dimension defining social capital as inherent in the social structure, enabling the actors to access resources and to achieve goals that otherwise would not be possible.416

• Bowles and Gintis (2002) draw on the relational dimension, defining social capital as referring "…to trust, concern for one's associates, a willingness to live by the norms of one's community and to punish those who do not."417

• Fukuyama (1995) and Ostrom (2000) refer to both, the relational dimension and the cognitive dimension by defining social capital as "…the existence of a certain set of informal rules or norms shared among members of a group that permits cooperation among them"418 or as "…shared knowledge, understandings, norms, rules and expectations about patterns of interactions that groups of individuals bring to a recurrent activity."419

In order to derive a definition for social capital that suits the purpose of this study, recall that the objective of this study is two-fold: (a) Evaluation of the importance of the contact network and of the contacts to other VCs as source of deal flow quantity and quality and (b) analysis of the effect of the VCs' network position within the syndication network on deal flow quantity and quality.

For the analysis of the network position (b), certainly the focus is laid on the structural dimension of social capital. However, with respect to (a), the relevant dimension of social capital is more in the field of the relational dimension, because social capital can explain why VCs make use of their contact network (all deal flow sources within the contact network) and syndication network (contacts to other VCs).

For the purpose of this study, it can be followed that social capital should therefore be defined in two ways: On the one hand side, it is regarded as inherent in the social

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416 See Coleman (1988), p. S98. In his article, Coleman also mentions trustworthiness, expectations, obligations, norms and sanctions, see Coleman (1988), pp. S102-S105. However, his main point, as presented earlier in this study, is that social capital is inherent in the social structure.


structure of relationships among and between actors, enabling actors to access resources and, due to and determined by the structure of relationships, to achieve goals that otherwise would not be possible. On the other hand, social capital is also represented in the norms to which actors in a network adhere to.

Social capital is a concept that is comprised of several theoretical strands, each of which describing the benefits of different aspects of a network structure. In the following sections, these theories are explained and it will be derived, which of them will be applied in the context of syndicated investments by VCs.

3.3.3 Social Capital Theories

Theoretical approaches regarding the structural analysis of social networks and also regarding the concept of social capital are based on two major controversies:

The first one refers to the question, whether social capital is to be seen as individual good or as collective good. The individual good-perspective focuses on the use of social capital by individual actors, i.e., "...how individuals access and use resources embedded in social networks to gain returns...". Here, the focal aspects are the investments of individuals in social relations and the question how they generate returns from capturing the embedded resources. This usage of the theoretical concept therefore identifies social capital as the value of an individual's social connections. Under this approach, the network position of an actor and his relationships to others are seen as source of various resources such as material, information, or emotional aid, and the configuration of relationships among actors comprises significant information and control benefits. Analysis on the level of single actors in a network focuses on questions such as how

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420 As becomes obvious from this and previous chapters, this definition refers to definitions applied by Coleman (1988), Burt (1992), Burt (1997) or Lin (1999a).


422 Lin (1999a), p. 31.

423 See also Lin (1999a), pp. 30-31.

central the actor is positioned in the network, to what extent the actor has non-redundant contacts, or whether the actor is dependent on other actors. Exemplary for this kind of analysis are the studies of Burt, in which he examines the causal relationship between the structural autonomy of companies and their profit, or between the number of structural holes in the network of managers and their career paths.

In contrast, the collective good-perspective focuses on the concept of social capital at the level of groups. Important questions are, how groups develop and maintain more or less social capital and how the stock of social capital within a group helps the individual group members. In this perspective, social capital as collective asset of groups is emphasized. The analysis on the level of groups can relate to subgroups or to the entire group of a network.

With respect to the subgroups within a network, the analysis focuses on three aspects: One aspect is to examine the so-called cliques. A clique is formally defined as a subset of actors within a network, in which all actors are adjacent (connected) to each other, but in which there are no other actors in the network that are also connected to all of the members of the clique. A second aspect is to employ the concept of structural equivalence. Actors are said to be structurally equivalent if they have the same pattern of ties, i.e., if they have the same ties to all other actors within the network. A third aspect focuses on the identification of hierarchies among the subgroups and to allocate a role to each of the subgroups within this hierarchy. With this kind of analysis, for

429 Originally, the concept of structural equivalence goes back to the work of Lorrain/White (1971). See for example Lorrain/White (1971), p. 50.
example, the assertiveness of subgroups can be quantified. 431 Exemplary for the analysis on the level of subgroups are the works of Putnam (1995) or Fukuyama (1995). 432 Another pool of measures and methods of analysis focuses on the examination of entire networks and all ties within a network. 433 There are two important implications regarding this level of analysis: The first one is that, when examining entire networks, comparisons are necessary. For example, one could analyze why one society is able to produce innovations while another society is not. The second implication is that analyses on the level of individual actors and on the level of subgroups can be compared or related to the analysis on the level of the entire group. For example, the entire network might be described regarding centrality by drawing on the results of the centrality measures for individual actors, i.e., the entire network is described by showing that individual actors are extremely high in centrality compared to the rest of the network. 434

The second controversy relates to the question whether it is the weak ties between actors, the existence of structural holes, or open network structures that lead to benefits for the actors, or, whether it is the strong ties, dense and cohesive networks characterized by network closure that actors or groups of actors benefit from. 435 In his seminal article on the strength of weak ties in the context of job search, 436 Granovetter found that it is not the strong connections to other actors that deliver new information on potential job opportunities. Rather, it is the so-called weak ties that yield new information, i.e.,

431 The graph theoretic mechanics of this analysis also draw on the concept of structural equivalence. See Lorrain/White (1971).

432 Although the study of Putnam, for example, also applies to the whole society (USA), the concepts also apply to parts of a social network.


434 See Jansen (2003), p. 33. The same could be done, for example, for density measures by comparing the density in the local network structures of individual actors and comparing it to the overall network density. This, however, depends on the individual network structure, because, for example, in very large networks, density will be lower by definition (due to size).

435 See the work of Granovetter (1973) on the strength of weak ties, and the theory of Burt (1992) on structural holes. For the importance of strong ties, see for example the works of Coleman (1988) or of Portes/Sensenbrenner (1993).

436 See Granovetter (1973); Granovetter (1974). In the context of job contact networks, see also Calvó-Armengol (2004).
connections of ego's direct contacts to other actors that are not tied to ego. In a similar vein, and on the basis of the weak tie argument, Burt (1992) developed the so-called structural hole theory. In this approach, it is not the weakness of the ties that delivers social capital, but it is the structurally autonomous network position of an actor, i.e., having non-redundant contacts or building the bridge between otherwise disconnected actors.

To better understand the difference regarding the two controversies mentioned above, it is helpful to look at the five potential benefits social capital can produce, which follows in the next sections. In these sections, several theories that the social capital concept comprises of will be explained. In section 3.3.4 then, single theories out of the overall social capital concept will be selected, which are used at a later point in the study to derive hypotheses on the connection between a VC's network position and its deal flow quantity and quality.

### 3.3.3.1 Information or the Theory on the Strength of Weak Ties

One benefit social capital can deliver is information. This aspect has been especially emphasized in the seminal work of Granovetter (1973) regarding the strength of weak ties. Granovetter intuitively defines ties regarding their strength based on a combination of the intimacy, the emotional intensity, the amount of time, and the reciprocal services. The theory states that, "[if] one tells a rumor to all his close friends, and they do likewise, many will hear the rumor a second and third time, since those linked by strong ties tend to share friends. If the motivation to spread the rumor is dampened a bit on each wave of retelling, then the rumor moving through strong ties is much more likely to be limited to a few cliques that that [rumor] going via weak ones; bridges will not be crossed."

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439 See Granovetter (1973) and Granovetter (1974).
An underlying thought behind this argument is that, if strong ties (for example friendship ties) connect actors A and B and also actors A and C, likelihood for a strong tie between B and C increases once they meet. As explained in section 3.2.4.1, this argument refers to the cognitive balance theory. Consequently, Granovetter assumes that a triad, in which A is connected to B and C by strong ties, but B and C are not connected, cannot exist, i.e., is a 'forbidden triad', as presented in figure 3.3.

These triads are 'forbidden' due to the fact that processes of cognitive balance tend to eliminate them. Rather, three strong ties will develop if people know each other for a long enough period of time.

The implications of these thoughts are significant and Granovetter uses the concept of a bridge to illuminate his argument: A bridge is a connection in a network providing the only path between two actors. This means that, if actors A and B are connected by a bridge, the only way information or other resources can flow from any contact of A to any contact of B, is through the connection between A and B. Now, back to the forbidden triad explained above: If the forbidden triad is absent, Granovetter follows that, due the processes of cognitive balance, no strong tie can be a bridge, since otherwise the strong ties of A would, in the long run, be strong ties of B as well. That means that no strong tie

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can be a bridge. What is important, however, is that consequently all bridges are weak ties, but logically, not all weak ties are bridges.

With his work on the strength of weak ties, Granovetter explained that these weak ties are the important element in order for an actor to receive more and newer information.

3.3.3.2 Power through Structural Autonomy or the Structural Hole Theory

Another value social capital comprises of, are benefits gained by an actor due to his structurally autonomous position in a network. This so-called theory of structural holes was mainly developed by Ronald Burt. In his seminal work, Burt (1992) built on the weak tie argument set forth by Granovetter. However, the major difference in Burt's theory is that, it is not the weakness of ties that puts an actor in a beneficial position. Rather, it is the existence of the so-called structural holes. Based on the following figure, the functioning of structural holes shall be explained.

Figure 3.4: Structural holes and weak ties

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446 See Granovetter (1973), p. 1364. There is only one exception: A strong tie can only be a bridge in a case if neither party to the bridge has any strong ties, which is highly unlikely in networks of any size.


448 See Burt (1992), p. 27.

There are three clusters of actors: The cluster of actors around Ego, the cluster around actor A, and the cluster around actor B. The pattern of ties of Ego is unique, with Ego having two strong ties (solid line) to the own cluster and one weak tie (dashed line) to each of the other clusters. In addition, one can observe three clusters of structural holes in this system, i.e., the structural holes between every actor (except Ego) in Ego's cluster and every actor in A's cluster; the holes between every actor (except Ego) in Ego's cluster and every actor in B's cluster; and the holes between actors in A's cluster and actors in B's cluster. Now, on a first view, the weak tie argument delivers the same results as the structural hole theory: Ego is in the best position to receive new information, followed by actors A and B, followed by everyone else in the network. This is because Ego has two weak ties, A and B have one each, the other actors have none. Equivalently, Ego has the most structural holes he spans, followed by actors A and B, followed by the other actors, who have fewer. So why need a theory on structural holes? Burt provides two answers. First, the cause for Ego being in a beneficial position to receive information is not the weakness of the ties itself. Independent of whether the tie between Ego and actor A and Ego and actor B is strong or weak, the existence of a structural hole that Ego spans with his ties to either A or B is the cause for the information benefits. Second, however, it is not only an informational advantage Ego can benefit from. In addition, and maybe even more important, structural holes deliver control benefits to Ego (and of course to actors A and B, since they span one structural hole each, as well): If, for example, actor A intends to do a transaction or intends to cooperate with one actor from Ego's cluster, the coordination of this transaction or cooperation can only be made possible through Ego. Therefore, Ego could play actor A off against the actor in the own cluster, potentially gaining a benefit from being in a kind of brokerage position.

Another aspect is important regarding the structural hole theory, that needs highlighting. There are basically two ways in which the structural hole theory can be applied in analyses: One way is to take all actors of a network and see which actors span more

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451 See Jansen (2003), pp. 29-30. Of course, the downside of structurally autonomous actors might be that they are excluded by actors within the clusters due to the fact that the structurally autonomous actor might only have weak ties to the members within the clusters.
structural holes than others. A second way is to classify the actors of a network into subgroups based on certain criteria. For example, in the case of the VCs, one could categorize them based on the dimension 'industry focus' (whether they focus on one/a few certain industries or whether they do not). In the above figure, that would mean that the actors in Ego's cluster, for example, all are VCs that specialize in certain industries, actors in A's cluster do not specialize in industries but they specialize on specific investment stages, and actors in B's cluster do both, they focus on certain industries and on investment stage(s). Then, structural hole theory can be applied by analyzing, whether actors benefit from more often spanning structural holes between these subgroups. Because actors can play different roles when representing a link between subgroups, this kind of analysis is also denoted as role analysis.\textsuperscript{452}

### 3.3.3.3 Power through Social Influence or the Significance of Strong Ties for Different Types of Actors

In his study on structural holes, Burt (1992) analyzed, which type of ties are beneficial for different types of managers within an organization.\textsuperscript{453} He found that most managers, especially high-ranking men, benefited most from flat network structures and entrepreneurial-like networks. Specifically, it was beneficial for them to have many contacts to other managers that were themselves not connected or weakly connected. However, there are two groups of managers, for which this was not the case: Women and entry-rank men. For them, hierarchical networks were most beneficial, with strong ties to high-ranking and influential managers.\textsuperscript{454} The reason behind this empirical finding is that women and entry-rank men did not gain benefits from many structural holes in their contact network, that might provide them with entrepreneurial opportunities and a widespread network. Rather, they needed contacts to colleagues, who were socially

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\textsuperscript{452} The different roles refer to the possibilities that, in the example above, Ego, A, and B could belong to the same group, or, Ego and B belong to the same group but A belongs to a different group, and so on. A detailed description of the various roles will be provided in section 3.4.5.3. An example for role analyses is to be found in Fernandez/Gould (1994).

\textsuperscript{453} For a detailed description of the population of the study, see Burt (1992), pp. 115 ff.

\textsuperscript{454} See Burt (1992), pp. 157-158.
influential and who could protect them. The main challenge that these two groups of managers were facing was to legitimize their capabilities.455

### 3.3.3.4 Solidarity in Groups or the Strength of Strong Ties

As discussed earlier, one form or dimension of social capital comprises values such as trust, norms, and sanctions.456 Norms and sanctions have the effect that opportunistic behavior of actors is sanctioned by other actors in groups that are characterized by strong ties and a dense and cohesive structure.457 The mechanism underlying this phenomenon is the so-called closure of social networks. A proponent of this theory is Coleman, who uses the example of the wholesale diamond market in New York to illustrate this point: Several Jewish merchants, who are tied to each other by ethnic and family ties, and who frequently interact in other private environments such as visiting the synagogue, exchange valuable bags of diamonds without any formal insurance. The insurance against opportunistic behavior is the potential loss of all relationships for the merchant who cheats, i.e., this merchant would lose religious, community, and family ties.458 Therefore, the strong ties and the closure and cohesiveness of the social network are the mechanisms that lead to solidarity in the group.

### 3.3.3.5 Trust in the Prevalence of Norms

Another form of values that social capital comprises or delivers are norms, manners of behavior, or morals, which are valid for everyone in the social system.459 According to Putnam (1995), the root for trust in norms and morals is to be found in the socio-structural context: He showed that memberships in clubs promote the development of

455 This finding is also supported to some extent by the research of Uzzi. He found that it is beneficial for firms operating in the New York apparel industry to build strong ties with other firms in the market to be able to do valuable transactions. However, there is also a threshold, i.e., a point at which strong ties are not beneficial anymore. See Uzzi (1996); Uzzi (1997).

456 See section 3.3.2.


459 Studies on this form of social capital have been done, for example, by Coleman (1988), Putnam (1993a), Putnam (1993b), and Putnam (1995).
weak ties, which are able to span a bridge across differences in ethnic and status backgrounds.\textsuperscript{460} Equivalently, Coleman (1988) presents the case of families that moved to a city, in which norms and moral behavior are prevailing. This form of social capital enables the parents to let their children go to school alone, because other (structurally) unrelated adults will look after the children.\textsuperscript{461} The value of social capital therefore lies in the fact that, based on the structure of relationships and through the prevalence of certain norms, cooperative action is made possible, i.e., actions that would have been rejected in absence of these norms due to high uncertainty.\textsuperscript{462}

In the following section, it will be derived which of the theoretical concepts described above are suitable to be applied to the context of this study.

3.3.4 Application of Social Capital Theories to the Deal Flow of Venture Capital Firms

As becomes obvious, social network analysis and social capital theories cover a variety of approaches and concepts to analyze networks on the level of individuals (persons, firms, etc.) or on the level of groups. These approaches either focus on the benefits of open networks and structural holes or on the benefits of dense networks and group closure. To apply these theories to the context of this study, and to determine, which of the theoretical strands serves the purpose of this study, the above mentioned theoretical approaches have been summarized and categorized in a matrix, which is structured based on the two major controversies explained earlier and presented below.

Based on the analysis on the level of individual actors, the goal of this study is to determine to what extent the individual actors, i.e., VCs, are different with respect to their deal flow, and whether the position of the firms within the syndication network is able to explain the differences in deal flow. Since network analysis offers a broad spectrum of network measures, for the derivation of hypotheses it has to be deduced, which of the theories serves best as explanatory basis for the differences in deal flow.

\textsuperscript{462} See Sandefur/Laumann (1998), pp. 494 f.
There are two basic argumentative ways that can be followed: One theoretical strand explains that it is the weak ties and the existence of structural holes that offer competitive advantages for individual actors. The other strand argues that it might rather be dense networks and strong ties among the actors that contain a competitive advantage. Relating this to the syndication network and deal flow of VCs, the question is, whether firms that hold positions characterized by weak ties or structural holes have a quantitatively or qualitatively higher deal flow. Or, whether firms have deal flow advantages that hold positions, which are characterized by dense network structures and strong ties.

Drawing on the theoretical explanations and on previous research, it can be derived that, in the context of deal flow for VCs, the first theoretical strand is likely to play a significant role. That means, it can be argued that, above all, weak ties and structural holes will have a significant influence on the deal flow quantity and quality of VCs within the syndication network. The general logic for this argumentation is three-fold:

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463 Own illustration.
First, in order for VCs to generate a steady stream of investment opportunities they can select from, the access to information on investment opportunities is vital.\textsuperscript{464} As explained above, in cohesive or dense networks, the information flow is limited due to the fact that actors tend to receive the same information from different sources again and again. Therefore, according to the theory on the strength of weak ties, being in network positions that expose the actors to new information should yield a competitive advantage in terms of information on potential investment opportunities.

In terms of the structural hole theory, having information and control benefits, i.e., for example, being in a brokerage position, should also provide a competitive advantage to VCs. Having non-redundant ties to other VCs in the network can therefore be expected to play a crucial role. In the same vein, being constrained by other VCs based on the network structure might have a significant negative impact on the ability of VCs to access new information.\textsuperscript{465}

Second, since establishing and maintaining relationships costs time and energy, VCs only engage in them if they expect that the effort is worth it, i.e., not only in terms of economic success of the portfolio company but also in terms of future benefits through the reciprocation of deal flow.\textsuperscript{466} Therefore, it can be expected that VCs engage in syndication relationships very selectively in order not to invest time and effort in a relationship, which is not worth it in the sense of deal flow reciprocation. Also, in order to maximize deal flow reciprocation it is beneficial to selectively invest in multiple contacts rather than in only a few.\textsuperscript{467} However, given that a VC has a fixed amount of time to be spent on relationships, having multiple contacts means less effort spent on every single one of them. Consequently, it might not be strong ties that yield an advantage in terms of deal flow, but rather the weak ones.


\textsuperscript{466} This argument also refers to a key rationale for syndication, i.e., the reciprocation of deal flow. See also section 2.1.4.3. See also Lerner (1994), pp. 17 f.

\textsuperscript{467} Of course, the author is aware that this is a trade-off decision. Taking it to the extreme, if a VC only had one contact that frequently delivers many offers to join investments, that might be better than having many contacts delivering only few offers to join investments. However, due to the fact that it can be assumed that only one firm will not have an infinite number of investments to offer, multiple contacts might be beneficial.
The Concept of Social Capital

Third, strong ties and cohesive network structures can harm VCs in financial terms because strong ties might lead to dependency on others. In that case, this kind of relationships tend to limit the options to engage in investments with other VCs that might offer interesting investment opportunities.\footnote{See Uzzi (1996), pp. 690 ff.; Uzzi (1997), pp. 57 ff.}

This being said, when analyzing the individual VC's network position, the theories on the strength of weak ties and on the benefits of structural holes represent the theoretical foundation, on the basis of which hypotheses on the connection between the VCs' network position and their deal flow quantity and quality will be derived.

As has been explained in the section on structural hole theory, and as can already be noted at this point, an analysis based on structural hole theory will also be applied to VCs by classifying them into certain subgroups. By doing this, a role analysis will be performed. This kind of analysis is, to some extent a mixture of subgroup analysis and analysis on the level of individual actors, because, although the VCs will be categorized, the goal of the analysis is still to examine, whether individual actors benefit from their structural position.

Again, recall that the objective of this study is two-fold: In a first step, it will be analyzed to what extent VCs make use of their general contact network (all deal flow sources within the contact network) and of their contacts to other VCs as sources of deal flow quantity and quality. If VCs make heavy use of their network, and also of their contacts to other VCs, then this analysis basically justifies the second step: The analysis of the VCs' network position and its impact on deal flow quantity and quality. The theoretical foundation for the second step (analysis of network position) has been explained above.

However, when analyzing the importance of the contact network and of the syndication network for the deal flow generation of VCs, it is drawn on the benefits that social capital delivers on the level of the entire group. That is, social capital theory holds that, especially in situations with high uncertainty, cooperation is made possible based on the general prevalence of norms among actors.\footnote{See Coleman (1988), pp. S99 f.; Sandefur/Laumann (1998), pp. 494 f.} Since venture capital investments are often
characterized by high uncertainty, the trust in certain behavioral norms among actors can be expected to be important. That means that the level of social capital inherent in a group makes it possible that actors of that group exchange resources such as information on potential investment opportunities. In the case of the VCs' contact (and syndication) network, this level of social capital is expressed, for example, by a functioning mechanism of deal flow reciprocation. Offering (high-quality) deals to other VCs is based on the trust in the expectation that this behavior will be reciprocated in the future. If offers to join investments are not reciprocated, the level of social capital also makes possible to sanction actors by excluding them from future investments. This is where the level of social capital inherent in a group or in a network can be observed.

Overall, the theoretical foundation for this study is represented by the left column in figure 3.5. In order to proceed, an appropriate research design has to be specified that reflects the two-fold objective. This design will be developed in the following sections.

3.4 Research Design

3.4.1 Description of the Basic Structure of the Research Model

In this section, the aspects regarding the deal flow generation of VCs are brought together with the theoretical foundations on social capital and on formal network analysis. The goal is to develop a basic model that serves as basis for the empirical study. To do this, it is necessary to briefly recall some of the content that has been discussed earlier.

Regarding the value generating stages of VCs, it has been shown that the stage of deal flow generation constitutes a basic prerequisite for the business model of VCs to function.\textsuperscript{470} Vater (2002) could show that the generation of deal flow is, except for the due diligence phase, the stage within the value chain of VCs that is most important.\textsuperscript{471} Given the high importance of deal flow generation, it is worthwhile to look at this stage in more detail.

\textsuperscript{470} See the detailed explanations in section 2.1.3.4. See also Betsch/Groh/Schmidt (2000), p. 118; Lockett/Wright (2001), p. 378.

In the section on how the contact between a VC and a potential portfolio company comes about, it has been shown that the contact network of VCs plays an important role in generating deal flow. A few empirical studies exist that look at the network of VCs and partially also at their deal flow. However, there are three main shortcomings that need to be addressed: First, most studies do not differentiate between deal flow quantity and quality. Second, the few existing studies on network positions do not differentiate between the embeddedness of the firms in the local network (ego-network) and their embeddedness in the entire network structure (total network). Third, in terms of network position, only the measure of centrality has been looked at so far. However, although centrality is an important aspect, there are several other measures characterizing a VC's network position in the syndication network, that are even more suitable to deliver valuable insights with respect to the generation of deal flow.

Based on the theoretical explanations presented earlier and based on previous research discussed, the research design needs to reflect the two-fold objective of the study: In a first step, the general importance of the contact network of VCs with respect to their deal flow quantity and deal flow quality will be analyzed. In addition, the role that other VCs play as source of deal flow will be evaluated. In a second step, a detailed analysis of the VCs' network position will be performed and it will be tested whether differences in network positions can explain the variance in deal flow quantity and quality. In this context, ego-network measures and total network measures are differentiated. In addition, it will be analyzed whether actors that more often represent a link between subgroups benefit from their structural position. This second step will be split up into two sub-steps: The first sub-step is to check to what extent firm attributes alone are able to explain the difference in deal flow quantity and quality. The second sub-step then is to individually add network measures to the firm attributes in order to see the differential effects and the gain in explanatory power of the model based on the specific network measures. According to this process, the following research model can be derived:

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472 See sections 2.2.4.1 and 2.2.4.2 on the search activities and on the sources of deal flow.

473 Studies that make that differentiation are the one of Fried/Hisrich (1994) and the one of Vater (2002). However, the former is on the US market and based on a fairly small sample size (18 VCs), and the latter can partially not be compared to this study. Reasons have been explained above. See section 2.2.4.2.
Theoretical Foundation

The remainder of chapter three is organized as follows:

First, it is explained in detail how deal flow quantity and quality are measured in this study (section 3.4.2). Second, it will be shown, how the importance of the general contact network and of the contacts to other VCs as source of deal flow quantity and quality will be evaluated (section 3.4.3). Third, before explaining the individual network measures that serve as independent variables, it needs to be described, how an entire network structure can be characterized (section 3.4.4). This step is partially necessary to later perform the analyses on the level of individual VCs,\textsuperscript{475} but it also delivers valuable insights, for example, whether benefits are distributed equally or unequally among the VCs. Fourth, the network measures that will be employed, are explained in detail (sections 3.4.5 and 3.4.6). Finally, the chapter is summarized and the detailed research design is presented (section 3.5).

\textsuperscript{474} Own illustration.

\textsuperscript{475} That is, the algorithms of many network measures require that a network structure is dissected into its so-called components, which will be explained in the relevant section.
3.4.2 Measurement of Deal Flow as Dependent Variables

Regarding the measures for deal flow quantity and quality, it is important to distinguish between the two goals of this study. In the following two sections (3.4.2.1 and 3.4.2.2), the measures for deal flow quantity and quality are described which are used for the analyses to achieve goal (b). That is, they are used as dependent variables for examining the effect of the VCs' network position on deal flow quantity and quality. Then, in section 3.4.3, it is referred to goal (a), i.e., the measurement of the importance of the general contact network and of other VCs as source of deal flow. For this analysis, the letters A, B, C, A', B', and C' are used, as will be seen in the following figures.

3.4.2.1 Deal Flow Quantity

As explained before, one important aspect regarding the deal flow of VCs is its quantity. Deal flow quantity simply relates to the average number of investment opportunities a VC receives.\textsuperscript{476} The VCs can either receive business plans sent to them unsolicited by the capital seeking firm, or they receive the business plans through some contact in their contact network. When received through a contact out of the network of the VC, this can be of various kinds, i.e., the referral can come from a bank, university or research centers, private or other contacts, or from other VCs. Now, when analyzing whether the network position of VCs within the syndication network has an effect on deal flow quantity, it should only be taken into account what part of all investment opportunities received actually stem from other VCs. Therefore, in this study, not the total average number of investment opportunities that come from all sources is the relevant number, but this part of the investment opportunities that stem from other VCs. This logical selection is necessary since this study refers to the analysis of the syndication network \textit{among} VCs. Therefore, the dependent variable 'deal flow quantity' is the product of the average number of investment opportunities received per year, the percentage share of investment opportunities received from network contacts, and the percentage share of investment opportunities received from other VCs.\textsuperscript{477} Consequently, the dependent variable is an

\begin{footnotesize}
\textsuperscript{476} As operationalized, for example, in Wells (1974), Tyebjee/Bruno (1984), Schröder (1992), Vater (2002).

\textsuperscript{477} Also, as explained before, since buyout investments are excluded from this analysis, only those investment opportunities are considered that can be allocated to venture capital investments according
\end{footnotesize}
Theoretical Foundation

Absolute number reflecting a VCs ability to generate deal flow quantity through contacts to other VCs. The simple logic can be illustrated as follows. In this figure, for now, ignore the labels A, B, and C, which will be needed for explanations further below.

![Logic to measure deal flow quantity](https://example.com/figure3_7)

*These include for example lawyers, consultants, and others.

3.4.2.2 Deal Flow Quality

The ways in which deal flow quality can be measured have been presented in section 2.2.2. It has been explained that, for the purpose of this study, the relevant indicator for deal flow quality is the final deal rate of VCs, i.e., the percentage of investment opportunities finally invested in (of all investment opportunities received). However, the percentage of investment opportunities invested in is multiplied with the investment opportunities received, and, analog to the measure for deal flow quantity, with the share coming from network contacts, and with the share stemming from other VCs.479

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478 Own illustration.

479 Alternatively to the measures explained, it can be thought of measuring deal flow quality on a project-by-project basis. That means, it could theoretically be tracked, which investment opportunities actually have been financed by VCs and whether these investment opportunities are economically successful, thereby indicating the quality of the deal flow. However, due to two reasons this way is only a theoretical exercise and cannot be followed in practice: First, data on the economic success of the portfolio companies is not available in a database and even with a questionnaire the data could probably not be retrieved. This is due to the fact that venture capitalists would probably not disclose such data, or, if at all, primarily for the successful portfolio companies. Second, since the data is not available in a database, a questionnaire would have to be used. But due to the vivid personnel turnover and the market
Graphically, the logic is the same as presented in the figure above, with the exception that the box at the top of the tree refers to the deal flow quality (not deal flow quantity), i.e., to the deal rate multiplied with the investment opportunities received. For the deal flow quality measure, the labels are recoded into A', B', and C', while the apostrophe indicates that it is referred to deal flow quality.

3.4.3 Measurement of the General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow

Relating to the idea of social capital, the measurement of the importance of the contact network and of the syndication network indicates whether social capital in the form of values and norms serve as the underlying basis that makes exchange and cooperation in a network possible. The trust in the prevalence of norms then is to be seen as a form of social capital.

Based on the logics to measure deal flow quantity and deal flow quality as presented above, the rationale to assess the general importance of the contact network and of other VCs as source of deal flow is the following. In order to refer to specific elements in these logics, the labels A, B, C, A', B', and C' have been assigned. For deal flow quantity, A equals the percentage of the average number of investment opportunities received per year, which stem from a network contact. B is the remainder to 100%, i.e., the percentage of the average number of investment opportunities received per year, which a VC received unsolicited. C is the percentage of the average number of investment opportunities received per year, which (out of the network contacts) comes from other VCs. Analogously, the denotations A', B', and C' correspond to the equivalent percentages, but for those investment opportunities that VCs finally invest in.

The general importance of the contact network as source of deal flow for VCs can now be measured by the comparison of the values for A and for B (and A' and B' analogously). If A (A') is larger than B (B'), then network contacts deliver more investment opportunities than unsolicited investment opportunities.

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development of the venture capital industry, those employees who have decided on investments several years ago are often not reachable anymore to answer the questionnaire. Therefore, this way of measuring deal flow quality cannot be followed.

Refer to figure 3.7.
to the VC as compared to unsolicited proposals. In order to test the general importance of the contact network with respect to the difference between deal flow quantity and deal flow quality, the shares A' and A need to be compared. If A' is larger than A, i.e., if the share of investment opportunities that network contacts deliver, is higher for those investments, in which a VC finally invests in, then the contact network is of high importance for generating deal flow quality.

With respect to the importance of 'Other VCs' as source of deal flow, the share C (C') needs to be compared to the shares for the other sources within the contact network (universities, banks, private contacts, other). If C (C') is larger than any of the other sources, then the source 'Other VCs' is obviously the most significant in delivering investment opportunities. As regards the difference of the importance of 'Other VCs' as deal flow source for deal flow quantity and quality, the shares C' and C need to be compared. If C' is larger than C, it means that a larger part of the high-quality investment opportunities (in which the VCs have finally invested in) come from the source 'Other VCs'.

3.4.4 Measures to Characterize the Entire Network Structure

As to the structural characteristics of entire networks, there are several measures, by which a network can be described on a macro-level. These include the necessary dissection of the network into its so-called components, an analysis of the overall density prevalent in the network, and an analysis regarding the transitivity, clustering, and centrality of the entire network. Thereby, an understanding of the network structure on an overall level is gained. It helps to assess whether potential benefits inherent in the network structure are distributed equally or unequally and also whether potential benefits are more due to local network structure (in the actors' neighborhood) or due to the overall network structure. Relating this to the idea of social capital, these measures indicate, to what extent also the amount of social capital is distributed equally or unequally among the actors.

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481 Either in terms of deal flow quantity, or in terms of deal flow quality.

482 The dissection of a network into its components is a necessary step because many network measures can only be derived for the components of a network. Details follow below.
Dissecting an entire network into its components refers to an important property of a graph, i.e., its connectedness. A graph is connected, if all pairs of nodes are connected, which means that each actor can reach any of the other actors by some path length. The actors in a connected graph need not be connected by direct links, i.e., for a graph to be connected it is sufficient that each actor can reach all of the other actors by either direct or indirect links. Thus, in a connected graph, no node is disconnected, and all the nodes together are denoted as a component. In contrast, in a disconnected graph, there are one or more nodes, which are not connected to the component. This or these disconnected node or nodes are, by definition, also components. An example is illustrated in the figure 3.8.

Many methods within formal network analysis require that the graph under consideration is connected. Therefore, the syndication network of the VCs has to be dissected into its components before the analyses on the level of individual actors are performed.

While the dissection of a network into its components is a necessary step, the following measures are used to get a feeling for the overall network structure, which is useful to evaluate, whether the amount of social capital in the network is distributed equally or unequally among actors.

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484 Own illustration.
3.4.4.2 Density

Another important characteristic of the overall network structure is its density. Density refers to the actual number of connections or lines between nodes, compared to the maximum possible number. The maximum possible number of lines or connections in a network is determined by the number of nodes or actors, denoted by \( n \), in that network. Since a network is represented by a square actor-by-actor matrix, showing which actors are connected to each other, the maximum possible number of lines is equal to \( n \times n \).

However, since ties of actors with themselves (the main diagonal in the actor-by-actor matrix) are ignored, the maximum number of ties is equal to \( n \times (n-1) \). Now, this is the maximum number of ties in a directed graph, i.e., in a graph, in which the directionality of relations is observable. In this case, the relationship of actor A to actor B can be present, but the relationship from actor B to actor A might be absent.\(^{485}\) In the case of undirected ties, however, it is only noted, whether a relationship between two actors exists or whether it does not. In this case, the relationship from actor A to actor B is the same as the one from actor B to actor A. More formally, let each element in the actor-by-actor matrix be denoted as \( x \), i.e., the binary value for the relation between actors A and B is denoted as \( x_{ij} \). In the case of directed data, it holds that \( x_{ij} \neq x_{ji} \), and in the case of undirected data, it holds that \( x_{ij} = x_{ji} \). Since in an undirected network, the relations are symmetric, the maximum possible number of ties is equal to \( n \times (n-1)/2 \). The density algorithm in network analysis software packages counts the number of ties that actually exists and divides it by the number of maximum possible number of ties for that network. In other words, for binary data, density is calculated as the ratio of adjacencies that are present compared to the number of pairs of actors, i.e., what proportion of all possible dyadic ties are actually present. Now, this is the case for binary data.

In the case that the data of the network is valued, i.e., if some form of the strength of ties is provided, the density algorithm sums up the values of all relations and divides it by the

\(^{485}\) This can be the case, for example, if each member in a group of actors is asked, whom of the other actors of that group they consider to be a friend. In that case, actor A might call actor B a friend, while actor B does not call actor A a friend. The direction of the relation between actors A and B would therefore go from actor A to actor B but not in the opposite direction.
number of possible ties. That means, density for valued data is defined as the average tie strength of ties across all possible ties.\(^\text{486}\)

The network under consideration in this study is based on data, which is undirected and valued. However, for some methods and algorithms in formal network analysis it is necessary to dichotomize the data, i.e., to transform the valued into binary data. Therefore, density, for example, can be calculated for the valued matrix as well as for the binary matrix.

3.4.4.3 Transitivity

As briefly explained earlier, transitivity refers to triadic structures within a network. A triad is a network of three actors, which is called transitive, if all three actors are connected to each other. Transitivity originally refers back to balance theory and relates to the situation that, if actor A is connected to actor B, and actor B is connected to actor C, chances are high that actors A and C are also connected.\(^\text{487}\)

When considering undirected data, as is the case with the data in this study, there are four possible types of triadic relations, i.e., no ties are present, one tie, two ties, or all three ties are present.\(^\text{488}\) Analyzing triadic structures might provide insight on the extent to which a network is comprised of 'isolation' (no tie is present), 'couples' (one tie is present), 'structural holes' (two of three ties are present), or 'clusters' (all three ties are present).\(^\text{489}\)

In the context of this study, above all an understanding of the existence of structural holes might give a good sense of the overall potential of actors to benefit from them. Although this analysis on the macro-level (entire network) does not yield precise insight on the access of individual actors to opportunities, it still draws picture of the overall potential how actors in the network, in general, can benefit from the existence of structural holes. Specifically, the higher the percentage of triads (of all possible triads) that contain two of three connections, and in which the connections AB and BC exist but not AC, the higher

\(^{486}\) See Hanneman/Riddle (2005), chapter 8, pp. 2-3.

\(^{487}\) See, for example, the discussion of balance theory as proposed by Heider (1946). See Heider (1946), p. 107. See also section 3.2.4.1 for an explanation of balance theory.

\(^{488}\) In directed graphs, there are 16 possible types of triads. For a further discussion, see Wasserman/Faust (1994), p. 244.

\(^{489}\) See Hanneman/Riddle (2005), chapter 8, p. 8.
the percentage of structural holes and, consequently, the higher the potential for actors to exploit those opportunities.

3.4.4.4 Clustering

Many researchers have noted that, in large real-world networks, often a paradoxical structural pattern can be found: On the one hand side, it is the case that most of the people someone knows also know each other. This implies that in most large networks, a significant proportion of all existing ties are 'clustered' into local neighborhoods, meaning that actors often are embedded in fairly dense local structures. On the other hand, in many large networks, the geodesic distance between any two actors is surprisingly short. That is, in most empirical networks, any two nodes can reach each other at very short path lengths, a phenomenon also known as 'small world phenomenon'.

There are two parts to this paradoxical finding. One is to measure the distance between nodes, and the other is to measure the extent to which actors are embedded in dense local neighborhoods. Measuring this extent is exactly what the so-called clustering coefficient does. The overall clustering coefficient for a graph is basically the average value of all densities in each actor's local neighborhood. That means, the algorithm calculates the density in the neighborhood for each actor and then averages it across all actors. A

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490 See Hanneman/Riddle (2005), chapter 8, pp. 10-11.

491 Geodesic distance: Given two actors in a network, there might be several paths that connect these actors. The shortest path that exists is called the 'geodesic'. The 'geodesic distance' is defined as the length of the shortest path between two actors. If, for example, actors A and B are directly connected (adjacent), then the geodesic distance is one. If the shortest path between A and B went through actors C and D, then the geodesic distance would be three. See Wasserman/Faust (1994), pp. 110-111.

492 See Watts (1999), p. 493. The small world phenomenon goes back to the psychologist Milgram (1967) and refers to the fact that, in large networks, the distance between any two nodes is relatively short. Milgram (1967) presented this idea, illustrating that any two individuals on the planet are connected via a chain of no more than six acquaintances. See Milgram (1967), pp. 60 ff. These large networks are characterized by low overall density and a high average density in local neighborhoods. The small world phenomenon can also be observed when examining, for example, internet networking platforms such as Open BC. When selecting any member from the Open BC network, the system shows via whom one is connected to that selected person. In can be observed, in most cases, the connection is established with no more than five to six intermediate acquaintances. For sure, this quick experiment would in no way prove the point of small worlds in a scientific sense, however, it is interesting to experience that the theoretical concept seems holds in practice.

493 Measures on the local networks of each actors will also be explained in more detail further below.
weighted version of this number assigns weights based on the size of the actors’
neighborhoods.
What the clustering coefficient highlights, is, to what extent the actors in the network are
embedded in dense local structures. What makes most sense, is to compare the average
density of local neighborhoods (clustering coefficient) to the overall density of the
network. If they are basically equal, then the density in the overall network is not much
different from the local structures actors are embedded in. However, if, for example, local
structures are characterized by much higher density than is the overall network, then the
network is probably characterized by very dense local neighborhoods or structures while
at the same time showing gaps between these local structures. This could be another hint,
which would suggest the existence of structural holes that exist between the local
neighborhoods.

3.4.4.5 Centrality
Of primary concern of many network researchers is the question which actor(s) in a
network are the most important or most powerful. Although most sociologists would
probably agree that power is a fundamental element of social structures, it is much less
clear what exactly power is.494 Nonetheless, several concepts and measures have been
developed that intend to grasp various notions of power and importance, often also referred
to as prominence.495 These measures, which all belong to the so-called measures of
centrality, include the definitions on degree centrality, closeness centrality, and
betweenness centrality. Although the basic concepts of centrality measures go back to
works of other earlier researchers,496 a major proponent in developing the more modern
forms and concepts of centrality as they are often used today was Linton C. Freeman.
Centrality measures can be calculated for individual actors, for subgroups, or for entire
networks. Although the focus of this section is to explain centrality for the entire network,

495 See Wasserman/Faust (1994).
496 See for example the early works of Shaw (1954), Mackenzie (1966), Nieminen (1973), Nieminen
it first has to be explained how the various measures are calculated for individual actors, since this is the basis for the aggregation to a network index of centralization.

The centrality or centralization of a network shows whether the amount of power that exists in a network is equally distributed or whether it is centralized on some of the actors. More explicitly, power can be understood as a consequence of the pattern of the relations, and the question is, whether power is equally distributed or whether it shows a certain degree of concentration or centralization. This is exactly what the analysis of centrality aims at. Before applying the concept of centrality to describe the entire network, some preliminary explanations have to be made, referring to the three basic versions how centrality is measured, i.e., based on degree, closeness, and betweenness. To better understand these approaches, the following simple graphs shall be used, which are referred to in this text as star, circle, and line graph:

![Star graph, Circle graph, Line graph](image)

Figure 3.9: Star graph, circle graph, and line graph

The analysis of centrality aims at differentiating between actors that are in favored or in disadvantaged structural positions within the network. The extent to which actors hold advantageous positions, can basically be determined in three different ways, i.e., based on degree, closeness, and betweenness. All operationalizations of these centrality measures have as results that, in the star graph, the actor in the center of the star (actor A) is the most central and that the star graph shows the highest degree of centralization. In

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500 These are the measures the three centrality concepts are based on. See also Freeman (1978), p. 219.
addition, in the circle graph there are no differences regarding the centrality of actors, and the circle shows the lowest possible degree of centralization. 501

**Degree centrality:** The degree of an actor \( i \) is simply the count of the number of other actors that are adjacent to actor \( i \), in other words, the degree is equal to the number of direct contacts of an actor. 502 Examining the three types of graphs, we note that, in the star network, actor A has the highest degree, i.e., number of direct contacts. While all other actors in this network have a degree of one, actor A has a degree of six. The question is, why actors in the networks are more (or less) important or powerful and what exactly it is that makes them more (or less) important or powerful. Assume, for example, that the actors in the star network intend to exchange resources. If actor D does not provide resources to actor A, A will have various other opportunities to get access to the resource. 503 However, if the opposite situation is the case, i.e., if actor A does not provide a resource to actor D, D is constrained and will not be able to take part in an exchange at all. That makes A more powerful, while the other actors are, to some extent, dependent on him. Considering the circle graph, one easily notes that each actor is equally connected as regards the degree. Therefore, no actor is in an advantageous position. As to the line network, the situation is different: Actors A and G are at a disadvantage, since they have a degree of one compared to a degree of two for all other actors. 504 Formally, degree centrality for individual actors is given simply by

\[
C_{D_i} = \sum_{j} x_{ij} = \sum_{j} x_{ji} \quad \text{for} \ i \neq j
\]

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502 This is, of course, only the case for binary data. If the data of a network is valued, the degree will be the sum of the strengths of the ties.

503 Of course, this is true under the condition that one of the other actors A is connected to also has the resource and is willing to exchange the resource that A desires.

504 In the case of the line network it seems that all actors except A and G are in equal positions. In centrality concepts explained further below it will be shown that this is actually not true. However, for now and based on the calculation of centrality based on degree, it is correct.
with $i$ and $j$ denoting the actors, and $x$ denoting the value of the elements in the actor-by-actor adjacency matrix.\(^{505}\)

**Closeness centrality:** Besides degree, the so-called closeness of an actor is another reason for him to be more powerful. Closeness is defined as the inverse of distance. Therefore, actors that are at shorter distances to all other actors are closer and therefore have favored positions. If applied to the star network, actor A is at the geodesic distance of one from each other actor, while all other actors are at a geodesic distance of one to actor A and of two to all other actors. Therefore, actor A is more central in the sense that he is closer to all other actors and therefore potentially is more important or powerful. In the circle graph, all actors have identical distributions regarding closeness.\(^{506}\) In the line network, the middle actor D is closer to all others than all other actors. Following in closeness scores are actors C and E, then B and F, then A and G. Based on this way of measurement, closeness is also an approach to differentiate important or prominent from less important or prominent actors. Actor closeness can be regarded as an indicator for potential independence of actors or for the efficiency of actors in a network.\(^{507}\) That is, since actors with high closeness centrality have a low geodesic distance to all other actors in the network, they can access other actors at more easily than actors that are more apart from others. Formally, closeness centrality for individual actors is calculated by

\[ C_c = \left[ \sum_{j=1}^{N} d(n_i,n_j) \right]^{-1} \quad \text{for } i \neq j \]

---

\(^{505}\) Based on the basic form of degree centrality, an alternative concept exists that has been developed by Phillip Bonacich. This measure takes into account not only the direct connections an actor has but all connections, and assigns an attenuation factor of $<1$ to weight connections that are more than one step away from ego. Thereby, indirect contacts are included with decreasing importance. See, for example, Bonacich (1972a), pp. 113 ff.; Bonacich (1972b), pp. 176 ff.

\(^{506}\) See Hanneman/Riddle (2005), chapter 10, p. 5.

\(^{507}\) See Jansen (2003), p. 140.
More simply, closeness centrality is the reciprocal of the sum of the distances of all actors to all other actors (except from each actor to himself).  

**Betweenness centrality:** The third concept, besides degree and closeness, asks, to what extent an actor sits between other actors. In other words, betweenness centrality measures the extent to which the geodesic paths between two other actors go through the focal actor. The more often the focal actor is on the geodesic path that links two other actors, the higher is his score on betweenness centrality. The potential of actors with high scores on betweenness centrality lies in the fact that they can broker contacts between the actors on the connecting paths of which they lie. In the star network, actor A shows the highest score on betweenness, because A lies between all other pairs of actors and no other actor lies between actor A and another actor. More simply spoken, if A intends to contact F, A can do so. If F wants to contact C, F can only do so via A. A therefore holds the most advantaged position. In the circle network, each actor is positioned between one other pair of actors. Therefore, again, no actor is in an advantaged position. In the line network, actors that lie closer to the middle, have higher betweenness scores, and are therefore in an advantaged position. Betweenness centrality for individual actors is calculated by

**Formula 3.3:** \[ C_{Bj} = \sum_{j<k}^{n} \sum_{k=i}^{n} b_{jk}(n_j) \text{ for } i \neq j \]

with

**Formula 3.4:** \[ b_{jk}(n_j) = \frac{1}{g_{jk}} \times g_{jk}(n_j) \]

---

508 Based on the basic form of closeness centrality, several alternative concepts of closeness have been developed, which do not support the focus of this study and are therefore not explained in detail. For the so-called eigenvector centrality, see for example Jansen (2003), p. 150. For the so-called reach centrality, see Hanneman/Riddle (2005), chapter 10, p. 18. For further closeness measures, see the works of Hubbell (1965), Katz (1953), Taylor (1969), and Stephenson/Zelen (1989).

509 The concept of betweenness centrality goes back to an even earlier work of Freeman. See Freeman (1977), p. 39.


511 The expression \( j<k \) below the sigma signs means that, for example, only the pair \((j,k)\) is being regarded and not, in addition, the pair \((k,j)\).
where $b_{jk}$ denotes the probability that a connection (geodesic path) occurs between actors $j$ and $k$. $b_{jk}$ is the relation of the number of geodesics $g$ between $j$ and $k$ that go through $i$, divided by the total number of geodesics between $j$ and $k$. However, since the betweenness score also depends on the size of the network, and simply increases with an increasing number of nodes, a measure has to be applied that normalizes for the size of the network. Therefore, the measure presented above is normalized based on the maximum betweenness possible in a graph. Freeman (1977) showed that the maximum possible betweenness is equal to

$$\text{Formula 3.5: } \max C_b = \frac{n^2 - 3n + 2}{2}$$

and the relative betweenness centrality of a point in a graph can then be expressed as

$$\text{Formula 3.6: } C_{b_i}^r = \frac{2C_{b_i}}{n^2 - 3n + 2}.$$

This measure shows, on a normalized basis, to what extent relative to the size of the network, an actor occurs on the geodesic path that links two other actors.

Both, degree centrality and closeness centrality measure the independence of actors from others as intermediaries. In contrast, betweenness centrality measures the dependence of other actors on the focal actor and also the ability of the focal actor to broker contacts and extract profits from his structural position. Since degree centrality and closeness centrality to some extent measure the same characteristics, and since a measure based on degree will be included in the analysis through another network measure, the focus will

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512 Based on the basic form of betweenness centrality, an alternative measure is to not only incorporate the geodesic paths into the calculation, but all paths. This measure has been developed by Freeman/Borgatti/White (1991). See Freeman/Borgatti/White (1991), pp. 141 ff.


514 A measure based on the average degree of actors, i.e., the average strength of ties, will be included as independent variable. See section 3.4.5.1.1.
be laid on the betweenness centrality measure. When applying betweenness centrality to
the context of the syndication network of VCs, high betweenness scores indicate that
firms often lie on the shortest path between two other firms. This could mean that the
focal firm might be able to extract profits in terms of information on potential investment
opportunities and that it can broker the contacts between other firms.

After having explained how centrality is measured for individual actors, it is now turned
to show how betweenness centrality is measured on the level of the entire network.
To do this, Freeman refers to two requirements for a measure of betweenness centrality
that have to be satisfied: First, the measure needs to show to what extent the most central
actor is more central than the others. And second, it ought to be based on the maximal
possible value given the network size. More formally, let

- \( n \) denote the number of nodes in a network,
- \( n_i \) denote actor \( i \),
- \( n^* \) denote the most central actor,
- \( C_B \) denote the value for betweenness centrality.

The formula looks as follows:

\[
C_B = \frac{\sum_{i=1}^{n} [C_B(n^*) - C_B(n_i)]}{\max \sum_{i=1}^{n} [C_B(n^*) - C_B(n_i)]}
\]

In this formula, the numerator represents the sum of differences in centrality of all actors
from the most central actor in a network of size \( n \). The denominator is the maximum
possible sum of differences in centrality, or, in other words, the maximum possible
centralization of a network, which is given in the star network.\(^{515}\) The value for \( C_B \), or
betweenness centrality for entire networks, therefore ranges from 0 to 1, with 0 meaning
that there are no inequalities in the centrality of actors (like in the circle graph), and 1

\(^{515}\) See Freeman (1978), pp. 227-228.
meaning that inequalities regarding centrality among actors are at their maximum (like in the star graph). Therefore, what the centrality measure does is that it shows the extent of inequality in the observed network as a percentage of the inequality in a star network of the same size.\footnote{See Freeman (1978), p. 228.}

### 3.4.5 Network Measures as Independent Variables

The measures that characterize an actor's network position relates to the idea of social capital in the sense that social capital is to be seen as a value inherent in the network position or in the relationship structure that an actor has. Therefore, actors will differ regarding the amount of social capital based on varying network positions. Measures that characterize a network position help to capture the different amounts of social capital that lies in the network position of actors.

Social network analysis offers a wide range of measures to characterize a network and the position of an actor within the network. Since the goal of this study is to explain differences in the quantity and quality of deal flow of individual VCs, it is necessary to select those measures that reflect the theoretical basis presented earlier. That means, the independent variables used in this study need to relate to the general theoretical arguments conveyed by the theory on the strength of weak ties and by the structural hole theory. Therefore, several independent variables that meet these requirements and that capture different aspects of an actor's network position have been selected. In the following sections it will become obvious that the present study extends existing research by incorporating a comprehensive set of network measures comprised of various important dimensions of an actor's network structure.

These network measures can be categorized into two groups, i.e., ego-network measures, and measures that are calculated based on all relationships in the network structure (denoted as total network measures). Recall that the ego-network of an actor is defined as the neighborhood of a focal actor, the ego. The ego-network or neighborhood comprises all nodes or actors that are adjacent to ego (termed alters) and the connections among
Network measures that are calculated based on the ego-network of actors only take into account the local environment of relationships of each actor. Thereby, the local structure of the network surrounding ego is analyzed. In contrast, there are measures that are calculated for individual actor as well, but that take the relationships of the entire network into account. These kind of measures refer to the embeddedness of actors in the overall network structure.

The independent variables used in this study comprise both, ego-network measures (average strength of ties, structural hole measures) as well as measures that are based on the entire network structure (betweenness centrality, multiconnectivity).

3.4.5.1 Ego-Network Measures

3.4.5.1.1 Average Strength of Ties

One element of the theoretical argumentation is that it is the weak ties (instead of strong ones) that might have an influence on deal flow. Therefore, a measure for the strength of ties is needed, that characterizes how frequent or intense the relationships between VCs are. As presented in section 3.2.3.2, relationships can be measured in two ways, i.e., either on a binary level (relationship is present or absent, indicated in an actor-by-actor matrix by a '0' for absence, or by a '1' for presence) or on a valued level (strength of relationship is measured, indicated in an actor-by-actor matrix with, for example, the frequency of interactions). The strength of ties in the case of the syndication network of VCs is the frequency of joint investments of two firms. In the terminology of social network analysis, the number of ties an actor has (or its strength) is also denoted as the so-called degree of an actor. The formula to calculate the degree looks as follows, where $d$ denotes degree, $i$ and $j$ denote actors, and $x$ is the element in the actor-by-actor matrix. The point in the index where normally $j$ would appear, indicates that the sum is taken across all $j$.

---

517 Refer back to section 3.2.3.1.

518 A network can be represented as a matrix, in which the rows and the columns are the same (actors), and in which the cells (elements) of the matrix indicate whether a relationship between two actors exists and, eventually, how strong the relationship is.
That is, in a binary network (a matrix that only shows whether the relationship between two actors is present or absent), the degree indicates the number of direct ties an actor has to other actors. In the case of the syndication network this measure indicates with how many different other VCs the focal VCs has invested. Obviously, in order to verify the theoretical argumentation in the prevailing case, a measurement on the valued level is necessary. However, when strength of ties is measured in network analysis tools, the algorithm that measures the degree sums the frequencies of interactions, and results in the sum of strengths of all relationships an actor has with other actors in the network. What is needed though for this study is a measure that indicates the average strength of the syndication relationships a VC has. Therefore, in order to derive a measure that indicates the average strength, the degree as calculated for the valued syndication network is to be divided by the degree as calculated for the binary network.\textsuperscript{519} This logic amends the above formula to

\begin{equation}
\text{Formula 3.9: } d_{avg} = \frac{d_{val}}{d_{bin}} = \frac{\sum_{j=1}^{N} x_{ij}}{\sum_{j=1}^{N} x_{ij}} \text{ for } i \neq j
\end{equation}

where $d_{val}$ indicates degree measured based on valued data, and $d_{bin}$ indicates degree measured based on binary data. Thereby, the sum of the strengths of all relationships is divided by the number of relationships to different actors, resulting in the average strength of the syndication relationships for each VC.

\textsuperscript{519} Although the syndication network of VCs has been measured based on valued data, this valued actor-by-actor matrix can easily be transformed into a binary actor-by-actor matrix with simple matrix operations. Thereby, the new binary matrix only shows whether a relationship between two VCs exists or whether it is absent.

\textsuperscript{520} This measure is not provided by common network analysis software packages, but has been developed and calculated by the author to serve as appropriate measure for the average strength of existing ties of the VCs in the syndication network.
Structural Hole Measures: Effective Size and Constraint

Another element of the theoretical argumentation presented above is that actors, who hold network positions characterized by structural holes, might have advantages in accessing new information and thereby might have a competitive advantage. However, as Burt (1992) explains, "[there] is no certain indicator that a structural hole is present. The hole itself is an invisible seam of non-redundancy waiting to be discovered by the able entrepreneur." With the term 'structural hole', Burt refers to network measures that indicate to what extent individual actors have non-redundant contacts and to what extent individual actors are constrained by the structure of relationships of their direct contacts.

Regarding the redundancy aspect, Burt developed a measure, which basically calculates the number of non-redundant contacts an actor has in his ego-network. The measure is called effective size. The size of an ego-network is the number of direct contacts ego has. Burt's measure now takes the size of an actor's ego-network and deducts a redundancy factor to result in the effective size.

Assume that actor \(i\) has direct relationships with actors \(j\) and \(q\), and that actors \(j\) and \(q\) also have a direct relationship. The argumentation is that the time and effort \(i\) invests in the relationship with \(j\) is redundant in the sense that the information or resources that \(j\) has to offer might also pass to \(i\) through the connection between \(i\) and \(q\). Abstaining from the derivation of the formula, the effective size of \(i\)'s network is calculated by:

\[
\text{Formula 3.10: } \sum_j \left[ 1 - \sum_q p_{iq} m_{jq} \right] \text{ for } q \neq i, j
\]

where \(p_{iq}\) is the proportion of \(i\)'s time and effort invested in the relationship with \(q\) (interaction with \(q\) divided by the sum of \(i\)'s relations; let \(z\) denote the strength of relationships).

---

522 Besides the two mentioned structural hole measures, there are two other standard measures developed by Burt, which are frequently used in social network analysis. However, since they strongly relate to the measures used in this study it is abstained from using and explaining them in detail. One is the so-called efficiency, which is the effective size normalized with the network size of the actor. The second is the so-called hierarchy, which is a measure that describes the nature of the constraint on an actor, i.e., to what extent the constraint is concentrated on one other actor. See also Burt (1992), p. 53 and pp. 140 ff.
523 Which is equal to the degree measure calculated for a network with binary data.
Theoretical Foundation

Formula 3.11: \[ (z_{ij} + z_{qi})/ \sum_j (z_{ij} + z_{ji}) \] for \( i \neq j \),

and where \( m_{jq} \) is the marginal strength of \( j \)'s relation with contact \( q \) (interaction between \( j \) and \( q \) divided by the strongest of \( j \)'s relationships),

Formula 3.12: \[ (z_{jq} + z_{qj})/ \max(z_{jk} + z_{kj}) \] for \( j \neq k \).\(^{524}\)

When aggregating the simple product \( p_{iq}m_{jq} \) across all contacts \( q \), what is measured is the portion of \( i \)'s relationship with \( j \) that is redundant to \( i \)'s relations with other direct contacts \( i \) has. Subtracting this expression \( p_{iq}m_{jq} \) from 1 (as in formula 3.10) then gives the non-redundant portion of the relationship. Consequently, formula 3.10 is the aggregate of all non-redundant portions of relationships between \( i \) and possible contacts \( j \).

Essentially, what effective size measures is the number of alters of ego minus the average degree of the alters within the ego-network, while the ties to ego are not counted. Interpreting this measure, one could say that effective size measures how many different or non-redundant other actors (potential sources of information or other resources) the focal actor can access in his ego-network. Relating this to the syndication network of VCs, it means that VCs, which have more non-redundant syndication contacts might be in a favorable position to receive information on investment opportunities. This can be illustrated in a hypothetical example: Assume that VC A has, in the past, syndicated one time each with firms B, C, D, and E. Also, VCs B and D have jointly invested once, as well as C together with E, and D together with E. Putting this simple structure into a graph, it looks as presented in figure 3.10.

The effective size of the ego-network of VC A is its degree minus the average degree of the direct contacts of A, i.e., the effective size for A is equal to 4-1.5 = 2.5. Assume that A has found an investment opportunity and he intends to invite another VC F to join this

\(^{524}\) The proportion is equal to the interaction of \( i \) with \( q \) divided by the sum of \( i \)'s relations. The marginal strength is equal to the interaction of \( j \) with \( q \) divided by the strongest of \( j \)'s relationships with anyone of \( i \)'s ego-network. See Burt (1992), p. 51. For a further discussion of this measure see also Borgatti (1997), who amends Burt's original formula. Burt's original formula is correct for the focal node in an ego-network. Borgatti amended the formula so that it can also be used to calculate the effective size for the other actors in a focal actor's ego-network. See Borgatti (1997), pp. 35 ff.
Whether the effective size of A's ego-network increases depends on whether F is also syndicating with A's other direct contacts B, C, D, and E.

\[
\begin{array}{c|c|c|c|c|c|c}
 & A & B & C & D & E \\
\hline
\text{Average degree*} & & & & & \\
\text{B} & 1 & & & & \\
\text{C} & 1 & & & & \\
\text{D} & 2 & & & & \\
\text{E} & 2 & & & & \\
\hline
\text{\(\Sigma\)} & 6 / 4 = 1.5** & & & & \\
\end{array}
\]

* Not counting ties to A
** Represents the average degree of A's direct contacts

Figure 3.10: Example on effective size

There is one case, in which the size of A's ego-network decreases: That is, if F is also connected to all of A's other syndication partners B, C, D, and E. In that case, the average degree of A's contacts (including F) is 2.8, resulting in an effective size of A's ego-network of 5 - 2.8 = 2.2. If F has syndicated before with three out of A's syndication partners, A's effective size would increase to 2.6; if F has syndicated with two out of the four, it would increase to 3.0; if F has syndicated with one, effective size would incline to 3.4; and if F had not invested before with anyone of B, C, D, or E, the effective size of A's ego-network would increase to 3.8. Therefore, the effective size of A's ego-network will increase more, the fewer of A's direct contacts F is also syndicating with. The idea of effective size is to measure the extent to which a contact has the potential to deliver new information on investment opportunities. The more F is involved in A's ego-network structure, the less is F's potential to deliver new information to A.

Another structural hole measure Burt developed is the so-called constraint. In contrast to the notion of redundancy, constraint measures the extent to which the structure of the

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525 Based on a binary network (it is only shown, whether ties exist or not, but not the strength of ties is shown), and in the case that A invests again with one of B, C, D, or E, the effective size of A's ego-network would not change. Therefore, in this example, it is explained to what extent a new contact changes the effective size of A's ego-network.

526 Own example and illustration.
relationships of ego's direct alters constrain ego. Assume the following situation: If actor $i$ intends to exchange resources or enter a transaction with actor $j$, but actor $j$ also has other alternatives to do the transaction, the structure of actor $j$'s network constrains $i$'s opportunities. To lead this to a more formal description, assume the following situation: Actor $i$ is directly connected to actors $j$ and $q$, and $q$ is directly connected to $j$ as well. If $p_{iq}$ denotes the proportional strength of $i$'s relationship with $q$, and $p_{qj}$ denotes the proportional strength of $q$'s relationship with $j$, then, if the product $p_{iq}p_{qj}$ is high, time and effort that $i$ invests in the relationship with $q$ leads back to $j$. That, however, makes it difficult for $i$ to develop a structural hole between the two contacts because they have a direct relationship themselves. If the product $p_{iq}p_{qj}$ is aggregated across all contacts $q$ and the relationship of $i$ to $j$ is added, this results in

\[
\text{Formula 3.13: } \left( p_{ij} + \sum_{q} p_{iq}p_{qj} \right)^2 \quad \text{for } q \neq i, j
\]

which defines constraint. By multiplying the strength of connection of $i$ to $q$ by the lack of structural holes around $j$, the measure defines the constraint on $i$ due to the lack of structural holes around contact $j$. The opportunities $i$ has, are constrained in the sense that $i$ has invested much of his time in relationships that lead back to a single contact. The measure ranges from a minimum of $(p_{ij})^2$ for the case that $j$ is disconnected from all other actors, to a maximum of 1 for the case that $j$ is $i$'s only contact. If measured for all contacts $j$ of actor $i$, the measure gives the aggregate constraint on $i$'s opportunities within the network.\(^{527}\) In other words, if $i$ puts much effort in the relationship to $j$, and if $i$ also devotes much effort to $q$, and $q$ on his side devotes much effort to $j$, then the constraint of $j$ on $i$ is high. The following example, graphically presented in figure 3.11 illustrates this point:

The constraint that $j$ exerts on $i$ depends on three elements, which are the effort $i$ puts into the relationship with $j$ ($p_{ij}$), the effort $i$ puts into the relationship with $q$ ($p_{iq}$), and the effort $q$ puts into the relationship with $j$ ($p_{qj}$). Given that the effort that $i$ can spend is fixed, this means, that the constraint that $j$ exerts on $i$ depends on the extent to which $j$ is also 'used' from $i$'s other contacts $q$.

\(^{527}\) See Burt (1992), p. 55.
While commonly not interpreted by network analysts in this way, when dissecting the formula for constraint, notice that the varying element in this game is the effort that \( q \) spends on the relationship with \( j \): If \( q \) had more contacts than in this simple example (contacts to which \( i \) is not connected to), then the value for \( pq_j \) would decrease and the constraint of \( j \) on \( i \) would decrease as well because the element \( pq_j \) is part of the product in the second part of the formula for constraint (see above). That is, the more \( q \) is connected to others that are not part of \( i \)'s contacts, the less the constraint that \( j \) exerts on \( i \). An example illustrates this point:

As is obvious, the effort that \( q \) can spend on \( j \) has declined to 1/6, meaning that the product \( p_{iq}pq_j \) in the formula decreases, resulting in an overall lower constraint of \( j \) on \( i \).  

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528 Own calculation and illustration.
529 Own calculation and illustration.
530 Of course, to calculate the overall constraint that \( j \) exerts on \( i \), also the contact to \( k \) would have to be taken into account. For reasons of explanation and simplicity though, this is abstained from at this point.
For the case of the syndication network of VCs, a VC A is constrained by a firm B, if A devotes much effort in the relationship to B, and VC B is also 'used' as a syndication partner by A's other syndication partners (in whom A also invests time). VC A, by investing in B, with B being 'used' by A's other contacts, makes A dependent on B. The extent to which A is dependent on B, is a function of the extent to which A's other contacts 'use' B as a contact.

However, in the context of the VCs' syndication network, the constraint measure can also be interpreted in a different way: Although Burt's measure can be understood with the notion of constraint, what the measure in the context of the VCs' syndication network also could mean is that VCs that are connected to well-connected other VCs will benefit from them. To explain this, refer to the above two figures and assume that the actors i, j, and q are VCs. As explained with the above examples, VCj exerts less constraint on VCi in the second example, which is due to the fact that VCq is also connected to other actors besides VCi and VCj (the points without labels in the extended example). Strictly following Burt's interpretation, this higher connectedness of VCq just means that VCj exerts less constraint on VCi. In the context of the syndication network this could also be interpreted in the way that, besides the fact that the formula leads to a lower value for constraint, VCi is connected to another VCq that on his side is very well-connected to other VCs. As it will be shown later on, based on these explanations, the important research question posed by Hochberg, Ljungqvist and Lu (2007) can be addressed, i.e., how VCs may form relationships with influential VCs in the network.\textsuperscript{531} Thereby, the present study contributes to the academic discussion in the field of syndicated venture capital investments and with respect to the access of individual actors to specific influential others.

### 3.4.5.2 Total Network Measures

The level of social capital that an actor has can also be characterized based on total network measures. The extent to which an actor is embedded in the overall relationship

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\textsuperscript{531} See Hochberg/Ljungqvist/Lu (2007), p. 296.
structure of the entire network indicates this level of social capital. The embeddedness of an actor in the network structure will be characterized based on the following measures.

3.4.5.2.1 Betweenness Centrality

In contrast to the previously explained ego-network measures, centrality is a measure which is calculated based on the entire network structure. As has been explained above, there are three main forms of centrality measures, i.e., degree centrality, closeness centrality, and betweenness centrality. In the earlier section on tie strength, it has been shown that the average tie strength (based on the valued and binary degree of actors) will be included as independent variable. Since degree centrality is identical to the degree measure\(^{532}\) and since closeness centrality measures similar characteristics as degree centrality, the centrality measure that will be calculated for individual actors in this study is betweenness centrality. Recall that betweenness centrality measures the number of times an actors lies on the geodesic (shortest) path between two other actors. Since the graph considered is fairly large,\(^{533}\) a relative betweenness centrality measure is taken, which is the betweenness centrality of an actor normalized with the maximum betweenness possible in the graph of a given size. It is given by

\[
C'_B = \frac{2 C_B}{n^2 - 3n + 2}
\]

with \(C'_B\) denoting the index for an actor's betweenness centrality, \(C_B\) denoting the score for the non-normalized betweenness centrality and \(n\) denoting the number of nodes in the network.\(^{534}\) That is, the normalized betweenness centrality shows the extent to which an actor occurs on the geodesic path between two other actors.

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\(^{532}\) Based on the binary data matrix.

\(^{533}\) As will be seen later, there are 172 VCs included in the calculation of network measures.

\(^{534}\) Refer back to section 3.4.4.5 for more details.
In the context of the VCs’ syndication network, higher betweenness means that a VC more often represents the shortest link between two other firms, and thereby might be in an advantaged position.

3.4.5.2.2 Multiconnectivity

Another measure included as independent variable is the so-called multiconnectivity. Multiconnectivity, also referred to as point connectivity, is calculated for each actor but the calculations are based on the entire network structure. The algorithm for point connectivity calculates for each actor, how many nodes would have to be removed for this actor to not be able to reach another (specific) actor by any path length. This procedure is repeated for this actor vis-à-vis each actor in the network. The result is an actor-by-actor matrix with the cells of the matrix showing the number of nodes that would have to be removed in order for the focal actor to become disconnected from the respective other actor (for that element in the matrix). More formally, the result is an $n \times n$ - matrix, which shows in row $i$ column $j$ the local point connectivity from node $i$ to $j$, with $i \neq j$. This is equal to the number of different paths from node $i$ to $j$. If, for each actor in this matrix, the average across all other actors is taken, this measure can serve as an indicator for the connectedness of an actor in the network. Put differently, point connectivity conveys the notion of dependency and vulnerability of an actor's network by showing whether he is dependent on the contact to specific others or whether he has multiple alternative paths to reach other actors. Applied to the syndication network of VCs, the measure indicates the potential for a firm, even if one or multiple other firms were removed from the network, to still be able to reach another firm or to retrieve information from it. Therefore, the higher the score on multiconnectivity, the less dependent on specific VCs is the focal VC and the less vulnerable is the network of the focal VC.

535 The measure of connectivity originally goes back to the idea to characterize the connectedness of an entire graph. It shows how vulnerable an entire network (graph) is to the removal of single or multiple ties. In this context, see also the works of Harary/Norman/Cartwright (1965), Frank (1971), or Peay (1974).


Research Design

The network measures explained above refer to benefits that VCs have based on their network position vis-à-vis other individual VCs. However, as has been introduced with respect to the structural hole theory, in a role analysis it can also be analyzed, whether individual VCs have benefits from being in network positions that link different subgroups of VCs within the network. This will be explained in the following section.

3.4.5.3 Role Analysis

A role analysis proceeds in two steps: First, the actors of a network are categorized into subgroups based on certain criteria. These criteria are selected by the researcher and they, of course, should correspond to the context of the network under consideration.\(^\text{538}\) Second, based on this categorization, it is examined, to what extent the actors play certain roles with respect to the subgroups.\(^\text{539}\)

There are five different roles that an actor can play, which are denoted as coordinator, gatekeeper, representative, consultant, and liaison.\(^\text{540}\) The following figure illustrates these roles, which are also denoted as roles of brokerage:

![Figure 3.13: Positional roles of brokerage\(^\text{541}\)](image)

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\(^{538}\) In the present study, as will be seen later, a categorization of the VCs will be made based on a two-dimensional matrix: One dimension refers to the fact whether the VCs have an industry focus, the other dimension refers to the fact whether they have a focus on investment stages. See section 6.3.5.1.


\(^{540}\) Although Fernandez and Gould use a different expression for the role 'consultant' (they use the term 'itinerant broker'), in this study 'consultant' will be used because it more intuitively hits the point. See also Hanneman/Riddle (2005), chapter 9, p. 15; Fernandez/Gould (1994), p. 1459.

The actor playing the different roles in these examples is actor B. The ellipses around the actors indicate whether they belong to the same subgroup or to different ones. The roles are characterized as follows:

- **Coordinator**: A, B, and C belong to the same subgroup, B coordinates the interaction between A and C.
- **Gatekeeper**: B is at the boundary of its own subgroup and controls the access of outsiders (A).
- **Representative**: B is in the same subgroup as A and acts as the contact point to outsiders.
- **Consultant**: A and C are in the same subgroup, and B acts as an external consultant being in a different subgroup.
- **Liaison**: A, B, and C all are in different subgroups and B is coordinating or mediating the contact between A and C.

Important to note is that the direction of the flow of information is given in these examples, indicated by the arrow heads. As will be explained in section 5.1 (data collection), for this study the directionality of the syndication relationships between VCs cannot be seen. That is, it can be seen whether relationships exist but not their directionality. Based on this limitation, not all of the roles described above can be analyzed in this study: With undirected data (directionality of relationship not visible), the roles 'gatekeeper' and 'representative' yield the same result. Because they deliver the same results, only one of them will be included in the analysis, arbitrarily chosen it is the role of the 'gatekeeper'. Since the role 'coordinator' refers to analyzing whether B is between A and C (all are in the same subgroup), this aspect of B's network is already captured in the betweenness centrality measure being included (see above). The roles 'consultant' and 'liaison' both make sense to be analyzed, also for undirected data. Therefore, actors will be analyzed with respect to playing three roles: Gatekeeper, consultant, and liaison.
The categorization of the VCs is two-dimensional and will be based on whether they focus on certain industries and whether they focus on certain investment stages,\textsuperscript{542} so that they will be allocated into a 2x2-matrix:

<table>
<thead>
<tr>
<th>Industry focus</th>
<th>Investment stage focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Firms in each quadrant are assigned a certain name as indicated in the figure. Based on this categorization and based on the role analysis, it will be examined whether VCs that more often play one of the roles explained above, benefit in terms of deal flow quantity and/or quality.

In the sections above, it has been explained, which network measures are included in the analysis. These measures capture the amount of social capital inherent in a VC's network position. However, in order to assess whether including network measures helps in explaining the quantity and quality of deal flow, these network measures will individually be added to a set of firm attributes that might affect the deal flow of VCs. These firm attributes are explained in the following section.

\textsuperscript{542} In his study, Vater (2002) showed that the classification based on industry focus and focus on investment stages is a relevant approach to segmentation. See Vater (2002), p. 96. See also Norton (1995), p. 21.

\textsuperscript{543} Own illustration.
3.4.6 Firm Attributes

In deal flow literature, there is no existing categorization, which shows the determinants of deal flow. Therefore, four dimensions that might influence a firm's capabilities to influence deal flow quantity and quality have been determined based on discussions with experts in the venture capital market. These include the dimensions of size, time, geography, and corporate routines, which are applied to both, deal flow quantity and deal flow quality.

The dimension of firm size with respect to the potential to generate deal flow is operationalized by the number of employees. Intuitively appealing, with more employees it seems logical, that a larger number of investment opportunities can be identified and successfully screened.

The dimension of time is included as the age of the firm in years. The logic behind this variable is that it takes time to build up and maintain relationships to other firms within the network. Intuitively, older firms might have an advantage with respect to their network position, i.e., they might have been able, over the years, to put themselves into a position within the network that yields benefits in terms of receiving information on potential investment opportunities.

A geographic component is included in order to detect, whether being in multiple regions in Germany has an influence on identifying (high-quality) investment opportunities. Therefore, the number of offices is selected as further variable.

In addition, another variable is included, which refers to corporate routines and their potential benefits. The logic is that a standardized and systematic measurement of deal flow might have an influence on the firms' awareness of their own deal flow properties (quantity and quality). Furthermore, only by systematically measuring deal flow, a

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544 These information have been collected by a questionnaire, as will be explained in section 5.1. The questions have been discussed with VCs previous to sending out the questionnaire, so that those elements could be covered that, from the perspective of the VCs, are likely to influence the deal flow of their firms.

545 Of course, this holds under the assumption that firms devote the same share of time and effort of their employees into the generation and screening of deal flow.

546 Here, of course, the assumption has to hold that multiple offices in Germany are not located close to each other but that they are spread geographically throughout the country. However, this is only a rhetorical discussion since it only makes sense to have multiple offices if the cover multiple sub-regions in a larger region.
management of deal flow is possible in order to successfully make use of for example those sources, that generate the most or the best investment opportunities. In this context, the firms have been asked whether they (a) track the number of investment opportunities received per year, (b) trace back all received investment opportunities to the sources the firm received them from, (c) trace back those investment opportunities to the original sources, in which they finally invest in.

3.5 Summary and Detailed Structure of the Research Design

Due to the characteristics of the venture capital market and of venture capital as financing method, traditional theories on financial and capital markets as well as the transaction cost approach has been shown to not be able to serve as theoretical basis in the context of this study. Rather, a theoretical concept is used that serves the purpose to explain the general benefits of networks and to also explain the benefits that actors have based on their structural position within a network. Based on the methods of social network analysis, this theoretical concept has been found in social capital theory, including the general theory on the trust in the prevalence of norms, the theory on the strength of weak ties, and the theory of structural holes.

Trust in the prevalence of norms has been shown to be the underlying basis that makes the exchange of resources among actors in a network possible. One example for those norms in the VCs' syndication network could be the expected reciprocation of deal flow. The strength of weak ties lies in the fact that weak ties can be 'bridges' to actors that deliver new information. In contrast, in the structural hole theory it is argued that it is not the weakness of ties that yields informational benefits. Rather, it is the non-redundancy of contacts in the network, and the lack of constraint in an actor's network that deliver informational and control benefits.

Based on these theoretical concepts, a research design has been developed that proceeds in two steps: First, the general contact network (including all sources of deal flow) and the VCs' syndication network (relationships of VCs among each other) are evaluated with respect to their importance for the generation of deal flow quantity and quality. Second, the VCs' syndication network is analyzed by the methods of formal network analysis. Several network measures, grouped into ego-network measures and total network
measures, are calculated. According to the goals of the study, their individual effect on the VCs' deal flow quantity and quality will be analyzed. To do this, several firm attributes are included in a model, and then, successively, network measures will be added individually. However, before the second step is performed, the entire network will be examined in order to get an understanding of the overall characteristics of the network structure, and in order to assess whether the potential benefits are distributed equally or unequally among the VCs.

The research design including based on the single measures explained in the previous sections is illustrated below:

Figure 3.15: Detailed structure of the research model

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547 Own illustration.
4 Derivation of Hypotheses

Based on the theoretical explanations and the research model developed, in this section, hypotheses will be derived for the two parts of the research model. Hypotheses regarding goal (a), i.e., the general importance of the contact network and of other VCs as source of deal flow, will be derived in section 4.1. Hypotheses for goal (b), i.e., the effect of the network position on deal flow quantity and quality, follow in section 4.2. As explained before, the hypotheses regarding goal (a) and their testing shall be perceived as the starting point and as the justification for performing the analyses regarding goal (b), on which the focus of this study is laid. The hypotheses for goal (a) are still being derived and later tested in order to present a comprehensive picture of the VCs under consideration. Finally, in section 4.3, the derived hypotheses are summarized.

4.1 Hypotheses on the General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow

Based on social capital theories explained, previous empirical research, and the logics to measure deal flow quantity and quality, several hypotheses on the general importance of the contact network and of other VCs as source of deal flow for the generation of deal flow can be derived. In the hypotheses, the letters A, B, C, A', B', and C' relate to those used in figure 3.7.

In social capital theories, it has been explained that, in general, for the exchange of information, trusted norms and reciprocity serve as the basic underlying mechanisms.\textsuperscript{548} Especially in environments characterized by high uncertainty, such as in the venture capital industry, these mechanisms imply that the contact network of VCs can be expected to play an important role with respect to deal flow generation.\textsuperscript{549} That is, the level of social capital in the form of values and norms, can be seen as the lubricant that makes the exchange of resources possible. In the context of this study, resources are information on potential investment opportunities.

\textsuperscript{548} See the explanations in section 3.3.3 and 3.3.4.
\textsuperscript{549} See Bygrave (1988), p. 137.
The first hypothesis refers to the question, whether VCs in the German market receive more investment opportunities from their network contacts or whether they receive more unsolicited. For the US market it could be shown that more than half of the investment opportunities received, come by referral.\textsuperscript{550} For the German market it was found that approximately 50% of the investment opportunities received, come by referral.\textsuperscript{551} While there already is data for the German market on the question, which is also addressed by the first hypothesis, the latter will still be set up in order to be able to draw a consistent picture for the VCs under consideration in the present study. The first hypothesis consequently refers to deal flow quantity and the argumentation is as follows.

Based on the fact, that VCs spend the largest amount of time on the identification and on the evaluation of investment opportunities,\textsuperscript{552} it can be assumed that they also intend to optimize the output of that process.\textsuperscript{553} In terms of deal flow quantity, the output of that process is a sufficiently large number of investment opportunities the VC can select from. At the same time, the VCs try to optimize the quality of their deal flow, which means, that they try to identify as many investment opportunities as possible that meet their investment criteria. Because VCs assume that investment opportunities, which come by referral, potentially meet these criteria better, the VCs can be assumed to put a larger amount of time into the establishment and maintaining of their general contact network than they put into marketing activities, which might increase the number of investment opportunities received unsolicited. The reasons why a VC can be assumed to spend more time on its network than on other activities are therefore two-fold: One aspect is certainly, that the referrers potentially better know the investment criteria of the VC. However, the second aspect is that referrers cannot afford to refer bad deals to the VC, which is due to the fact that such behavior will be punished by the VC by, for example, excluding the referrer from future business. This mechanism can be understood as social capital inherent in the relationship network. Now, if a VC knows that this mechanism is

\textsuperscript{550} Wells found that 61% of the investment opportunities came from referrals, Tyebjee/Bruno found a value of 65%. See Wells (1974), p. 57; Tyebjee/Bruno (1984), p. 1055.


\textsuperscript{553} Also refer back to the value chain of VCs, i.e., see section 2.1.3.4.
in place, and if the VC therefore expects to receive high-quality deals from its referrers, then it can be assumed that VCs spend more time on establishing and maintaining its network than it spends on other activities (such as marketing) to generate deal flow quantity. If one can also assume that the sources (either contact network or unsolicited) yield a number of investment opportunities as output that corresponds to the effort that the VC spends on that source, then the number of investment opportunities received from network contacts can be expected to be higher than the number received unsolicited. A verification of HI 1 would lead to the conclusion that the contact network of VCs is important because it delivers \textit{many} investment opportunities. It follows:

HI 1: Of all investment opportunities received (irrespective of their quality), the percentage of investment opportunities received from a network contact (A) is higher than the percentage received unsolicited (B), so that A>B.

The second hypothesis refers to the same question as the first, this time though relating to deal flow quality, i.e., to those investment opportunities that actually get funded by the VCs. For the US, it has been found that most deals that are funded, came by referral. For the German market, there is no such data. The argumentation is similar to the one developed for HI 1: Based on social capital theory, that trust in norms of behavior is the basic underlying mechanism that makes collaboration possible, it should follow for VCs and their general contact network, that only those deals get referred, which probably meet the quality criteria of the VC. This is due to the fact, that, if a source out of the contact network frequently refers bad quality deals to a VC, the VC will probably lose interest in the relationship it has to that specific referrer and sanction him by exclusion from future transactions. Therefore, two assumptions can be made: The VC has trust in

\footnotesize

554 If HI 1 will be confirmed, this would be in line with the findings for the US market, however, it would go against the findings for the German market.

555 However, the study was based on a fairly small sample size of 18 VCs. See Fried/Hisrich (1994), pp. 31 f.

556 Refer back to section 3.3.3.5.

557 Although, for example, referrers such as lawyers or consultants do not directly invest with VCs, it would still be negative for their reputation if they were known for frequently referring bad deals. If they frequently did so, the VC could sanction them by not collaborating with them in the future.
the norms of behavior, i.e., trust in the referrers' judgment and trust in that no bad deals are referred. And, the referrers can be assumed to know well the investment criteria of the VCs.

If confirmed, the result would be in line with the empirical finding of Fried and Hisrich (1994) for the US market, and would lead to the conclusion that the contact network of VCs in Germany is important because it delivers high-quality investment opportunities. It follows:

HI 2: Of those investment opportunities that get funded, the percentage of investment opportunities received from a network contact (A’) is higher than the percentage received unsolicited (B’), so that A’>B’.

Hypothesis HI 3 is set up to evaluate, whether the contact network is more important for the generation of deal flow quantity, or for the generation of deal flow quality. It will therefore be examined, whether the percentage of referrals is higher for those investment opportunities that get funded (deal flow quality) compared to all investment opportunities received (deal flow quantity). The argumentation is analog to the one for HI 2: Since the referrers probably know the investment criteria of the VC and since underlying norms of behavior prevents the VCs' contacts to refer bad deals, the 'referred' portion of those investment opportunities that get funded should be higher than the 'referred' portion of all investment opportunities. If confirmed, the conclusion would be, that the contact network of VCs in Germany is important because, above all, it delivers high-quality investment opportunities. Therefore, it can be hypothesized:

HI 3: The percentage of funded investment opportunities received from a network contact (A’) is higher compared to the percentage of all investment opportunities received from a network contact (A), so that A’>A.

Hypotheses HI 4 - HI 6 address the importance of other VCs as a source of deal flow. That is, the importance of the source 'Other VCs' within the contact network is compared to the importance of the other sources within the network (universities/research centers,

Hypotheses on the General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow

banks/investment banks, private contacts, other). Wells (1974) and Tyebjee and Bruno (1984) could show for the US that approximately 30% of the investment opportunities received, stemmed from other VCs or other professional sources.\(^{559}\) For the German market, Vater (2002) found a value of approximately 7%,\(^{560}\) while, at the same time, the respondents regarded the source 'Other VCs' as very important.\(^{561}\) Since these results are contradictory, hypothesis HI 4 relates to the question, how important the source 'Other VCs' is with respect to all investment opportunities received (deal flow quantity). HI 5 is analog to HI 4 but refers to deal flow quality, i.e., the funded investment opportunities. HI 6 then, again, compares deal flow quantity with deal flow quality by examining, whether the percentage referred by other VCs is higher for deals that get funded compared to all deals received.

As derived above, most of the effort that a VC spends on generating deal flow, he will put into that source from which it expects to receive the highest quality of deals. If it can be assumed, based on the norms of behavior among VCs, that other VCs only refer those deals that meet the investment criteria of the VC the deal is referred to, then the highest quality of deals can be expected to come from the source 'Other VCs'. This, in turn, implies that VCs, on average, put most of their effort for deal flow generation into contacts to other VCs. If one can assume that the 'output' of a network source (investment opportunities received) depends on the effort spent on that source, then the source 'Other VCs' should not only deliver the most investment opportunities compared to the other sources, but it should also deliver deals with the highest quality.

Note that a central aspect underlying this argumentation is based on the norms of behavior, i.e., that a VC only refers those deals that meet the investment criteria of the VC the deal is referred to. That is, the amount of social capital (prevalence of norms and trust) in the network VCs have among each other, enables the exchange of information on investment opportunities.

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560 In his study, Vater differentiates between several types of VCs. The one that is relevant for the present study ('Venture-Capital-Gesellschaften'), showed a value of approximately 13%. However, in the relevant group, only 7 firms are included (in addition, the other groups even show lower values). Therefore, it is questionable, whether the result can be used as reliable comparison for the results of the present study. See Vater (2002), p. 144.
It can therefore be derived that, not only for deal flow quantity but also for deal flow quality, the source 'Other VCs' should account for the largest portion. A confirmation of HI 4 would lead to the conclusion, that 'Other VCs' as source of deal flow is important because it delivers *many* investment opportunities. A confirmation of HI 5 would imply that 'Other VCs' as source of deal flow is important because it delivers *high-quality* investment opportunities. It therefore follows:

**HI 4:** Based on deal flow quantity and based on the deal flow sources within the contact network, other VCs (C) represent the largest single source, so that C > any other single source.

**HI 5:** Based on deal flow quality and based on the deal flow sources within the contact network, other VCs (C') represent the largest single source, so that C' > any other single source.

The final hypothesis HI 6 is set up to examine, whether the benefit of 'Other VCs' as source of deal flow is larger for the generation of deal flow quantity, or, for the generation of deal flow quality. Therefore, the percentages C' and C have to be compared. If C' is higher than C, consequently, above all the high-quality investment opportunities come from other VCs. Again, the theoretical reasoning why this can be expected is that the amount of social capital in the form of norms of behavior allows VCs to trust the referrers' judgment. This is the case because the referrer knows that if he refers bad deals, he will be sanctioned by being excluded from future transactions. In addition, other VCs probably know best the investment criteria of their peers A confirmation of HI 6 would lead to the conclusion that 'Other VCs' as source of deal flow is important because, *above all*, it delivers *high-quality* investment opportunities. Therefore, it follows:

**HI 6:** The percentage of investment opportunities referred to by other VCs is higher based on deal flow quality (C') than it is based on deal flow quantity (C), so that C'>C.
4.2 Hypotheses on the Connection between Network Measures and Deal Flow

The hypotheses on the connection between network measures and the deal flow of VCs aim at analyzing whether differences in the amount of social capital in the form of structural embeddedness in the network leads to differences in deal flow quantity or quality.

This section is structured according to the independent variables used, i.e., ego-network measures (average strength of ties, effective size, constraint), total network measures (betweenness centrality, multiconnectivity), and network measures regarding the role analysis (gatekeeper, consultant, liaison). Hypotheses will be derived on the expected impact of these variables with respect to deal flow quantity and quality. Consequently, 16 hypotheses will be set up, deduced on the basis of the theoretical explanations presented earlier.

4.2.1 Ego-Network Measures

4.2.1.1 Average Strength of Ties

While Granovetter verified his theory based on an empirical study in an area that is unrelated to venture capital or financial investments, the fundamental characteristic of that situation was similar to the one prevailing in the syndication network of VCs: Basically, it is about receiving novel information. In the case Granovetter studied, it was information on potential job opportunities that people receive. In the case of the prevailing study, it is about information on potential investment opportunities that VCs receive. Recall, the findings of Granovetter hold that people that were weakly tied benefited from these weak ties because they delivered new information on potential job opportunities. This, from a theoretical perspective, is due to the fact that a triad with

562 Recall that deal flow quantity as dependent variable is measured as the average number of investment opportunities received per year, multiplied with the percentage that comes out of the contact network and with the percentage that stems from the source 'Other VCs'. Equivalently, deal flow quality is measured as the average number of investment opportunities received per year, multiplied with the respective deal rate of the VC and with the percentage that comes out of the contact network and with the percentage that stems from the source 'Other VCs'. See also section 3.4.2.

Derivation of Hypotheses

strong ties between A and B, A and C, but not between B and C, cannot exist. Due to the processes of cognitive balance, in the long run, BC would occur as well.\textsuperscript{564} If this triad (AB, AC, but not BC) is absent, then no strong tie can be a bridge, or, consequently, all bridges are weak ties.\textsuperscript{565} Since these bridges are important for receiving new information, which is also vital for VCs with respect to information on potential investment opportunities, it should be followed that weakly tied VCs will have a competitive advantage in terms of deal flow quantity. Therefore, the argument regarding the VCs' syndication network holds that weak ties are beneficial because they deliver \textit{many} investment opportunities. The amount of social capital is then inherent in the VCs' ability to access new information, based on their relationship structure. It follows:

HII 1: A higher average strength of ties will negatively affect deal flow quantity.

Strictly according to the theory on the strength of weak ties, it should also hold that, the weaker the average tie strength, the larger the number of investment opportunities received from other VCs and finally invested in. Consider the following two situations, which are, of course, simplified examples:

![Case 1 and Case 2](image.png)

Figure 4.1: Two cases on tie strength\textsuperscript{566}

\textsuperscript{564} See Newcomb (1961), pp. 160 ff. Also, refer back to section 3.3.3.1.

\textsuperscript{565} See Granovetter (1973), p. 1364.

\textsuperscript{566} Own illustration.
When drawing on the tie strength argument, several elements in these two situations have to be imagined to be constant (or the same) for all actors:

- A has a given amount of time/resources he can spend on the relationships to his contacts.
- Actors B, C, D, E, and F all have a fixed number of contacts to whom A is not connected (these contacts all deliver the same quality of information).
- The level of trust A has in his direct contacts is the same for all (B, C, D, E, and F).

Given these conditions and exclusively looking at the tie strength, it should follow that in case 1, A is exposed not only to a wider supply of information. But because it is different (newer) information that A receives, he might also be able to extract those that are of interest for him. Relatively, in case 1, A does not receive a higher percentage of high-quality information (because also the quantity of information received increases). But absolutely, in case 1, A is in an advantageous position because, bottom-line, the number of high-quality pieces of information should be higher than in case 2.\textsuperscript{567} Transferring this to the VCs' syndication network, it should follow:

HII 2: A higher average strength of ties will negatively affect deal flow quality.

\subsection*{4.2.1.2 Effective Size}

Effective size is a structural hole measure that indicates to what extent an actor has non-redundant contacts in his ego-network. According to the theoretical argumentation, information benefits in a network structure are inherent in those network positions (held by actors), that are rich in non-redundant contacts.\textsuperscript{568}

Recall that effective size measures the extent to which an actor has access to different sources of information (in terms of other actors). In contrast, if an actor only has

\begin{footnotesize}
\begin{enumerate}
\item[567] Of course, with growing firm size, the number of deal finally invested in should increase. In the two examples above, it was assumed that actor A, in both cases, has the same size (amount of resources he can spend). In order to control for this effect, a variable is included that captures firm size.
\end{enumerate}
\end{footnotesize}
redundant contacts, chances are high that he will hear the same information again and again, and, theoretically, he will not become cognizant of any new opportunities arising in the network. Given that new information on potential investment opportunities is critical for VCs, logically, having non-redundant contacts can be assumed to have a significant impact on the VCs' ability to access new information on potential investment opportunities. That is, in terms of deal flow quantity, theory predicts that having more non-redundant contacts will positively affect the number of investment opportunities a VC becomes aware of. The amount of social capital is therefore expressed in the non-redundancy of a VC's syndication contacts. Consequently, it follows:

HII 3: A larger effective size will positively affect deal flow quantity.

Having non-redundant contacts can also be seen as a prerequisite for achieving deal flow quality. That is, if a VC only had highly redundant contacts in its ego-network, information that flows through this ego-network is highly redundant as well. Assume an example of a redundant network, in which three VCs A, B, and C are all strongly connected with each other, so that strong ties exist linking A with B, A with C, and B with C. Now, of course, there could be the unlikely case that one, two, or all three VCs have an unlimited pool of high-quality investment opportunities they can refer to each other. In that case, the redundancy of their contacts would not be an issue. However, realistically, high-quality investment opportunities are scarce, especially in times when 'too much money is chasing too few deals', i.e., in times when deal flow becomes even more important. It becomes obvious that actors A, B, and C would have limited exposure to new information on potential investment opportunities (of course, in this example, it is assumed that these are the only contacts they have). In contrast, assume VC A had another contact to VC D, to whom VCs B and C are not connected. For A, this would represent a non-redundant contact, which delivers, in a first sense, more

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569 Refer back to section 3.4.5.1.2.
570 See Gompers/Lerner (2000), p. 282; Kaplan/Stein (1993), p. 313. The scarcity of high-quality investment opportunities in the German venture capital market has been verified by several venture capital managers in telephone conversations performed throughout the course of the research. As can be seen in figure 2.3, there is a considerable amount of capital, which has not been invested yet. This aspect has also been discussed with VCs and could be confirmed.
investment opportunities. However, by being exposed to a wider supply of potential deals, also the number of deals received from other VCs and finally invested in (deal flow quality) should also increase (in absolute terms). Therefore, having non-redundant contacts can also be assumed to be a prerequisite to access high-quality investment opportunities. The social capital that a VC has is, again, expressed by the non-redundancy of his syndication contacts, so that it follows:

HII 4: A larger effective size will positively affect deal flow quality.

4.2.1.3  Constraint

Constraint is the second structural hole measure included in the analysis, however, it captures a different notion of the ego-network (as compared to effective size). Constraint measures the extent, to which an actor is dependent on other actors, or, in other words constrained by the relationship structure of his direct contacts. As shown in the formal description of the measure, constraint on an actor $i$ is high if he invests much effort in a relationship to $j$, who is also 'used' by many others $q$, or, if $q$ also devotes much effort in the relationship to $j$. However, as has also been explained in the examples for the measure, in the context of the VCs' syndication network, this measure can also be interpreted in a different way: If VC A is connected to VCs B and C, and A devotes much effort to the relationships to B and C, then the constraint of B on A will be lower, the more C is connected to further VCs D, E, F, etc. If C is well-connected, the measure for constraint will be lower. In that case, VC A should benefit from VC C because VC C has multiple other relationships. In contrast, if VC C is connected to those others that are also connected to VC A, this will slow down the decrease of the constraint measure and A will not benefit that much from the contact to C. Because being connected to well-

571 Of course, one would argue that, with growing size of the firm, it is possible to have more syndication relationships and that, just based on the firm's size, also deal flow quality (in absolute terms) must increase. To account for this effect, a variable measuring firm size (number of employees) will be included in the regression models to filter out the differential effect that effective size has on deal flow quality.

572 See Burt (1992), pp. 54-57.

Derivation of Hypotheses

connected others can be assumed to deliver a higher number of investment opportunities, it can be derived:

HII 5: A higher constraint will negatively affect deal flow quantity.

At the same time, if A is highly constrained by B, A seems to not have many other alternatives to interact with. Also it would be that A does not have contacts that, on their side, are well-connected. Therefore, chances to receive information on high-quality investment opportunities should be lower, the higher the constraint on A is because A then seems to be dependent on a few others that are not well-connected. Therefore, it follows:

HII 6: A higher constraint will negatively affect deal flow quality.

4.2.2 Total Network Measures

4.2.2.1 Betweenness Centrality

Following the theoretical reasoning on betweenness centrality, an actor is in an advantaged structural network position, the more often he sits between two other actors. Betweenness centrality measures this extent by examining all geodesic paths from each actor to each other actor in the network. The advantage for the actor that sits between two others lies in the fact that he can broker the contact and that he can potentially retrieve information that flows from the one actor to the other. Applied to the VCs' syndication network, this means that the more often a VC sits between two other VCs, the higher should his potential be (a) to retrieve information on potential investment opportunities, and (b) to control the information flow and to extract those investment opportunities.

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574 Again, as was the case with effective size, the absolute deal flow quality, which is the measure in this study, should increase. To account for the effect of firm size on the absolute measure of deal flow quality, a variable for firm size will be included. Thereby, the differential effect of constraint on deal flow quality can be filtered out.

575 See also the explanations of this measure in sections 3.4.4.5 and 3.4.5.2.1.

576 See Freeman (1977), pp. 39 f.
opportunities that are of higher interest for him. Therefore, the amount of social capital is inherent in a higher betweenness centrality, which should lead to higher deal flow quantity, so that it follows:

HII 7: Higher betweenness centrality will positively affect deal flow quantity.

In the same vein, since holding a network position characterized by high betweenness centrality brings a VC into the favorable structural position to potentially be able to extract the high-quality investment opportunities, higher scores on betweenness centrality should also induce higher deal flow quality:

HII 8: Higher betweenness centrality will positively affect deal flow quality.

4.2.2.2 Multiconnectivity

Recall that multiconnectivity is measured by the point connectivity of an actor.\textsuperscript{577} In this study, the average point connectivity for each actor is calculated, which is equal to the average number of nodes that would have to be removed in order for the focal VC not to be able to reach another (specific) VC. Point connectivity thereby indicates the vulnerability of a VC's network structure.\textsuperscript{578} The more nodes can be removed for the focal VC to become disconnected from another VC, the more invulnerable the network of that VC is. Therefore, the more alternatives a VC has to reach another VC within the network, or, in other words, the more often a VC has invested with different other VCs, the more paths in the network this focal VC will have to receive information on potential investment opportunities.\textsuperscript{579} This VC's network structure is consequently less vulnerable (and the VC is less dependent on certain network contacts), so that higher scores on

\textsuperscript{577} Refer back to section 3.4.5.2.2.

\textsuperscript{578} The measures of connectivity refer back to the calculation of the connectedness of graphs, i.e., entire networks. For early works on this measure, see Harary/Norman/Cartwright (1965), Frank (1971), Peay (1974).

\textsuperscript{579} See the general argument on the benefits of having multiple paths available in Hanneman/Riddle (2005), chapter 7, pp. 12 f.; Wasserman/Faust (1994), p. 115.
multiconnectivity should lead to higher deal flow quantity. The value of social capital therefore lies in the invulnerability of a VC’s network structure. It follows:

HII 9: Higher multiconnectivity will positively affect deal flow quantity.

In addition, the more often a firm has invested with different other firms, the more exposed the focal firm will be towards a wider supply of deals. Analog to the argumentation on effective size and constraint, this wider supply of deals should also positively affect the absolute deal flow quality of the VC. Therefore, it can be assumed, that the higher the score on multiconnectivity, the higher the deal flow quality of that focal VC will be, so that it follows:

HII 10: Higher multiconnectivity will positively affect deal flow quality.

4.2.3 Role Analysis
For the derivation of hypotheses with respect to the three different roles (gatekeeper, consultant, liaison), recall that the VCs will be categorized along the two dimensions 'industry focus' and 'focus on investment stage'. When deriving the hypotheses for the different roles, it need not be differentiated between them because the theoretical rationale is the same for all three of them: In the case that a VC plays the role of a gatekeeper, it can control resources that come from and that flow to another subgroup. Being a consultant, a VC also has a contact to a different subgroup. And playing the role 'liaison' a VC has contact to two different subgroups. In all cases, and based on the structural hole theory, the VC should benefit from playing more often one of these roles because it has access to new information and because it has the chance to control the information flow. Assume that VC A is a stage specialist, i.e., it focuses on one or a few investment stages but it does not focus on specific industries. If that VC becomes

580 Analog to the previous explanations on effective size and constraint, a variable for firm size will be included to filter out the addition effect that multiconnectivity has on deal flow quality (to exclude the possibility that only by growing firm size the absolute deal flow quality measure increases).

581 Remember that the role 'gatekeeper' yields the same results as the role 'representative' in the case of undirected data as is the case in this study. See section 3.4.5.3.
cognizant of an investment opportunity that meets its focus on investment stages but which is in an industry that VC A is not experienced in, A might refer that deal to another VC B with the relevant industry focus. That is, VC B might be in a favorable position the more often it plays one of the roles described above because the access to outside subgroups might deliver benefits in terms of information on investment opportunities. In general, VCs should benefit from being more often in positions that represent a link between different subgroups. These VCs should not only benefit in terms of deal flow quantity, but because they can also potentially control the information flow between subgroups they might be able to extract those deals that are interesting for them, i.e., they should also benefit in terms of deal flow quality. In the case of the network considered in this study, relationships are equal to syndicated investments. This means that the more often a VC syndicates with VCs from other subgroups and thereby has access to information from different subgroups, the more this VC should benefit in terms of deal flow quantity and quality. For the three different roles and the two dependent variables (deal flow quantity and quality), it follows:

HII 11: Being more often in a gatekeeper position will positively affect deal flow quantity.
HII 12: Being more often in a gatekeeper position will positively affect deal flow quality.
HII 13: Being more often in a consultant position will positively affect deal flow quantity.
HII 14: Being more often in a consultant position will positively affect deal flow quality.
HII 15: Being more often in a liaison position will positively affect deal flow quantity.
HII 16: Being more often in a liaison position will positively affect deal flow quality.

582 Important to note is that, by the network analysis software, two measures for each role are calculated: The algorithm (a) counts the actual number of times that a VC plays a specific role, and (b) provides a normalized measure of this count. Because with growing size of a network it necessarily occurs that an actor plays one of the roles, the non-normalized counts are being compared to results that would occur if relations were distributed randomly. That is, given the number and the size of the subgroups, the software calculates many theoretical networks and compares the actually observed results (a) to the theoretical ones. The result of that comparison is the normalized score for the specific roles (b). By using the normalized measure, the researcher can be confident that the results did not occur randomly. Therefore, in this study, the normalized scores are used. See Hanneman/Riddle (2005), chapter 9, pp. 19-21.
4.3 Summary of Hypotheses

The hypotheses derived above, including their expected signs, are summarized in the following overviews. In the first table, the hypotheses on the general importance of the contact network and of the contacts to other VCs for the generation of deal flow quantity and quality are presented. The second table shows the expected connection between network position and deal flow quantity and quality.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Expectation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI 1</td>
<td>A&gt;B</td>
</tr>
<tr>
<td>HI 2</td>
<td>A'&gt;B'</td>
</tr>
<tr>
<td>HI 3</td>
<td>A'&gt;A</td>
</tr>
<tr>
<td>HI 4</td>
<td>C&gt;any other source</td>
</tr>
<tr>
<td>HI 5</td>
<td>C'&gt;any other source</td>
</tr>
<tr>
<td>HI 6</td>
<td>C'&gt;C</td>
</tr>
</tbody>
</table>

Table 4.1: Hypotheses on the importance of the contact network

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Expected sign (hypothesis)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deal flow quantity</td>
</tr>
<tr>
<td>Tie strength</td>
<td>- (HII 1)</td>
</tr>
<tr>
<td>Effective size</td>
<td>+ (HII 3)</td>
</tr>
<tr>
<td>Constraint</td>
<td>- (HII 5)</td>
</tr>
<tr>
<td>Betweenness centrality</td>
<td>+ (HII 7)</td>
</tr>
<tr>
<td>Multi-connectivity</td>
<td>+ (HII 9)</td>
</tr>
<tr>
<td>Gatekeeper</td>
<td>+ (HII 11)</td>
</tr>
<tr>
<td>Consultant</td>
<td>+ (HII 13)</td>
</tr>
<tr>
<td>Liaison</td>
<td>+ (HII 15)</td>
</tr>
</tbody>
</table>

Table 4.2: Hypotheses on effects of network position on deal flow quantity/quality

583 Own illustration.
584 Own illustration.
5 Data Collection and Methodological Approach

In order to perform the analyses as described in the research model, data must be collected for three areas: First, as basis for the formal network analysis, information needs to be collected on the syndication network of VCs. This means that a dataset is needed on investments of VCs, for which a database called VentureXpert of Thomson Financial has been used. The syndication network has then been analyzed with the help of a software package for network analysis called UCINET 6. Second, data must be collected on the quantity, quality, and sources of the deal flow of those VCs that are part of the network under consideration, i.e., of those firms that are part of the dataset, for which the network analysis is performed. Third, further information on certain characteristics of the VCs needs to be gathered that cannot be extracted from the dataset derived from the VentureXpert database. The information for the second and third area, i.e., data on deal flow and information on further characteristics has been collected by a questionnaire that has been sent to those VCs, which are part of the syndication network. While the data on investments of VCs is secondary data, the information collected on deal flow and on further characteristics of VCs is primary data. How the data collection has been performed, will be described in detail in the following sections.

5.1 Data Collection

5.1.1 Data on Investments of Venture Capital Firms

5.1.1.1 Data Collection and Data Measurement

As explained in section 3.2.3.2, several aspects regarding the collection and the measurement of network data have to be considered before any network analysis is being performed.

Data collection: As to the data collection, there are several ways, in which network data can be gathered including questionnaires, interviews, experiments, observations, or

585 See section 3.5.
archival records. For the purpose of this study, i.e., in order to collect data on investments of VCs, the most appropriate way is to use a database that contains this information. Of course, certain aspects regarding the validity and reliability of the information in the database have to be evaluated, which will be discussed further below. In the case of this study, the database VentureXpert from Thomson Financial has been used. VentureXpert contains information on investments of VCs and PEs from all over the world. Nevertheless, within this database, the user is able to retrieve data, based on certain selection criteria. For example, selections can be made regarding the nation of the portfolio company, the nation of the VC or PE, the investment date, or the investment stages that should be considered. As will be discussed below, these selection criteria will be used to determine the network boundaries, a necessary condition for any formal network analysis.

Measurement of network data: As to the measurement of network data, the unit of observation, the modeling unit, and the quantification of the relations require attention. For the purpose of this study, the unit of observation is the individual VC and its investment relations to other VCs. On these entities, measurements are collected. The modeling unit refers to the level, at which network data is presented, i.e., it can be presented on the level of individual actors, of dyads or triads, of subgroups or actor subsets, or of the entire network. The choice of the modeling unit depends on the research question asked. In the case of this study, the impact of network measures on deal flow quantity and quality on the level of individual VCs will be focused on. Nevertheless, as discussed earlier, also the entire network structure will be looked at as well as the benefits that individual VCs have due to their network position with respect to certain subgroups. Regarding the quantification of relations, the two dimensions directionality

587 The information on investments will be collected given certain limiting criteria, i.e., information will be collected for a certain time period, region, and investment stages. This will be explained in detail in the following section.
590 See Wasserman/Faust (1994), p. 44.
and numeration are relevant. The data on the investments of VCs that can be retrieved from the VentureXpert database does not reveal the directionality of relations in the case of syndicated investments. That means, if two or more VCs jointly invested in a portfolio company, the data does not reflect, which VC had the role of the lead investor and which VC acted as co-investor. Neither does the database show, of course, which VC was the one, that initially originated the deal, i.e., that identified the investment opportunity. However, what the data shows are the individual VC(s) that jointly invested in a portfolio company. In addition, the names of the portfolio company as well as of the VCs that invested, are shown. That is, the dataset contains the information, in which portfolio company has been invested and who the one or more investors were, which are the necessary pieces of information for this study.

The second dimension regarding the quantification of relations refers to the numeration, which can either be binary, i.e., dichotomous, or valued. In the case of binary data, information only exists on whether a relationship between two actors is present or absent. In the case of valued data, information also exists about the strength, intensity, or frequency of the relation. The original data on investments of VCs retrieved from VentureXpert is not valued, i.e., one can only see if a VC invested in a portfolio company or if it did not. However, as will be explained in detail in the following sections, the data originally retrieved will be prepared and formatted in a way that, with the help of the software package UCINET 6, matrices can be generated that transform the basic information into a valued matrix. In the case of this study, this valued matrix then contains the information, how many times two specific VCs jointly have invested in portfolio companies.

However, as is common and necessary in any formal network analysis, the network boundaries have to be defined, being explained in the next section.

592 In their study, Hochberg/Ljungqvist/Lu (2007) for example assume that the VC providing the largest amount is the lead investor. See Hochberg/Ljungqvist/Lu (2007), p. 259. However, in this study it is abstained from making this assumption because as discussions with managers from the private equity and venture capital industry have shown, it cannot be taken for granted that the lead investor always contributes the largest amount.
5.1.1.2 Definition of Network Boundaries

One of the central challenges in social network analysis is to specify the boundaries of the network under consideration, i.e., to specify, which actors and which relationships belong to a network and which do not. For analyses that include small sets of actors such as the employees of a service station or the faculty of an academic department, the boundaries of the network are relatively easy to draw. In contrast, in cases with many actors, this issue might not be that easy to deal with.

More specifically, there are two dimensions regarding network boundaries that have to be looked at. The first refers to the question, which actors to incorporate, and the second refers to the question, which type of relations to incorporate. Both questions can only be answered with respect to the research question being asked and with respect to the kind of analysis being performed. What that means and how it has been applied to the analysis of the syndication network of VCs, will be explained in the following.

5.1.1.2.1 Boundaries to Define the Actors

As to the first dimension, i.e., potential criteria to set the boundaries to define relevant network actors, there are several possibilities such as:

- Boundaries of organizations or groups
- Geographic boundaries
- Boundaries based on participation in certain events
- Boundaries based on characteristics of actors
- Boundaries based on the relationships of actors among each other

In most cases, it is reasonable not to define network boundaries based on one criterion but on the basis of multiple criteria, since incorporating only one criterion might lead to a network, in which the enclosed actor set is defined insufficiently. For example, in an analysis of the relationships between start-up companies and banks the existence and also

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the absence of relations are of importance. However, if the network boundaries have only been set based on existing relationships among actors, the absent relations cannot be identified.\textsuperscript{596} Therefore, it is often advisable to use multiple criteria to specify the network boundaries. Laumann, Marsden and Prensky (1989) present two different approaches to define network boundaries. One approach, called the realist approach, identifies network boundaries and membership as perceived by the actors themselves.\textsuperscript{597} A second way of defining network boundaries is called the nominalist approach. Here, not the actors, but the researcher determines the criteria, who belongs to the network and who does not. In this case, the actors themselves do not necessarily have to share the feeling that they belong the same network. The approach followed in this study is the nominalist approach.

To define the boundaries of the syndication network of VCs, definitions or limitations regarding several dimensions had to be made. These dimensions included:

- Geographic focus (nation) of the portfolio companies and of the VCs
- Type of VCs to be included, i.e., type of venture capital providers to be included
- Time period to be considered
- Investment stages to be considered

The decision regarding the geographic focus of this study needed to be made based on what kind of data was available from VentureXpert. The decision referred to two dimensions, i.e., the nation of the VCs and of the portfolio companies. Criteria to decide upon these questions were feasibility and practicability with respect to the goal of this study, i.e., to perform a thorough and detailed network analysis while still being able to manage the amount of computation implied by extensively large network.\textsuperscript{598}

\textsuperscript{596} See Jansen (2003), p. 72.

\textsuperscript{597} See Laumann/Marsden/Prensky (1989), pp. 61 ff. For example, a street corner gang consists of its members, however, who is member and who is not a member of the gang, is determined by whom the persons in the gang perceive as being members. See Wasserman/Faust (1994), pp. 31-32.

\textsuperscript{598} Standard network analysis software packages available on the market, often show limitations when it comes to analyzing large networks. Also, more powerful computers would have to be used to perform these analyses. By 'large', networks including several thousand actors including their relationships are meant.
The questions mentioned lead to a 2x2-matrix presented below:

<table>
<thead>
<tr>
<th>Portfolio companies</th>
<th>VCs</th>
<th>International</th>
</tr>
</thead>
</table>
| German              | 1. Investments in German portfolio companies  
|                     | 2. German VCs               |                                    |
| International       | 3. No allocation of investments to VC possible | 4. No allocation of investments to VC possible |

Figure 5.1: Theoretical options for geographic focus of this study

There are four theoretical options that could have been chosen, two of which are, however, not feasible. The horizontal axis shows that either only German VCs or German and foreign VCs can be taken into account. The vertical axis refers to the investments, or portfolio companies, that are taken into account, which can also be either German or German and foreign ones. In order to decide, which of the four theoretical options to follow, it is important to compare what data exactly is needed for the analyses, and what data the database is able to provide. What is needed for the analyses is data on investments by VCs, subject to the conditions that it is discernible which individual VCs have invested jointly. Based on this and based on what VentureXpert is able to deliver, two options had to be eliminated, which is due to a reason inherent in the database: Although VentureXpert shows the name and nation of both, VCs and portfolio companies, it does only indicate, where the headquarter of the specific firm is located. For example, investments actually done by the Spanish office of 3i Group is, in VentureXpert, recorded as an investment of 3i Group Plc. That is, it is not possible to allocate the investments to the regional offices of VCs. Therefore, options three and four had to be eliminated. Option one is certainly possible, however it does only take into account VCs, the headquarters of which are located in Germany. What would then be

599 Own illustration.
excluded from the analyses were non-German VCs that still are active in the German venture capital market. Since there are several key players, i.e., non-German VCs, that are still very active in the German market, missing them would not reflect the actual status of syndication relationships in the German venture capital arena. However, in order to best reflect the German market, it has been decided to only include those non-German VCs that had an office in Germany. Therefore, what is included in the analyses then, are investments in German portfolio companies, done by German VCs and those non-German VCs that had an office in Germany during 1998-2005.

In addition to selecting the geographic focus, decisions had to be made regarding the type of the firm, the time period, and the investment stages.

As to the type of the firm, it has been decided not to exclude any type of equity provider, since, if they fulfill the other criteria mentioned above and the further criteria that will be discussed below, and if they have invested in a German portfolio company, they are obviously active in the German venture capital market and should therefore not be excluded from the analysis.

Regarding the time period, for which the network data should be generated, the development of the German venture capital market has been taken into account. Based on this development, a decision had to be made as to when to set the starting point for the measurement of the network data. This starting point has been set to the beginning of 1998, since several indicators such as the funds invested, the number of inquiries of firms seeking equity capital, or the exits through IPOs increased significantly during that time. Especially the latter, i.e., the number of exits through IPOs might be a reasonable indicator for the market mood in the German venture capital market, since it indicates the general upswing and boom during that time very clearly. Since the development and

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600 It has been assumed for this analysis that, if non-German VCs (with an office in Germany) invested in German portfolio companies, these investments have been generated by the German office of that VC.

601 The selection of the time period will be referred to further below.

602 Also bear in mind that further limiting criteria will be explained below, such as the time period considered or the investment stages. For example, only investments will be looked at, which are investments in the stages seed/start-up, early stage, expansion, or later stage. Any buyouts or acquisitions will be excluded. Thereby it can be ensured that only VCs are taken into account that are active in the relevant market segments. See below.

603 For a description of the development of the German venture capital market, see also section 2.1.2.
maintenance of relationships take time, and since relationships in this study are based on joint investments, it is advisable to take a time period into account, which is as long as possible. Therefore, the ending point for the measurement of the network data has been set to the end of 2005.

With respect to the investment stages, VentureXpert covers a large number of transactions historically around the globe, so that the search criteria include a large number of stages, which have been and still are used in different markets at different times. These investment stages, which partially also overlap, have been grouped to six categories, namely seed/start-up (including seed and start-up), early stage (including early stage and first stage), expansion (including expansion and second stage), later stage (including third stage, other later stage, and bridge), buyout/acquisition (including acquisition, acquisition for expansion, LBO, and recapitalization/turnaround), and other (including secondary purchase, open market purchase, private investment in public company, and VC partnership). In detail, the investment stages are defined as follows:

Seed/Start-up:

Seed: An investment strategy involving portfolio companies, which have not yet fully established commercial operations, and may also involve continued research and product development.

Start-up: Financing provided to companies for product development and initial marketing. Companies may be in the process of being organized or have been in business a short time but have not sold their product commercially.

Early stage:

Early stage: An investment strategy involving investments in companies for product development and initial marketing, manufacturing, and sales activities. The companies will not yet be generating a profit.

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605 Although partially deviating from categorizations explained before, here, the expressions and denotation as used by VentureXpert has been adopted in order to accurately present the categorization in that database.

**First stage:** The first round of financing following a company's start-up phase that involves an institutional venture capital fund. The round is usually a step-up in valuation, total size, and per share price for companies whose product(s) are either in development or commercially available.

Expansion:

*Expansion:* Financing provided for the growth and expansion of an operating company, which may or may not be breaking even or trading profitably. Capital may be used to finance increased production capacity, market or product development and/or to provide additional working capital.

**Second stage:** Working capital for the initial expansion of a company, which is producing and shipping and has growing accounts receivable and inventories. Although the company has clearly made progress, it may not yet be showing a profit.

Later stage:

**Third stage:** Funds provided for the major growth expansion of a company whose sales volume is increasing and which is breaking even or profitable. These funds are utilized for further expansion, marketing, and working capital or development of an improved product.

*Other later stage:* A fund investment strategy involving financing for the expansion of a company, which is producing, shipping, and increasing its sales volume.

*Bridge:* Equity financing for a company expecting to go public within six months to a year.

Buyout/acquisition:

*Acquisition:* The obtainment of control, possession, or ownership of a private portfolio company by an operating company or conglomerate.

*Acquisition for expansion:* Funds provided to a firm to finance the acquisition of companies.

*LBO:* A fund investment strategy involving the acquisition of a product or business, from either a public or private company, utilizing a significant amount of debt and little or no equity.

*Recapitalization/turnaround:* Strategy involving the debt restructuring of a company in order to reduce its level of gearing. Turnaround more specifically refers to financing
provided to a company at a time of operational or financial difficulty with the intention of improving the company's performance.

Other:

*Secondary purchase*: The purchase of stocks or holding from a private investor.

*Open market purchase*: This stage involves acquiring securities of companies whose common shares trade publicly.

*Private investment in public company*: Private venture investment into a publicly traded company.

*VC partnership*: Fund of fund investment.

Based on expert interviews and based on the findings of Vater (2002) it became obvious that the superordinate stage 'buyout/acquisition' implies a deal flow mechanism, which is not the same as the one for earlier financing stages. For buyout transactions or acquisitions, often investment banks are the ones that generate deal flow and that locate investment opportunities. However, this is different from the aspect considered in this study, i.e., how the network contacts between VCs influence the deal flow for these firms. Therefore, only investments have been selected that are either seed/start-up, early stage, expansion, or later stage investments, thereby referring to what previously has been defined as venture capital investments. Also excluded from this study are investments falling into the category 'other'. Including this category would dilute the clear focus of this study on venture capital providers.

Summarizing, the actors that are being incorporated in the network are defined based on the following criteria:

- German VC or PE or non-German VC or PE that had an office in Germany during the time period 1998-2005

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607 See Vater (2002), p. 144. He found that, for buyout funds, a major part of the deals stem from investment banks or M&A consultants. However, this is not the network that is intended to be studied within this work.

608 See section 2.1.1.
Data Collection

- Investments in German portfolio companies
- Time period from January 1, 1998 until December 31, 2005
- All investment stages, excluding what is denoted in VentureXpert as 'buyout/acquisition' and as 'other'
- All types of venture capital providers are included, as long as they fulfill the criteria above.

5.1.1.2.2 Boundaries to Define the Relationships

In terms of the relationships that are looked at in network studies, it is important to be clear about several aspects. First, the type of relationship that is intended to be gathered needs to be defined. Second, the numeration, and third, the directionality need to be clarified. As discussed above, the data on the investments of the VCs is valued and undirected.\(^{609}\) As to the type of the relationships, often in network studies, potential relations include:\(^{610}\)

- Exchange of non-material resources such as information
- Exchange of material resources such as lending or borrowing, etc.
- Kinship ties
- Friendship ties

In the case of this study, the type of relationship is clearly defined by the type of data gathered through the VentureXpert database. Relationships show the syndication of investments, i.e., whether two VCs jointly invested in a portfolio company. As explained above, also the frequency, i.e., how often two VCs jointly invested, is measured.

\(^{609}\) For details, see the previous section.

5.1.1.3 Description of the Network Data Retrieved

Based on the network boundaries, data has been retrieved from the VentureXpert database. What is needed, is a dataset containing investments of German and those non-German venture capital providers that have an office in Germany or had an office in Germany during 1998 until 2005. To get to this point, in a first step, investments of all investing firms, German or non-German, have been retrieved. In a second step, this dataset had to be adjusted, i.e., some entries had to be eliminated, which will be explained below. Finally, by manual research, from all included non-German venture capital providers within the dataset, those that had an office in Germany during 1998 until 2005 had to be identified. The original dataset retrieved as in a Microsoft Excel table from VentureXpert contained 1,691 investments, done by German and non-German providers of venture capital, for the time period from January 1, 1998 until December 31, 2005, for the investment stages seed/start-up, early stage, expansion, and later stage. In order to, at a later point in time, import the data into the network analysis software package UCINET 6, the data was set up as follows.

<table>
<thead>
<tr>
<th>Investment in portfolio company</th>
<th>Investor No. 1</th>
<th>Investor No. 2</th>
<th>Investor No. 3</th>
<th>…</th>
<th>Investor No. 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment 1</td>
<td>Investor 22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment 2</td>
<td>Investor 43</td>
<td>Investor 95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment 3</td>
<td>Investor 7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investment 1,691</td>
<td>Investor 135</td>
<td>Investor 150</td>
<td>Investor 212</td>
<td></td>
<td>Investor 428</td>
</tr>
</tbody>
</table>

Figure 5.2: Format of dataset including investments and investors

In the original data, of course, the names of the portfolio companies as well as of the investors are discernable, so that it is exactly identifiable, which investor(s) invested in which portfolio companies.

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611 Or during any part of the time period from 1998 until 2005.
612 The data was brought into exactly this format because this is a format that can be used as import format for UCINET 6. Obviously, VentureXpert does not provide its data in this format, so that considerable effort had to be spent on the preparation of data for the import into UCINET 6. See also further below.
613 Own illustration.
The first column of the table shows the names of the portfolio companies, the further columns relate to the investors. Due to confidentiality reasons, an ID number has been assigned to both, portfolio companies and investors.

Several adjustments had to be made to the original data as retrieved from VentureXpert. As to the investors, it appeared that, in the data downloaded, investors were denoted as 'individuals', 'undisclosed investor', 'undisclosed corporate investor', 'undisclosed non-venture firm', or 'undisclosed venture firm'. In those cases that one of these types of investors appeared as single investor for an investment, this entire entry, i.e., the row of the table, has been eliminated. For the total of 1,691 investments this occurred 79 times, i.e., 2 times the sole investor was an 'undisclosed non-venture firm', 77 time the sole investor was an 'undisclosed venture firm'. Based on the adjustments on the side of the investors, 1,691-79 = 1,612 investments remained.

As to the portfolio companies within the dataset, also some adjustments had to be made. In 34 cases, the data entry (row) had to be eliminated because there was no information receivable on these firms within VentureXpert. In four cases, although the names of the firms were discernable, VentureXpert did not have any further information on these firms. 30 cases had to be eliminated, in which the name of the portfolio company was not disclosed, i.e., denoted as 'undisclosed portfolio company'. After the elimination of the 34 entries, a total of 1,612-34 = 1,578 investments remained in the dataset.

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614 In the cases that one of these undefined investors jointly invested in a project together with other investors, of whom the names were known, not the entire entry (row) but just the undefined investor was eliminated. The investment with the other investors, of whom the names were known, remained in the dataset.
The original dataset contained 1,111 different portfolio companies. The number of different portfolio companies is lower than the number of investments, since one portfolio company can appear more than once in the dataset, i.e., those cases when the company received more than one round of financing.

On the side of the investors, the dataset contains 440 different investors, i.e., providers of venture capital. This number includes German and non-German investors. In order to find out, whether the non-German VCs had an office in Germany during 1998-2005, additional information in VentureXpert was scanned manually as well as were the internet homepages of the respective firms checked. In addition, the list of VCs has been discussed with a representative of the BVK to verify the information. Of the 440 different investors, 182 were German. For the 440-182 = 258 remaining firms, 52 were identified that had an office in Germany during 1998-2005 or that still have one, leaving a list of 182+52 = 234 investors, that, during the time period from 1998 until 2005, invested in

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615 Own illustration.

616 No restriction is being made regarding the number of offices in Germany, i.e., firms are eligible to be included in the network if they had at least one office in Germany during the relevant time period.
German portfolio companies, and in those investment stages corresponding to what previously has been defined as venture capital investments.

Figure 5.4: Number of venture capital providers with office(s) in Germany\textsuperscript{617}

When incorporating only those investments, in which at least one investor was either German or non-German but had an office in Germany in the relevant time period, from the 1,578 investments, 1,448 remain, i.e., 130 investments had to be excluded from the analysis. These investments were done by only non-German venture capital providers, which did not have an office in Germany during the relevant time period. That means for these investors it is assumed that they were not active in the German venture capital market on a frequent basis and will therefore not be considered as being part of the syndication network among VCs in the German market.

\textsuperscript{617} Based on the time period 1998-2005; own calculations and illustration.
Data Collection and Methodological Approach

The retrieved data on syndicated investments have been checked against other data sources. These include data from the BVK and another venture capital database called VC-facts. Comparisons on the basis of volume invested and number of investments led to the result that the data retrieved from VentureXpert is a reliable data source. However, besides any comparison made, which verified the data used, both other data sources could not have been used to perform this study. This is due to the fact that the BVK does not publish data on individual investments (confidentiality reasons), and that VC-facts has data on that level of detail available from 2003 onwards only. Therefore, VentureXpert represents the only source of data at all, to retrieve the data as needed.

Figure 5.5: Investments under consideration of geographic location of investors

The retrieved data on syndicated investments have been checked against other data sources. These include data from the BVK and another venture capital database called VC-facts. Comparisons on the basis of volume invested and number of investments led to the result that the data retrieved from VentureXpert is a reliable data source. However, besides any comparison made, which verified the data used, both other data sources could not have been used to perform this study. This is due to the fact that the BVK does not publish data on individual investments (confidentiality reasons), and that VC-facts has data on that level of detail available from 2003 onwards only. Therefore, VentureXpert represents the only source of data at all, to retrieve the data as needed.

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618 Own illustration.

619 Although not applying to the present study but more to network studies, in which individual persons are being asked about their perceptions of network structures, for more details on the topics of measurement accuracy, validity, and reliability of social network data, see the studies of Killworth/Bernard (1976); Killworth/Bernard (1979); Bernard/Killworth (1977); Freeman/Romney (1987); Lord/Novick (1968); Messick (1989); Conrath/Higgins/McClean (1983); Hammer (1985).

620 The basis for comparisons were the yearbooks of the BVK as well as aggregate data from VC-facts, kindly provided by its management.
Data Collection

5.1.1.4 Preparation of Data for Network Analysis

Data downloaded from VentureXpert does not come in a format ready for network analysis. After the adjustments explained above have been made, the data has been grouped in Microsoft (MS) Excel into three tables, i.e., data on the VCs (investor profiles), data on the portfolio companies (portfolio company profiles), and data on the investments (investment profiles including information on relevant investors). Based on these tables, an MS Access database has been constructed to be independent from downloads in VentureXpert. In addition, ID numbers have been assigned, above all, to ensure confidentiality vis-à-vis the VCs. Each VC has therefore been assigned a number, ranging from VC#001 to VC#440. The output of the MS Access database has then been used to import the data into UCINET 6 (network analysis software package). However, in order to import the data into UCINET 6, the so-called DL file format has been applied. A DL file is a file format that allows the user to specify in its header section to give certain instructions, how UCINET 6 should read the data below the header section. For example, it has been specified in the header section, how many different investments and how many different investors there are in the dataset on of the syndication network. That is, the present case the header section shows the information that the dataset contains 1,448 different rows (investments) and, in total, 234 different investors.

However, importing the network data into UCINET 6 is not the final step to prepare the data for a network analysis. The matrix that is required for this study needs to be a square actor-by-actor matrix, i.e., investor-by-investor matrix, with the values of the cells representing the number of interactions, i.e., the number of syndicated investments, of two actors. To obtain this matrix, the imported two-mode matrix is transformed into a one-mode matrix by a data transformation algorithm within UCINET 6. The values of the

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621 In the questionnaire, as explained later, it has been assured to the VCs that their names will not be disclosed.

622 The reader may wonder why there are 440 investors incorporated in the dataset, although there are only 234 investors that have offices in Germany or that had one during the time period from 1998-2005. The reason for this is that, in order to be independent from downloads from the VentureXpert database, the Access database contained more than the used 234 VCs and more than the 1578 investments.

623 See Borgatti/Everett/Freeman (2002).

624 For more options to import network data into UCINET 6, see Hanneman/Riddle (2005).
diagonal are set to zero, so that the matrix, which is then ready for network analysis, looks as follows:625

\[
\begin{array}{cccccccc}
  & VC#039 & VC#296 & VC#391 & VC#068 & VC#073 & VC#029 & VC#407 \\
VC#039 & 0 & 0 & 3 & 0 & 0 & 1 & 1 \\
VC#296 & 0 & 0 & 5 & 0 & 0 & 0 & 1 \\
VC#391 & 3 & 5 & 0 & 2 & 2 & 1 & \text{(6)} \\
VC#068 & 0 & 0 & 2 & 0 & 0 & 1 & 1 \\
VC#073 & 0 & 0 & 2 & 0 & 0 & 0 & 1 \\
VC#029 & 1 & 0 & 1 & 1 & 0 & 0 & 11 \\
VC#407 & 1 & 1 & 6 & 1 & 1 & 11 & 0 \\
\end{array}
\]

Figure 5.6: One-mode investor-by-investor matrix as basis for the network analyses626

The matrix says that, for example as expressed in row three, the VC with the number VC#391 has invested six times with VC#407. The data is now represented in a format, i.e., a valued investor-by-investor matrix, which is ready for the formal network analysis.

5.1.2 Data on the Deal Flow of Venture Capital Firms

5.1.2.1 Questionnaire as Data Collection Method

In order to match the results from the formal network analysis with the data on deal flow of VCs and to examine the potential connection between these two areas, a questionnaire has been used to gather data on the quantity and quality of deal flow. In an elaborate research on formal VCs, Vater (2002) analyzed the various steps of their value chain. Also covered in his study, although only as one element, is the deal flow. Vater also used a questionnaire,627 some questions of which served as basis for the questionnaire of the present study.

The foundation for the formulation of the questionnaire used in this study are the theoretical considerations that led to the research model explained in previous chapters as

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625 Presented here is the matrix when exported back into Excel because in the UCINET 6 output log file, the width of the columns is limited so that the labels of the columns cannot fully be read. When exported back into Excel, this problem does not exist, because the width of the columns can be adjusted.

626 Own illustration.

well as, as mentioned earlier, some of the questions used in the study of Vater (2002). Furthermore, the formulation of the questionnaire has been established based on a qualitative, preparatory study, which consisted of several conversations with scientists from the social network research field on the one hand side, and with managers of VCs on the other hand. Result of these conversations was the focusing and a further specification of several questions.

These questions have been arranged in a questionnaire and have been tested in a pretest with managers of five different VCs that are part of the network selected. They have been asked to complete the questionnaire and provide feedback with regard to various aspects. These aspects included the time need to complete the questionnaire, the understanding of the questions as well as their comprehensiveness, their clarity, and their unambiguousness. Also, they have been asked to give an assessment of the ability and willingness of venture capital managers to answer the questions. Result of the pretest were a number of adjustments and additions to the questions, for example regarding the categorization of the deal flow sources.628

Based on the qualitative preparatory study as well as based on the pretest, it could have been ensured that the formulation of the questions represent the content of the questions comprised in the questionnaire.

The questionnaire is made up of three parts: Part one consists of a short explanation, why and with which goal this study is being performed. This serves the purpose to provide the VCs with an introduction to the content and the background of the study. Also, some tips and details are provided with regard to the completion of the questionnaire. The time need has been determined in the pretest to be approximately 15-20 minutes. Also in part one, receiving the results of the study has been offered as reward for the participation in the study. Part two consists of questions regarding the deal flow of the VC, i.e., here, questions are being asked with respect to the quantity and quality of deal flow as well as the sources of deal flow. In part three, further, more general questions are being asked,

628 The feedback of the VCs was to further group the sources mentioned in the first version of the questionnaire.
which serve as further variables, or to evaluate whether the VCs included in the network correspond to the goal of this study.

5.1.2.2 Data Collection Process

The basis for the survey are those VCs, for which the selection procedure has been described in section 5.1.1.2. As described above, included in the network are 234 firms, which either have their headquarters in Germany or which have an office in Germany or had one during the time period from 1998-2005. Based on the feedback from the qualitative, preparatory study and the pretest, the following procedure for the data collection through the questionnaire has been followed:

In a first step, relevant contact persons in each VC have been contacted with an email invitation to participate in the study. Attached to this email was the questionnaire as pdf document. Also in this email, a username and individual password for each person contacted were included, in order to offer the possibility to complete the questionnaire in an online version. The respondents were offered three options to return the questionnaire, i.e., by completing it online, by printing out the pdf-version and sending it back to the fax number of the author, or by sending it by standard mail to the chair of the university in Aachen. What had to be ensured was that the author could identify, from which VC the questionnaire was returned, in order to match the data from the questionnaire with the results from the formal network analysis. To let this not be a problem for the respondents to answer, it has been guaranteed in the questionnaire that, of course, neither the names of the person that completed the questionnaire is disclosed, nor is it discernible, which VC answered the questionnaire. Therefore, as has been explained

629 Such as several firm attributes used in the regression models, as will be explained further below.
630 With the additional data, for example, it was possible to check whether the VCs focus on venture capital investments (recall that buyouts have been excluded).
631 The online version of the questionnaire was generated based on the internet platform provided by the services of Globalpark. Globalpark is a professionally managed online survey service that offers students, chairs of universities, firms, and private individuals the possibility to generate a questionnaire online with the help of a tool provided on the platform. This tool is called 'OPST 4.0', which stands for Online Panel Site Tool. It offers comprehensive features for the generation, management, tracking, and analysis of online surveys. See www.globalpark.de or www.unipark.de.
632 The mailing address of the chair was provided in the first part of the questionnaire.
above, all VCs that are part of the network, have been assigned an identification number (VC#...), which is used consistently throughout the study.

In a second step, one week after the initial email invitation has been sent, a considerable amount of time has been invested to make telephone calls to the contact persons of the VCs that have received an email invitation.

As addressee of the invitation email only those persons have been selected, who seemed to be able to answer the questions properly. The selection has been made upon the position the persons hold in the respective firm, i.e., CEOs and managers have been selected, who hold a leading position within the firm. To identify the relevant contact persons, a considerable amount of time has been spent to search through several potential sources: One source were private contacts to venture capital managers, who could either serve as respondents themselves, or who could name a colleague within their firm that is an adequate respondent. A second source were the directories of the European Private Equity & Venture Capital Association (EVCA) and the BVK that are publicly available on the internet.633 In these directories, the member firms of the associations are listed, often together with the names of the leading managers or CEO(s). A third source was the VentureXpert database, which also provides contact information on people working in the VCs, together with information such as functions, email addresses, and telephone numbers. However, this information is only available for part of the firms considered in this study. A fourth source to identify the appropriate contact persons was an intensive research of the VCs' homepages. Most often, the firms provide the names, functions, email addresses, and sometimes also the direct telephone numbers of the managers.

Based on these sources, a comprehensive list of all 234 VCs with appropriate contact persons, telephone numbers, and email addresses has been generated. For a minor part of the 234 firms though, no contact person could be identified. In these cases, the email invitation has been sent to the general email address of the firm.634

634 This could be done because part of the data collection process was to make telephone calls to the firms if no questionnaire was returned after one week. In the cases, in which the email invitation has been sent to the general email address of the firm, in the first telephone call it has been asked for an appropriate contact person and an invitation email was sent again directly to this person.
As stated above, after the initial email invitation, the contact persons of those firms that have not reacted to the email, have been called by telephone in order to check whether they are interested in the study and will participate or not.

Data collection via the questionnaire has been performed between March and May 2006. Out of the 234 firms, to 23 firms no contact could be established because there was neither a reaction to the initial email, nor were multiple telephone calls answered. Consequently, 211 VCs remained that have been contacted within this empirical research. From these 211 firms, 127 questionnaires have been returned, of which 84 (66%) were completed online, 36 (28%) were sent back by telefax, and 7 (6%) were returned by standard mail. The 'gross' return rate is therefore 60.2%, which is a remarkable result for an empirical research in the field of venture capital. To a large extent, this high return rate could be realized by the extensive effort spent on telephone calls to the venture capital managers.\textsuperscript{635}

Since it was important for the empirical analyses that the questionnaires were filled out as completely as possible, 2 out of the 127 received questionnaires had to be eliminated, so that 125 questionnaires remained.

5.2 \textbf{Statistics in Social Network Analysis}

In this section, first a few introductory comments have to be made on how statistical methods are applied to the research field of social network analysis. Then, a brief overview of the goals of analysis of these methods is presented. Finally, multivariate regression analysis as the method used in this study will be explained in more detail.

5.2.1 \textbf{Introductory Notes to Using Statistics in Social Network Analysis}

The development and application of statistical methods to social network analysis is a cutting-edge topic in network research.\textsuperscript{636} Some introductory comments have to be made

\textsuperscript{635} Obviously, that the researcher makes the effort to call each potential respondent individually, was perceived as a positive signal, which has been rewarded by participation in the research. This has actually been stated by several venture capital managers during the numerous telephone calls.

\textsuperscript{636} Statistical analysis of network data root back to the application in the research field of geography and diffusion of diseases during the 1940's and 1950's. For examples, see the development of the joint count statistic of Moran (1948), of the autocorrelation statistic developed by Moran (1950) and Geary (1954), or the quadratic statistic measure (today's quadratic assignment procedure) by Mantel (1967).
to understand how the methodical approach of inferential statistics in social network analysis looks like.

In standard statistics, society is seen as the aggregate of individuals, which are independent from each other. The unit of analysis is the individual, who has certain attributes such as age, income, sex, etc. Normally, these attributes are regarded as the cause for certain behaviors.\(^{637}\) Therefore, datasets commonly used in standard statistics are two-mode matrices with one mode being the individuals and the other mode being the attributes. In social network analysis, things are different. As explained before, individuals, neutrally denoted as actors, are embedded in systems of social relations or social structures. The units of analysis are the actors together with the relationships that exist among them, and based on these relationships, actors influence each other. Datasets are one-mode matrices, for example actor-by-actor matrices, showing the relationships between them.\(^{638}\)

When it comes to analyze social networks with the help of statistical methods, the measures (for example a \(p\)-value) that are calculated are basically the same, however, the way how these measures are derived, are different from the standard statistical procedures. The reason for this is that standard statistical methods are based on, among others, the two main conditions, i.e., that (a) the observations that are examined are independent of each other and (b) the observations are normally distributed.\(^{639}\) When calculating network measures, these conditions are both not satisfied. Since in a network, actors are connected to each other by relationships, they are not independent of each other anymore.\(^{640}\) Their connectedness is also the reason for the (mostly) non-normal distribution of variables measured.\(^{641}\) Therefore, the formulae for standard statistical measures cannot be applied, because the above conditions are not met and results would therefore be erroneous.\(^{642}\)

\(^{637}\) See Schwarze (2005), pp. 15 ff.


\(^{639}\) Here, it is referred to those conditions that are frequently violated in social network datasets.


\(^{641}\) If relationships in a network are distributed unequally among the actors, the network measures that are calculated based on the relationships are also distributed unequally. In such a case, the normality assumption does not hold. As will be seen later on, the relationships in the VCs' syndication network are distributed fairly unequally, so that statistical methods that do not make the normality assumption are required.

Nevertheless, there are two basic possibilities, with which statistical methods can be applied to networks. Obviously, one way is, that the networks under consideration are simply different networks, and thereby the actors are independent of each other. However, it is also possible to apply statistics to only one network: The procedure used is that the empirically observed structure of the network is compared to a theoretically expected structure. This method reverts to random matrix permutations. That is, the empirically observed matrix is being permuted hundreds or thousands of times. Then the empirically observed results are compared to those that can be observed in the permuted matrices. For example, the probability with which a certain result such as a regression coefficient occurs is calculated based on the comparison of the empirical result with the theoretical result of the permuted matrices. If 5% or 1% of the results based on the permuted matrices are the same or larger (or smaller) than the empirical result, the relationship between the variables can be considered statistically significant.643

In order to give an impression, which kinds of statistical analyses exist in social network analysis, they are described in the following section. However, since it would go beyond the scope of this study to explain all these methods in detail, they are just briefly sketched.

5.2.2 Overview of Statistical Methods and Selection of an Appropriate Method for this Study

The basic statistical methods used in social network analysis convey different goals of analysis. These methods can be categorized into three groups: Group one contains methods used to compare different relations between the same actors. While the methods of group two intend to explain relationships among actors based on attributes of actors, the methods of group three do exactly the opposite, i.e., they try to explain attributes of actors based on the actors' relationships among each other.

As to the first group, there are three analyses that can be performed. The first refers to a comparison between two means based on a t-test or based on the boot-strapping

643 See Snijders/Borgatti (1999), pp. 4 f.; Hanneman/Riddle (2005), chapter 18, p. 3. The methodical approach is also denoted as direct bootstrap method.
method. The second is based on the so-called quadratic assignment procedure (QAP), with which it can be tested whether a correlation exists between two relationships. Assume, for example, that there are two matrices, each containing the same set of actors. In matrix one, it is shown, whether the actors have a friendship relationship, and in matrix two, it is shown whether two actors live in the same village. With the help of the QAP correlation procedure, it can now be tested whether the relationship 'living in the same village' goes along with having a friendship tie. Third, QAP analysis can also be applied in the form of a regression between two relations, i.e., between two matrices.

The second group of methods refers to explaining relationships among actors by attributes of the actors. These methods all base on the notion of homophily. Recall that homophily expresses that 'birds of a feather flock together', i.e., that actors, who are similar in terms of attributes, are likely to share a relation. There are three methods in this group: While in the so-called joint count analysis, the densities of relationships within the networks of two groups of actors (of one network) are compared, in contingency analysis the densities of relationships within and between multiple groups are compared. With the help of the third method, i.e., the Moran/Geary statistic, also denoted as autocorrelation, it can be tested whether more similar actors (based on an attribute) are closer to each other in the network. This method also draws on the concept of homophily.

The methods contained in the third group relate to explaining attributes of actors based on relationships. Basically, there are two kinds of analyses, which are commonly applied. One is the comparison of means, based on a t-test or based on the bootstrapping method. The other one refers to regressions, either bivariate or multivariate. In these regressions, network measures serve as independent variables, and actor attributes serve as dependent variables.

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644 See, for example, Snijders/Borgatti (1999), pp. 3 ff.
645 In the QAP analysis, first, the Pearson correlation coefficient is calculated, and then, according to the previously described procedure, the empirical matrix is permuted to derive test statistics on the statistical significance. For the development of this method, see Mantel (1967).
646 In social network analysis, it is important to understand that attributes of actors as relationships: That two actors are living in the same village, for network researchers this means, that they share the relationship to live in the same village. That is, in an actor-by-actor matrix, a 1 would indicate that two actors live in the same village, a 0 would indicate that they do not.
647 For homophily theory, see the seminal work of McPherson/Smith-Lovin/Cook (2001).
648 For these analyses, see for example Cliff/Ord (1973).
649 For the development of this measure, see Moran (1950) and Geary (1954).
variables. Again, as explained before, since the actors and the derived observations are not independent of each other and are not normally distributed, the method being used is that the empirical vectors of the matrices are permuted randomly and thousands of times. The statistics observed in these permuted matrices are then used to be compared against the empirical observations to derive statistical measures, for example such as the probability for the occurrence of a regression coefficient of certain value.\(^{650}\)

5.2.3 Multivariate Regression Analysis for Social Network Data

As becomes obvious, the appropriate method to be applied in this study is multivariate regression analysis, since the goal of this study is to explain two attributes of the actors (quantity and quality of deal flow) on the basis of network measures. In this study, a linear regression model is applied, which is based on the ordinary least squares (OLS) method.\(^{651}\) However, the technique that is used is somewhat different from those used in standard statistics, which is due to the non-conformity with the conditions regarding the independence of observations and normality of the distribution. How the algorithm works, that is used to estimate standard errors and to derive the statistics of interest, is explained in the next section. Following this next section, it will be shown, which measures are used to specify the model.

5.2.3.1 Estimation Technique and Significance Tests

In statistical analysis of social network data, the permutation method is used to estimate standard errors and derive assessments of significance of the model and the coefficients. Instead of using standard statistics formulae and in order to not have to rely on the independence of observations and the normal distribution,\(^{652}\) the permutation algorithm

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\(^{650}\) See Hanneman/Riddle (2005), chapter 18, pp. 3-5.

\(^{651}\) Standard software for analyzing networks only deliver OLS regressions. OLS normally requires some basic conditions to be met, which have been extensively discussed in literature and should therefore not be repeated here. These include, for example, that the error terms follow a normal distribution. For a further discussion, see for example Hayashi (2000). However, as explained above, the permutation method applied in social network statistics makes possible that the OLS conditions do not have to be met.

\(^{652}\) Also the normality assumption is circumvented by using the method of matrix permutations.
proceeds in two steps. First, a (multivariate) regression across the corresponding cells of
the dependent and the independent variable(s) is performed. In the second step, the
algorithm randomly permutes the elements of the dependent vector and recomputes the
regression, storing the derived statistics for each analysis. This step is repeated thousands
of times. The algorithm is set to permute the matrices 1,000 times by default. The larger
the number chose, the more reliable the results are (and the longer it takes for the
computer to calculate). In the case of this study, in order to derive reliable results for the
standard errors and the significance tests, the number of random permutations has been
set to 20,000. Although this drove calculation time up, ensuring the reliability of the
results was felt to be more important. Based on these permutations, the standard errors for
the statistics of interest are derived. For each coefficient, the algorithm then counts the
proportion of random permutations that yield a coefficient as large (or as small) as the
one derived in step 1. Based on this procedure, \( p \)-values are calculated that indicate the
probability with which the derived results occur.\(^{653}\)

### 5.2.3.2 Model Specification

In this study, an approach has been selected to identify the differential effects that
network measures have for explaining the dependent variables. Therefore, first, a model
is being calculated that includes the firm attributes only, then the single network
measures are being added to identify their additional individual explanatory power.\(^{654}\)
Also, with this procedure it is possible to test the theoretically derived hypotheses, i.e.,
the expected impact of network measures on deal flow quantity and quality.
Based on multivariate regressions, several statistics are calculated. These include the
overall model \( R^2 \) as an indicator for the goodness-of-fit of the models. \( R^2 \) thereby
indicates, what percentage of the variance of the dependent variable can be explained by
the model. Also, an adjusted \( R^2 \) is derived, which adjusts the unadjusted \( R^2 \) for the effect
that the simple addition of independent variables to the model increases the unadjusted
\( R^2 \). The significance of these results is evaluated based on an F-test. In addition and, as

\[\text{\textsuperscript{653}} \text{ See Borgatti/Everett/Freeman (2002).}\]
\[\text{\textsuperscript{654}} \text{ This is a common approach in statistical analyses of relationship networks. See for example}
Hochberg/Ljungqvist/Lu (2007), p. 271.}\]
explained, based on matrix permutations, the statistical significance or robustness in form of a $p$-value is provided, along with the slope coefficients for each variable. With respect to the slope coefficient, also a standardized regression coefficient is calculated, which serves as an indicator for the relative explanatory power of each (independent) variable, compared to the others. Formally, the standardized regression coefficient for variable $i$ is given by

$$\beta_{std} = b_i \frac{s_{xi}}{s_y}$$

with $\beta_{std}$ representing the standardized regression coefficient, $b_i$ denoting the regression coefficient of the independent variable $i$, $s_{xi}$ being the standard deviation of the independent variable $i$, and $s_y$ denoting the standard deviation of the dependent variable. Also, for each independent variable, the statistical significance in form of a probability is calculated, again using permutation tests.\(^{655}\)

Since the independent variables are derived from one network of actors, chances are high that there exists some extent of collinearity between the variables. Correlation among network measures is usually higher than of variables used in non-network analyses. Potential multicollinearity issues among the variables are detected based on the examination of the correlation matrix.

When using the OLS method, the researcher has to be aware that this method is relatively sensitive to outliers.\(^{656}\) Therefore, the data needs to be analyzed regarding the presence of outliers, which have to be eliminated. To do this, the theorem of Tchebycheff is applied. Tchebycheff's theorem of inequalities has been discussed extensively in academic literature. Tchebycheff, a Russian mathematician (1821-1894) showed that, for any number of observations $N$, $N*(1-1/k^2)$ of the observations are in the range of $k$ standard

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\(^{655}\) See Hanneman/Riddle (2005), chapter 18, p. 5. These analysis explained above are all provided by the social network analysis software package UCINET 6. See Borgatti/Everett/Freeman (2002).

\(^{656}\) In the field of statistics research, methods also have been developed to cope with problems such as outliers. These fairly underused methods relate to the so-called 'robust statistics' or 'robust regression'. However, since in the network analysis software, these methods are not provided (as they are not in many statistics textbooks), they are not applied. Therefore, the identification of outliers in this analysis has been given special attention.
deviations from the mean. This holds for any distribution, also non-normal ones.\textsuperscript{657} Due to its applicability to variables, which are not normally distributed, the theorem will be applied. Several outliers have been identified and eliminated, as will be seen in the sections below.

In order to check for the robustness of the results derived, several alternative regression models will be calculated. These models are based on two different time periods, i.e., 1998-2001 and 2002-2005. The split between the time periods reflects the development of the venture capital market in Germany, which experienced an upswing until 2001 and a significant downturn from 2002 onwards. Consequently, it will be analyzed, whether the results are robust if regressions are performed for the time period characterized by the upswing and for the time period characterized by the downturn.\textsuperscript{658} In addition to robustness checks based on different time periods, further regression models will be calculated with respect to a subsample of the VCs included in the network in order to evaluate whether the results for the subsample are the same as for the full models. Therefore, six different robustness checks are being performed: Regression models for the time period from 1998-2001 and from 2002-2005 as well as for the subsample for deal flow quantity and for deal flow quality. Based on the various variables included, this results in 36 different regression models that are used to test the results for the full models.

The empirical design of the multivariate regression analysis is summarized below:

\textsuperscript{657} The theorem refers back to the works of Tchebycheff. See, for example, Tchebycheff (1867), pp. 177-184; Tchebycheff (1874), pp. 157-160. Tchebycheff developed this theorem together with Bienaymé, see Bienaymé (1853). See also early discussions of the theorem in Bernstein (1927), Berge (1937), Birnbaum/Raymond/Zuckerman (1947), Kendall/Sundrum (1953), Smith (1955), Mallows (1956). For its applicability, see Sachs (1978), p. 54 and p. 219.

\textsuperscript{658} Using different time periods as a basis for robustness tests also eliminates or at least reduces the potential problem of endogeneity of the variables. While the chosen approach represents an appropriate solution to minimize the potential endogeneity problem, in addition, the presence of endogeneity is not expected. This is due to the fact that the theoretically deduced hypotheses indicate that network positions have an effect on deal flow and not vice versa.
Data Collection and Methodological Approach

<table>
<thead>
<tr>
<th>Estimation Technique</th>
<th>Multivariate linear OLS regression analysis, using random permutation method to estimate standard errors and derive tests for significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modeling approach</td>
<td>Calculation of base case (firm attributes), individual addition of network measures to detect differential effects on dependent variables</td>
</tr>
<tr>
<td>Dependent variables</td>
<td>Deal flow quantity and deal flow quality</td>
</tr>
<tr>
<td>Independent variables</td>
<td>Firm attributes: Average number of employees, age, number of offices, systematic measurement of deal flow</td>
</tr>
<tr>
<td></td>
<td>Ego-network measures: Average tie strength, effective size, constraint</td>
</tr>
<tr>
<td></td>
<td>Total network measures: Betweenness centrality, multiconnectivity</td>
</tr>
<tr>
<td></td>
<td>Role analysis measures: Gatekeeper, consultant, liaison</td>
</tr>
<tr>
<td>Outliers</td>
<td>Detection and elimination of outliers based on Tchebycheff theorem (mean +/- four standard deviations for any distribution)</td>
</tr>
<tr>
<td>Model specification criteria</td>
<td>Overall significance: F-test</td>
</tr>
<tr>
<td></td>
<td>Coefficient significance: ( p )-values based on random permutation</td>
</tr>
<tr>
<td></td>
<td>Goodness-of-fit: ( R^2 ) and adjusted ( R^2 )</td>
</tr>
<tr>
<td>Robustness Checks</td>
<td>Multivariate regressions for time periods 1998-2001 and 2002-2005; multivariate regressions for subsample of VCs</td>
</tr>
</tbody>
</table>

Table 5.1: Overview of empirical design of multivariate regression analysis

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659 Own illustration.
6 Results of the Empirical Study

In this chapter, the results of the empirical study on the syndication network of VCs are reported. The chapter is organized according to the structure of the hypotheses derived: First, the results regarding the general importance of the contact network and of the source ‘Other VCs’ for the generation of deal flow quantity and quality will be described (section 6.1). Second, as explained above, in order to examine the network position of individual VCs and the effect on the VCs’ ability to generate deal flow, the entire network structure needs to be characterized (section 6.2). This includes the necessary step of dissecting the network into its components as well as the description of the entire network structure to evaluate whether the amount of social capital inherent in the network is distributed equally or unequally. Afterwards, the results regarding the potential connection between the independent variables (ego-network measures, total network measures, and measures derived based on the role analysis) and the quantity and quality of deal flow will be reported (section 6.3).

6.1 General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow

In the following, the descriptive statistics including the mean, median, minimum and maximum values will be presented. The measures under consideration are the percentages denoted as A, B, C, A', B', and C'.\textsuperscript{660} The descriptive statistics look as follows:

\begin{center}
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Measure & A & B & C & A' & B' & C' \\
\hline
Mean & 55 & 45 & 35 & 85 & 15 & 42 \\
Median & 50 & 50 & 30 & 90 & 10 & 35 \\
Minimum & 5 & 0 & 0 & 10 & 0 & 0 \\
Maximum & 100 & 95 & 100 & 100 & 90 & 100 \\
\hline
\end{tabular}
\end{center}

Table 6.1: Descriptive statistics for measures A, B, C, A', B', C' (N=125)\textsuperscript{661}

\textsuperscript{660} Refer back to figure 3.7 in section 3.4.2 and to section 4.1 for the definition of these figures and the derived hypotheses.

\textsuperscript{661} Own calculations and illustration.
Measure A is the percentage of the average number of investment opportunities received per year, which stem from a network contact. The mean value is 55%, the median is 50%. This shows that, based on deal flow quantity (average number of investment opportunities received per year), the percentage received from a contact out of the contact network is slightly higher than the percentage received unsolicited. The distribution of percentages across the VCs ranges from a minimum value of 5% to a maximum value of 100%, showing that there are large differences among VCs in terms of what percentage of the investment opportunities received come out of the contact network and what percentage comes unsolicited. The values for measure B do not need to be explained, since they simply are the remainders of the values for measure A (the same applies to B’ with respect to A’). Measure C shows, to what extent the average number of investment opportunities received per year come from other VCs. The mean value is 35%, the median is 30%, with a minimum value of 0% and a maximum value of 100%. These values show that the source 'Other VCs' accounts for a fairly large percentage of the total average number of investment opportunities received per year. The measures A', B', and C' refer to the equivalent percentages, but are based on the deal flow quality measure. Of those investment opportunities finally invested in, 85% were referred to the VC by a network contact. The median value is even higher with 90%. The minimum value is 10% and the maximum value is 100%, again showing the large discrepancies among individual VCs in the network under consideration. Measure C' refers to the percentage of funded investment opportunities, that stem from other VCs. The mean is 42% with a median of 35%, showing that a significant part of the finally funded investment opportunities originally were referred to the firm through another VC. Again, the minimum value of 0% and the maximum value of 100% show the large differences among individual firms.

6.2 Characterization of the Entire Network Structure

6.2.1 Components of the Network

At the beginning of a network analysis and as a precondition for many algorithms within formal network analysis, the network has to be dissected into its components. Recall that, in a component (connected graph), each actor can reach all other actors either directly or
Characterization of the Entire Network Structure

indirectly by any path length. The syndication network of VCs in Germany (of 234 firms analyzed) consists of 54 components, as displayed in the following table:

<table>
<thead>
<tr>
<th>Component</th>
<th>Number of VCs within component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>172 (main component)</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3-8</td>
<td>2</td>
</tr>
<tr>
<td>9-54</td>
<td>1 (isolates)</td>
</tr>
</tbody>
</table>

Table 6.2: Components and number of firms within components (N=234)

Component one is comprised of 172 VCs and is called the main component. In this group of VCs, each VC can reach each of the other VCs by some path through the network. Component two consists of four firms, components three to eight consist of two firms each, and components nine to 54 each consist of one VC. The latter are also denoted as the so-called isolates because they are not connected to any other node in the network. In the context of syndicated investments this does not mean that these firms have not invested but it means that these firms only have invested alone, i.e., none of their investments was syndicated. For the calculation of many network measures, it is necessary to perform the analysis on the basis of a connected graph, i.e., in this case, the main component. Therefore, those VCs not belonging to the main component have to be excluded from the analysis.

At this point, it is abstained from presenting a picture of the graph of the main component. This is due to the fact that the graph would show a very complex network structure with many points (VCs) and lines connecting the points (co-investment relationships among VCs). It basically looks like a big yarn ball, and just based on this picture it would not be possible to quantitatively measure single network measures or to capture whether single VCs have positional advantages in terms of deal flow.

In the next sections, the measures explained earlier (density, transitivity, clustering, centrality) are used to characterize the entire network structure. Based on these measures

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662 Refer back to section 3.4.4.1.
663 Own analysis.
(a) one gets an understanding of the network structure in general, and (b) it is possible to assess whether the amount of social capital inherent in the entire network is distributed equally or unequally among the actors.

An introductory comment has to be made with respect to all following sections: The main component consists of 172 VCs. If network measures are calculated (either for the entire network or for the individual VCs) these calculations have to be performed on the basis of these 172 VCs. Now, the response to the questionnaire survey was 125 usable questionnaires. Out of these 125 VCs that returned a questionnaire, 92 belong to the main component. Therefore, when characterizing the entire network structure (following sections), the results for the main component (172 VCs) will be shown. However, afterwards, when bringing together the network measures with deal flow data (which were gathered in the questionnaire), these calculations (descriptive statistics, multivariate regressions) can be performed for the 92 VCs only, because these have returned a questionnaire and belong to the main component.

The following sections on the characteristics of the entire network structure are, as explained, based on the 172 VCs of the main component.

6.2.2 Density

As explained in section 3.4.4.2, density on the level of the entire network can be calculated for binary and valued data with different interpretations and implications. For binary data, density is interpreted as the proportion of ties present compared to the maximum possible number of ties. For valued data, density is the average strength of ties. For the main component of the VCs' syndication network, the number of possible ties is $n \times (n-1) / 2$, or 172 x 171 / 2 = 14,706. The number of ties actually present is 1,210, and since this is a symmetric (undirected) matrix, it has to be divided by two as well, resulting in 605 different relations being present. This is equal to a density of 0.041, meaning that 4.1% of all possible dyadic ties are actually present. On the first view, 4.1% seems like a fairly small percentage. However, when considering the fact that relations

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664 Excluding outliers to be identified.
within this network are constituted based on joint investments, the result makes sense. If the density value for binary data in this network was very high, it would mean that investment relationships would need to exist between most of the firms, i.e., each VC would need to have invested with most of the other VCs. This, of course, is highly unlikely. Actually, just the opposite is the case. One would expect, that, on average, each VC invested with a fairly small number of the other firms. In light of this argumentation, the density value of 4.1% appears to be reasonable. In addition, there are several reasons why the density in the network under consideration can be expected to be relatively low: First, with increasing size of networks, density decreases. This is due to the limited capacity of individual actors to have relationships with other actors. In terms of the VCs, this limitation results from time constraints and financial constraints, i.e., the VCs do not have the time and the financial resources to join investments with all of the other VCs in the German market. Second, in kinship or friendship networks, density is usually higher than in professional networks. Third, a general agreement is that contact networks such as the syndication network require more time than networks, in which people interact, for example, on a sporadic basis. As to the second and third point, the VCs' network can be classified as professional contact network, i.e., the density in this network is supposedly low. Consequently, the density value of 4.1% is not an unexpected result. The standard deviation of the density is 0.199 or 19.9%, and measures the lack of homogeneity within the network, or the extent to which the results for the actors vary. This value implies that the variability among the actors is very high, i.e., the density for some actors is very high, while it is very low for others. In the context of the syndication network it means that some VCs have ties to (have invested with) many of the other firms, while other VCs only have ties to (have invested with) a small number of other firms. This already implies that the ties are distributed fairly unequally among the actors, which is also a first sign that chances and opportunities among firms based on their position in the network might be distributed unequally. This viewpoint is supported looking at the descriptive statistics of the density distribution. The mean is equal to the average number of times a VC has invested with different other firms and is equal to 7.0. That means, on average, each firm in the main component has jointly invested with seven

different firms. The maximum value is 71, the minimum value is 1, meaning that at least one firm has invested together with 71 different other firms and at least one firm has invested with only one other firm. Again, these numbers show a large variability in the distribution of the contacts in the syndication network.

Density can also be calculated for valued data. In this case the result represents the average tie strength across all possible ties (not all actual ties!). The sum of the values of all ties, i.e., 1,014, is divided by the number of possible ties, i.e., 14,706, resulting in a theoretical average tie strength of 0.069 across all possible ties. Though somewhat theoretical, this means that each VC has invested 0.069 times with each other firm of the network.\footnote{Bear in mind, that all these calculations refer to the main component, i.e., to the network that the 172 firms have among each other.} Although not being a measure normally calculated by network analysts, if one divides the density of the valued data by the density of the binary data, the result represents the average strength of the actually existing relationship: \[ \frac{0.069}{0.041} = 1.68 \] \[ \text{or} \quad \frac{1,014}{605} = 1.68. \] This means that, on average, each tie that exists, has a value of 1.68, i.e., the firms that have invested together, have done so 1.68 times, on average.\footnote{Recall that this value is calculated for the main component of 172 VCs. This value will be different from the one shown later on, because the descriptive statistics in the regression analyses further below represent the 92 firms that have participated in the survey and belong to the main component.} The standard deviation for the density of the valued data is 0.469, again implying that there is substantial variability in the number of times that the firms have jointly invested. The maximum sum of all ties of one actor is 180, i.e., one firm has invested 180 times with other firms (including multiple times with the same ones, i.e., these were not 180 different firms!). The minimum sum of all ties of one actor is 1.

Overall, an analysis of the graph's density shows that the amount of social capital in form of ties among VCs is distributed very unequally. This implies that probably there will also be substantial differences in the positional advantages of individual VCs.

### 6.2.3 Transitivity

As explained in section 3.4.4.3, the analysis of transitivity on the entire network might provide insight on the overall potential for actors to make use of structural holes.
UCINET 6 provides an algorithm that examines triadic structures (and thereby transitivity). The number of non-vacuous transitive ordered triples is 5,940, the number of all kinds of triples is 5,000,040. Therefore, the percentage of transitive triples of all ordered triples equals 0.12%, which is fairly low. However, of interest for this study is the percentage of all triples, in which connections AB and BC exist, but in which the connection AC is missing. The number of triples, in which AB and BC exist, is 22,394. Consequently, the number of triples, in which AB and BC exist but not AC, is equal to 22,394 – 5,940 = 16,454, and the percentage of triples that represent the potential for structural holes is 16,454 / 22,394 = 73.5%. Here, it becomes obvious that there is a substantial percentage of triples that, if one connection (AC) was added, became transitive. This high percentage shows that there is a significant chance for actors to benefit from many potential structural holes. However, whether actors actually make use of this potential in the sense that they have more or better investment opportunities, remains to be seen.

6.2.4 Clustering

As explained in section 3.4.4.4, the clustering coefficient is a measure to identify the extent to which the entire network is characterized by dense local neighborhoods that actors are embedded in. There is an unweighted and a weighted version of the clustering coefficient. The unweighted version calculates the average of the densities of each actor's neighborhood, while in the weighted version, a weight is assigned according to the size of each actor's neighborhood. Since larger local neighborhoods are usually less dense, the weighted average neighborhood density is usually lower than the unweighted one.

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668 Other software packages for network analysis, such as PAJEK, provide even more sophisticated options to analyze triadic structures. However, for the purpose of this study, the algorithms that UCINET 6 offers, are sufficient.

669 A triple is called transitive, when, if connections AB and BC exist, also a connection AC exists. The triple is denoted as vacuously transitive, if one of the two conditions is not met, i.e., either the connection AB, BC, or AC does not exist. See Wasserman/Faust (1994), p. 243. Note that, in the output presented, the 5,940 transitive triples are non-vacuous, i.e., these are triples of the form AB, BC, and AC.

670 In which either no tie, one, two, or all three ties exist.

671 In the output this is denoted as $i \rightarrow j$ and $j \rightarrow k$. 
In the present case, the weighted clustering coefficient is 26.5%, meaning that 26.5% of all possible ties in the local neighborhoods are actually existing. More meaningful in the context of this study, however, is the unweighted clustering coefficient, since it depicts how all actors, independent of the size of the neighborhood, are embedded in the network structure. The results show a clustering coefficient of 0.583, which means that, on average, the local neighborhoods of all actors show a density of 58.3%. That is, on average, 58.3% of all possible relations in each actor's neighborhood, are actually present. By itself, this value appears very high and it shows that the actors in the average neighborhood of a VC are very densely connected. The result becomes even more meaningful when being compared with the density of the entire network: In the overall network, only 4.1% of all possible ties are actually present, while the local neighborhoods are characterized by a very high density of 58.3%. This comparison implies that there are many dense local neighborhoods, however, probably there also exist gaps between these local structures. Analogously to the analysis on transitivity, this might indicate the existence of many structural holes and implies a large potential for actors to exploit positional advantages.

6.2.5 Centrality

Based on the explanations on centrality in section 3.4.4.5, betweenness centrality has been selected as the measure to characterize the centralization on the level of the entire network. The measure is based on Freeman's betweenness centrality approach.\textsuperscript{672} The overall network centralization index is 35.68%. Recall that betweenness centrality for the entire network is calculated in the way that 100% would indicate the maximal betweenness centrality as it would be the case in a star network of the same size (172 nodes). In order to assess whether 35.68% is a high or low value, a comparison to other networks would be necessary. Without any comparisons available, it can only be assumed that this represents a fairly significant amount of centralization. What makes more sense though is to look at the differences that exist among actors. The minimum betweenness centralization is 0 and the maximum is 5,308.87. The mean number of times that actors

\textsuperscript{672} See Freeman (1977), pp. 39-40.
lie on the geodesic paths between two other actors is 153.47, however, with a standard deviation of 508.19. Looking at the normalized betweenness, each actor, on average, accounts for 1.06% of the maximum possible betweenness, which is the mean of 153.47 divided by the maximum possible betweenness in this network, being equal to \(((172)^2 - 3 \times 172 + 2) / 2 = 14,535.673\). While the normalized mean betweenness centrality is fairly low, the standard deviation is high with 3.5%. These variability data once more reveal very clearly that there is substantial inequality in the distribution of power among actors, indicating that the amount of social capital based on network positions is also distributed unequally among actors.

### 6.3 Connection between Network Position, Firm Attributes, and Deal Flow

#### 6.3.1 Descriptive Statistics for the Dependent Variables

Two dependent variables have been defined, i.e., a measure for deal flow quantity and a measure for deal flow quality. Deal flow quantity has been operationalized as the product of the average number of investment opportunities received per year, the share of investment opportunities coming out of the contact network, and the share of investment opportunities coming from the source 'Other VCs'. Deal flow quality is equal to the product of the average number of investment opportunities received per year, the percentage of investment opportunities actually invested in (deal rate), the share coming out of the contact network, and the share of investment opportunities coming from the source 'Other VCs'. Since multivariate regression analysis based on the OLS method is relatively sensitive to outliers, they have been eliminated based on the previously defined procedure. Which observations, i.e., VCs, had to be excluded, will be explained in the following sections where relevant.

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673 See the formula for normalized betweenness centrality in section 3.4.4.5.

674 See also section 3.4.2.

675 Refer back to section 5.2.3.2.

676 Also, if an outlier is taken out which is farther away from the mean than +/- four standard deviations, for the same variable, the most extreme value at the opposite side has been taken out.
6.3.1.1 Deal Flow Quantity

In order to describe the deal flow quantity measure, it is helpful to individually examine the three elements that are used to derive the measure. The first element is the average number of investment opportunities received per year by the VCs, for the time period from 1998 to 2005. The second element is the percentage of investment opportunities received from a network contact, and the third element is the share of investment opportunities received out of the network, which stem from the source 'Other VCs'. The second and third element (percentage of deals coming out of the network and percentage of deals coming from other VCs) have already been described above, so that the focus here will be on the first element and on the product of all three, i.e., the measure for deal flow quantity. The descriptive statistics for the first element (average number of investment opportunities received per year) are presented below:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>401</td>
</tr>
<tr>
<td>Median</td>
<td>200</td>
</tr>
<tr>
<td>Minimum</td>
<td>12</td>
</tr>
<tr>
<td>Maximum</td>
<td>3,650</td>
</tr>
</tbody>
</table>

Table 6.3: Descriptive statistics for number of investment opportunities (N=92)

The mean of the average number of investment opportunities received per year (from all sources) is 401. With respect to other empirical studies for the German venture capital market, on a first view, this value is comparably high. Schröder (1992) found an average number of 193 investment opportunities received, while Vater (2002) found an average number of 321. Since the study of Schröder has been performed at the beginning of the 1990's, probably the results of Vater are more relevant as a basis for comparison. In his study, Vater also included firms that only invest in buyouts, and those firms on average only received 176 investment opportunities, which lowers the overall average value to

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677 As explained before, only those investment opportunities have been included, which do not fall into the buyout section.

678 Refer back to section 6.1.

679 Own calculation and illustration.


681 Buyouts include management buyouts, management buyins, and leveraged buyouts.
In the present study, buyout investments have been excluded. Adapting Vater's results for this effect, i.e., taking out the buyout firms, the average number of investment opportunities received per year increases to 425. Based on this calculation, the result of the present study is in line with the result Vater found.

The median value for the VCs in this study is 200. Since this value can be interpreted as the typical value, it shows that the mean of 401 is affected by outliers. However, since this is not the final measure for deal flow quantity, outliers are not taken out at this point, but, if at all, based on the final deal flow quantity measure. The descriptive statistics for the second and third element of the measure for deal flow quantity have been explained in the previous section and are therefore not repeated at this point. Rather, the descriptive statistics for the deal flow quantity measure are presented:

<table>
<thead>
<tr>
<th>Mean</th>
<th>61</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>21</td>
</tr>
<tr>
<td>Minimum</td>
<td>0</td>
</tr>
<tr>
<td>Maximum</td>
<td>420</td>
</tr>
</tbody>
</table>

Table 6.4: Descriptive statistics for the deal flow quantity measure (N=92)

Deal flow quantity is measured in absolute terms, i.e., the mean value of 61 means that, on average, VCs in Germany receive 61 investment opportunities per year from other VCs. Although the data show quite a substantial amount of variation, no outliers based on the definition for non-normal distributions needed to be eliminated. Due to this large variation, it can be assumed that there might be differences in the firms' ability to access information on investment opportunities from other firms.

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682 See Wright (1997), pp. 12 f.
683 See the descriptive statistics on measures A and C in section 6.1.
684 Own calculations and illustration.
685 That the maximum value still falls into this range shows that the standard deviation is fairly high. However, the criteria provided by the Tchebycheff theorem are fulfilled, so that the values are included. Anticipating the results, it has also been analyzed in separate multivariate regressions (not reported) whether eliminating further observations would change results. However, that could not be confirmed.
In order to describe the measure for deal flow quality, again it is helpful to look at the three different elements, which are used to calculate the measure. First, this is the percentage of investment opportunities VCs finally invest in, i.e., the deal rate. The second element is the percentage of investment opportunities finally invested in, which come out of the contact network, and the third element is the percentage of investment opportunities finally invested in, which, within the contact network, stem from the source 'Other VCs'. Again, the descriptive statistics for the second and third element will not be repeated, since this has already been done before. The descriptive statistics for the first element (deal rate) look as follows:

<table>
<thead>
<tr>
<th>Mean</th>
<th>4.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>1.5</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.1</td>
</tr>
<tr>
<td>Maximum</td>
<td>60.0</td>
</tr>
</tbody>
</table>

Table 6.5: Descriptive statistics for the deal rate (N=92)

The values represent percentages, i.e., the mean value of 4.8% indicates that, on average, VCs in Germany invest in 4.8% of all investment opportunities they receive per year. These results are comparable to those found in previous studies on VCs in Germany. While Schröder (1992) found a deal rate of 6.3%, Vater (2002) found an average deal rate of 2.7%. Looking at the minimum and maximum values of 0.1% and 60% respectively, again, a very large variation becomes obvious. An analysis of these firms shows the following: Above all, governmentally funded VCs show much higher deal rates of between approximately 20% to up to 60%. This result, which has also been found by Schröder (1992), is not surprising. However, if the results are adjusted for those firms, i.e., if those firms are excluded from the analysis, Schröder finds an adjusted deal rate of

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686 See the descriptive statistics for measures A' and C' in section 6.1.
687 Own calculations and illustration.
689 See Vater (2002), p. 153. Again, the results of Vater have been adjusted to reflect the exclusion of firms that solely focus on buyout investments.
Adjusting the results of the prevailing study for this effect, the deal rate decreases to an average of 2.1% with a median of 1.1%. Again, compared to the study of Vater, these results are very similar (2.7% deal rate in Vater's study compared to 2.1% in the present study). Interpreting these results, it becomes obvious that it is not only the deal flow quantity, but above all the quality of the deal flow that influences the business model of VCs. With an average deal rate of 2.1%, VCs are forced to identify and screen on average several hundred investment opportunities. This, however, costs time and energy, the reason for which it makes sense to put the focus on increasing the quality of deal flow, i.e., those investment opportunities that meet the criteria of the VC. Again, since this is not the final deal flow quality measure that enters the regression models, potential outliers are not taken out at this point but in the next step.  

As stated above, the descriptive statistics of the second and third element for calculating the measure for deal flow quality have been explained before. Therefore, the descriptive statistics for the deal flow quality measure are presented:

<table>
<thead>
<tr>
<th>Mean</th>
<th>2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>0.9</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>48.7</td>
</tr>
</tbody>
</table>

Table 6.6: Descriptive statistics for the deal flow quality measure (N=92)

The deal flow quality measure is an index, which indicates the extent to which a firm receives high-quality investment opportunities from other VCs. The values are presented in absolute terms, which means that, on average per year, each firm receives 2.5 investment opportunities from other VCs out of the network, in which it also finally invests in. Within these data, one outlier that significantly influenced the mean, has been eliminated (VC#391), together with the lowest value for this variable (VC#124). All other observations fulfill the criteria. Again, additional regressions have been performed to check whether the elimination of further observations would affect the results, but this could not be confirmed.
6.3.2 Descriptive Statistics for the Independent Variables

Following the structure of the research design, the independent variables include the ego-network measures, the total network measures, and the firm attributes. The descriptive statistics for these variables are described in the following. Also, the results of a test for multicollinearity are reported. Because the role analysis has a somewhat different character (analysis with respect to subgroups), it will be performed and presented in an own section further below (section 6.3.5).

6.3.2.1 Ego-Network Measures and Total Network Measures

The group of ego-network measures includes the average strength of ties and the structural hole measures, i.e., effective size and constraint. The group of total network measures includes betweenness centrality and multiconnectivity. The descriptive statistics for these measures are presented below:

<table>
<thead>
<tr>
<th></th>
<th>Average tie strength</th>
<th>Effective size</th>
<th>Constraint</th>
<th>Betweenness centrality</th>
<th>Multiconnectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.3</td>
<td>5.2</td>
<td>0.5</td>
<td>1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Median</td>
<td>1.0</td>
<td>2.0</td>
<td>0.4</td>
<td>0.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Minimum</td>
<td>1.0</td>
<td>1.0</td>
<td>0.0</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>2.5</td>
<td>64.0</td>
<td>1.0</td>
<td>36.5</td>
<td>5.9</td>
</tr>
</tbody>
</table>

Table 6.7: Descriptive statistics for ego-network/total network measures (N=92)

The average strength of ties has been defined as the degree of actors as calculated based on the valued dataset divided by the degree of actors as calculated based on the binary dataset. Applied to the syndication network of VCs this means, that the sum of syndicated investments of each firm is divided by the number of different firms the focal firm has invested with, resulting in the average strength of each tie. This measure indicates, how many times, on average, the focal VC invests with other firms, and thereby shows the average strength of the relations a firm has.

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694 Own calculations and illustration.
695 For the detailed theoretical and formal derivation, see section 3.4.5.1.1.
As can be seen, the mean of the average tie strength is equal to 1.3, which means that, on average, if VCs have invested with other firms, they have done so 1.3 times. Although at a first glance, this number seems fairly low, one has to bear in mind that this is the average value of the means for each firm, i.e., an average of all firms' averages. The maximum value is 2.5, indicating that this specific firm has invested, on average, 2.5 times with each of the firms it has ever invested with during the time period considered. The median or typical value equals 1.0, showing that, on average, VCs have invested once with each firm they have invested with. Again, since this is an average of all averages, it not surprising that this value is fairly low.

Two structural hole measures have been defined, which are the effective size and the constraint for each VC. Recall that effective size measures the size of the ego-network minus a redundancy factor, so that it indicates the number of non-redundant contacts. In other words, effective size measures the number of non-redundant or different sources of information for the focal actor.\(^{696}\) In contrast, constraint measures the extent to which the structure of the relationships of ego's direct alters constrains ego. More simply, an actor is constrained if he has connections only to other actors that have themselves many alternatives, or reversely, an actor is in a favorable position, if he has connections to others that are surrounded by structural holes, of which the focal actor benefits.

On average, the VCs of this network have an ego-network with an effective size of 5.2, meaning that, on average, the firms have connections to 5.2 firms in their ego-network, which are non-redundant. Following the idea behind effective size, this means that in the average ego-network there are 5.2 potential different sources of information. However, as is obvious from the typical value of 2.0, the mean is affected by outliers. The outlier in this case again is VC#391, which has been taken out together with the lowest value for that variable, which is VC#266.\(^{697}\)

The second structural hole measure is constraint. The measure ranges from 0 to 1, with 0 meaning that the focal actor is not constrained by the structure of the relationships in the alters network and 1 indicating that the focal actor is maximally constrained by the structure of the relationships of his direct contacts. The mean value for the network of

\(^{696}\) For the derivation of the measure, see also section 3.4.5.1.2.

\(^{697}\) VC#391 has been eliminated already as an outlier regarding the deal flow quality measure. Refer back to section 6.3.1.2.
VCs equals 0.5, with a minimum value of 0.0 and a maximum value of 1.0. These statistics show that constraint, as the other independent variables, is distributed very unequally among the VCs. Since the median is close to the mean (0.4 compared to 0.5), a fairly substantial part of the VCs can be assumed to be constrained by the structure of their direct contacts’ relationships.

As to the total network measures, the fourth independent variable to be included is the measure for betweenness centrality. Remember that betweenness centrality measures the prominence of actors in a network in the sense that the algorithm counts the number of times that the focal actor lies on the geodesic (shortest) path between two other actors. The measure has been normalized to account for the size of the network, so that the measure indicates the percentage (of the maximum possible betweenness centrality) an actor accounts for.\(^{698}\) As has been explained before, betweenness centrality measures an actor’s potential to broker contacts between other actors and to control the information flow between them.\(^{699}\) In the case of the syndication network of VCs, this would mean that firms with high scores in betweenness centrality might have an advantage in receiving and controlling information on potential investment opportunities.

The average percentage (of the maximum possible betweenness) that a VC lies on the geodesic path connecting two other firms is 1.2%. In absolute numbers that would mean that, on average, a VC is 1.2% \(\times\) 14,535 \(\approx\) 170 times between two other firms.\(^{700}\) The typical value (median) and the minimum value both equal 0.0%, and the maximum value is 36.5%. Interpreting the mean and the median, it becomes obvious that most VCs are not sitting between two other firms, indicating again, that the amount of social capital in the form of potential to extract information is probably distributed very unequally. One outlier could be identified (VC#391), which has been eliminated together with the lowest value for that variable (VC#266). Since these are the same firms that have been eliminated as outliers for the variable ‘effective size’, no additional outliers were eliminated.

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\(^{698}\) For the derivation of this measure, also see section 3.4.5.2.1.


\(^{700}\) The maximum betweenness centrality occurs in a star network of the same size. Here it is \(((172)^2 - 3 \times 172) \div 2 = 14,535\). Actually, the number 1.2% used in the product above has been rounded and the actual number that an actor, on average, occurs on the geodesic path between two other firms is 153. See also the descriptive statistics on betweenness centrality for the entire network in section 6.2.5.
The second total network measure included is multiconnectivity. Recall that multiconnectivity, also denoted as point connectivity, is a measure for the dependency of the focal actor on specific others, or, in other words, for the vulnerability of the focal actor's network. Point connectivity shows the average number of nodes that would have to be removed from the network in order for the focal actor to become disconnected from another actor.\footnote{For the derivation of this measure, see also section 3.4.5.2.2.} The network under study represents the VCs' relationship network based on syndicated investments, and since the graph of the main component is connected, each actor can reach any other actor by some path length. The question that the point connectivity measure answers is, how vulnerable the network of each actor is (on average) with respect to the removal of nodes.

The mean for point connectivity equals 2.8, indicating that, on average, 2.8 nodes would have to be removed from the network in order for one VC not to be able to reach another specific VC. The median or typical value is 2.3, implying that most firms are not connected to only one other firm. That is, if firm A was connected to only one other firm B (the paths from A to all other actors D, E, etc. then would go through actor B), the average point connectivity for firm A would equal 1.0 because only one node (firm B) would have to be removed in order for A not to be able to reach any other firm. Therefore, a median value of 2.3 indicates that most firms have multiple alternatives to reach other firms. However, as the minimum value of 1.0 shows, there are VCs, for which only one node needs to be removed in order for them to become disconnected from the other VCs. However, there are also firms that are fairly well-connected, i.e., the networks of which are relatively invulnerable with respect to the removal of nodes, expressed by the maximum value of 5.9.

6.3.2.2 \textit{Firm Attributes}

The descriptive statistics for the firm attributes, i.e., number of employees, age, number of offices in Germany, and the value for systematic deal flow measurement, are presented below:
Table 6.8: Descriptive statistics for firm attributes (N=92)\textsuperscript{702}

<table>
<thead>
<tr>
<th></th>
<th>Employees</th>
<th>Age</th>
<th>Offices</th>
<th>Deal flow measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>8.6</td>
<td>10.3</td>
<td>1.3</td>
<td>2.1</td>
</tr>
<tr>
<td>Median</td>
<td>5.0</td>
<td>7.0</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Minimum</td>
<td>2.0</td>
<td>2.0</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>30.0</td>
<td>133.0</td>
<td>5.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>

The average number of employees is 8.6, with a median of 5.0. The spread between minimum and maximum value is fairly large, with a range of 28. In terms of offices, the mean and median values are quite close to each other, indicating that most VCs in the German market have one office. Of course, the scores for deal flow measurement range from zero to three, indicating that there are firms that do not systematically measure deal flow at all and that there are firms that track their deal flow systematically.\textsuperscript{703} One outlier for the firm attributes could be identified, which is the maximum value of age, being 133 (VC#124). It has been eliminated, together with the lowest value for that variable (VC#309).

Based on the individual firms' data for the dependent variables, the independent variables, and the firm attributes, several outliers have been eliminated (VC#124, VC#266, VC#309, VC#391). Therefore, from the 92 VCs relevant in the network, 88 remain, based on which the regression analyses are performed. In several regression analyses performed separately and not shown in this thesis, it could be seen that these outliers significantly affected the results and therefore their elimination is justified. Several further regressions on the data excluding these outliers have been performed to check whether further observations had to be eliminated. However, no further eliminations of observations led to significantly different results.

6.3.2.3 Test for Multicollinearity

The test for multicollinearity needs to be performed, above all, for the firm attributes with respect to the network variables. As can be seen from table 6.9, there are no multicollinearity issues among these variables, highlighted in the area shaded in grey.

\textsuperscript{702} Own calculations and illustration.

\textsuperscript{703} Refer back to section 3.4.6 for a description of this variable.
The network measures (among each other) show a fairly high amount of collinearity (ranging between 0.459 and 0.880 in absolute values). However, two aspects are important in this regard: First, the results are not surprising because network measures are calculated based on one network, i.e., one set of actors and their relationships. All network measures, in some form, are calculated based on these relationships and then focus on different aspects regarding the relationship structure. An example explains this point: The correlation between tie strength and effective size is 0.613. Thus, average tie strength is positively associated with effective size. This is obvious because the number of direct contacts (degree) are used for both calculations. Nevertheless, both measures adhere to different arguments and capture different aspects of an actor's ego-network. While the average tie strength refers to the average number of times on VC invests with another firm, effective size captures the notion of redundancy or, better, non-redundant contacts.
The second aspect, which is important regarding the correlation among the network measures is that collinearity among the network measures is not an issue, because they do not enter the same regression equation. The models used include the firm attributes and

---

The second aspect, which is important regarding the correlation among the network measures is that collinearity among the network measures is not an issue, because they do not enter the same regression equation. The models used include the firm attributes and

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704 Own calculation and illustration. Already included in this table are the results for the test for multicollinearity for the variables gatekeeper, consultant, and liaison, referring to the role analysis. They will be referred to in section 6.3.5.
then, successively, each network measure on its own, in order to see the differential effects the network measures add to explaining the dependent variables.\textsuperscript{705}

Having explained and interpreted the descriptive statistics for the various independent variables, in the following sections the results of the multivariate regression analyses are reported. These results are the basis for answering the question, to what extent the VCs' differences in these variables (firm attributes and network measures) are able to explain the variance in the VCs' deal flow quantity and quality.

6.3.3 Connection between Independent Variables and Deal Flow Quantity

6.3.3.1 Effect of Firm Attributes and Ego-Network Measures on Deal Flow Quantity

The independent variables used in this section include the average tie strength, the effective size, and the constraint, which have been calculated for each VC in the network. The results of multiple regression analyses are presented in the following table. Four models have been calculated, model 4 has the best fit.

\textsuperscript{705} Although theoretically not allowed (and practically not provided in UCINET 6), another test for the existence of potential multicollinearity has been performed using standard regression in SPSS. The so-called Variance Inflation Factor (VIF) is calculated based on the unadjusted $R^2$. Values for the VIF higher than 10 indicate beginning multicollinearity issues, largely higher values would indicate severe issues. However, none of the tests for the following regressions when performed in the standard way showed multicollinearity issues based on the VIF, so that the results can be expected to be robust in this dimension.
Results of the Empirical Study

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>3.170 (0.270)*</td>
<td>3.303 (0.282)*</td>
<td>2.934 (0.250)*</td>
<td>2.865 (0.244)*</td>
</tr>
<tr>
<td>Age</td>
<td>-2.835 (-0.183)*</td>
<td>-2.939 (-0.190)*</td>
<td>-3.064 (-0.198)*</td>
<td>-2.319 (-0.150)</td>
</tr>
<tr>
<td>Offices</td>
<td>3.536 (0.040)</td>
<td>2.429 (0.028)</td>
<td>3.561 (0.040)</td>
<td>5.593 (0.063)</td>
</tr>
<tr>
<td>Deal flow measure</td>
<td>16.040 (0.184)*</td>
<td>14.400 (0.165)</td>
<td>12.824 (0.147)</td>
<td>14.501 (0.166)</td>
</tr>
<tr>
<td>Tie strength</td>
<td></td>
<td>19.340 (0.090)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective size</td>
<td></td>
<td></td>
<td>3.526 (0.220)*</td>
<td></td>
</tr>
<tr>
<td>Constraint</td>
<td></td>
<td></td>
<td></td>
<td>-69.034 (-0.250)**</td>
</tr>
<tr>
<td>Constant</td>
<td>22.780</td>
<td>2.222</td>
<td>17.363</td>
<td>53.320</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.120</td>
<td>0.128</td>
<td>0.166*</td>
<td>0.180*</td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
<td>0.068</td>
<td>0.064</td>
<td>0.106*</td>
<td>0.121*</td>
</tr>
<tr>
<td>N</td>
<td>88</td>
<td>88</td>
<td>88</td>
<td>88</td>
</tr>
</tbody>
</table>

* \( p < 0.05 \); test of significance based on 20,000 permutations
** \( p < 0.01 \); test of significance based on 20,000 permutations
The standardized regression coefficient is presented in brackets

Table 6.10: Regression models for ego-network measures on deal flow quantity

Overall, only two of four models are statistically significant at the level of \( p < 0.05 \) (models 3 and 4). Models 1 and 2 are statistically not significant overall, although single variables are at the level of \( p < 0.05 \). Model 1 shows that the firm attributes alone do not lead to a statistically significant result overall. Nevertheless, the regression coefficients of the variables 'employees', 'age', and 'deal flow measurement' are statistically significant \( (p < 0.05) \). Both, 'employees' and 'age' are significant in all models \( (p < 0.05) \), except for 'age' in model 4. The variable 'offices' is not significant in any of the models, while 'deal flow measurement' is in model 1 \( (p < 0.05) \). Of the independent variables, i.e., 'tie strength', 'effective size', and 'constraint', only 'tie strength' does not show statistical significance. While 'effective size' is statistically significant at the \( p < 0.05 \) level (model 3), 'constraint' is significant at the level of \( p < 0.01 \) (model 4). Overall, model 4 has the best goodness-of-fit, based on an \( R^2 \) of 18.0% and an adjusted \( R^2 \) of 12.1%. That is, 18.0% (unadjusted) of the variance of deal flow quantity can be explained by the explanatory variables. Model 3 shows a slightly lower goodness-of-fit with an \( R^2 \) of 16.6% and an adjusted \( R^2 \) of 10.6%.
6.3.3.2 Effect of Firm Attributes and Total Network Measures on Deal Flow Quantity

The independent variables used in this section include the betweenness centrality of the VCs and a measure for multiconnectivity, i.e., the point connectivity. The results of multiple regression analyses are presented in the following table. Three models have been calculated, model 6 has the best goodness-of-fit.

<table>
<thead>
<tr>
<th>Model</th>
<th>Employees</th>
<th>Age</th>
<th>Offices</th>
<th>Deal flow measurement</th>
<th>Betweenness centrality</th>
<th>Multiconnectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>3.170 (0.270)*</td>
<td>-2.835 (-0.183)*</td>
<td>3.536 (0.040)</td>
<td>16.040 (0.184)*</td>
<td>9.519 (0.176)</td>
<td></td>
</tr>
<tr>
<td>Model 5</td>
<td>2.980 (0.254)*</td>
<td>-3.067 (-0.198)*</td>
<td>3.454 (0.039)</td>
<td>13.219 (0.152)</td>
<td></td>
<td>14.986 (0.255)*</td>
</tr>
<tr>
<td>Model 6</td>
<td>2.819 (0.241)*</td>
<td>-2.468 (-0.160)</td>
<td>4.740 (0.054)</td>
<td>13.488 (0.155)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Model 1 represents the base case and is the same as in the previous section.
- Models 5 shows that the variables 'employees' and 'age' are statistically significant at the level of \( p<0.05 \). However, as in the previous section, 'age' shows a negative regression coefficient. The variable 'betweenness centrality' is statistically not significant. Overall, models 1 and 5 are statistically not significant. This is different with model 6, in which the variable 'multiconnectivity' has been added. In this model, again, 'employees' positively affects deal flow quantity \( (p<0.05) \). 'Multiconnectivity' shows a positive regression coefficient, being statistically significant at the level of \( p<0.05 \). Overall, model 6 is able to explain 18.3% (adjusted 12.4%) of the variability of deal flow quantity.

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707 Own calculations and illustration.

708 The base case models (including firm attributes only) are repeated where relevant for easier comparison.
6.3.3.3 Robustness Checks on Deal Flow Quantity

In order to test for the robustness of the results found, several additional regression models have been calculated. For all variables, multivariate regression models have been derived for the time period from 1998-2001, for the time period from 2002-2005, as well as for a subsample of the VCs included in the network. The subsample has been selected based on a segmentation of the VCs according to their foci on industries and investment phases.\(^{709}\) The results of the regressions are presented in the tables further below.

As to the firm attributes, the additional models show that the results in the full model for the variable 'employees' are robust. In all additional models (1998-2001, 2002-2005, subsample), 'employees' is statistically significant at the level of \(p<0.05\). With respect to the variable 'age', the robustness checks show similar results compared to the full models. In all additional models, the regression coefficients for 'age' are negative, and in many models the variable is statistically significant at the level of \(p<0.05\) (except for models 1b, 4b, 6b, and the ones for the subsample). The results in the full model for the variable 'offices' are confirmed in the robustness checks: The regression coefficients are positive and are largely statistically insignificant in all models (except for models 1c-3c, and 5c, which all refer to the models on the subsample). The regression coefficients for the variable 'deal flow measurement' are positive as in the ones in the full models. While there are only three exceptions (models 2a, 3a, and 5a), the results for this variable are statistically insignificant in models when a network measure is included as well.

\(^{709}\) For the segmentation, refer back to section 3.4.5.3 and see section 6.3.5.1 further below.
## Table 6.12: Robustness check for 1998-2001 on deal flow quantity

<table>
<thead>
<tr>
<th>Model</th>
<th>Employees</th>
<th>Age</th>
<th>Offices</th>
<th>Deal flow measurement</th>
<th>Tie strength</th>
<th>Effective size</th>
<th>Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1a</td>
<td>2.451 (0.241)*</td>
<td>-0.784 (-0.128)*</td>
<td>4.070 (0.049)</td>
<td>17,000 (0.187)*</td>
<td>-23.371 (-0.101)</td>
<td>2.609 (0.251)*</td>
<td>-105.493 (-0.374)**</td>
</tr>
<tr>
<td>Model 2a</td>
<td>2.538 (0.249)*</td>
<td>-0.842 (-0.137)*</td>
<td>5.644 (0.071)</td>
<td>18,393 (0.202)*</td>
<td>1.970 (0.101)</td>
<td>2.769 (0.251)*</td>
<td>-105.493 (-0.374)**</td>
</tr>
<tr>
<td>Model 3a</td>
<td>1.439 (0.141)*</td>
<td>-0.820 (-0.134)*</td>
<td>3.489 (0.042)</td>
<td>16,143 (0.177)*</td>
<td>-16.371 (-0.101)</td>
<td>2.609 (0.251)*</td>
<td>-105.493 (-0.374)**</td>
</tr>
<tr>
<td>Model 4a</td>
<td>1.570 (0.154)*</td>
<td>-0.960 (-0.157)*</td>
<td>6.536 (0.079)</td>
<td>13,659 (0.156)</td>
<td>37.767 (0.101)</td>
<td>2.609 (0.251)*</td>
<td>-105.493 (-0.374)**</td>
</tr>
<tr>
<td>Model 5a</td>
<td>1.966 (0.193)*</td>
<td>-0.782 (-0.128)*</td>
<td>3.776 (0.046)</td>
<td>16,951 (0.186)*</td>
<td>4.730 (0.057)</td>
<td>2.609 (0.251)*</td>
<td>-105.493 (-0.374)**</td>
</tr>
<tr>
<td>Model 6a</td>
<td>1.916 (0.188)*</td>
<td>-0.846 (-0.138)*</td>
<td>4.730 (0.057)</td>
<td>12,554 (0.138)</td>
<td>12.554 (0.138)</td>
<td>2.609 (0.251)*</td>
<td>-105.493 (-0.374)**</td>
</tr>
</tbody>
</table>

* \( p<0.05; \) test of significance based on 20,000 permutations
** \( p<0.01; \) test of significance based on 20,000 permutations

The standardized regression coefficient is presented in brackets.

---

## Table 6.13: Robustness check for 2002-2005 on deal flow quantity

<table>
<thead>
<tr>
<th>Model</th>
<th>Employees</th>
<th>Age</th>
<th>Offices</th>
<th>Deal flow measurement</th>
<th>Tie strength</th>
<th>Effective size</th>
<th>Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1b</td>
<td>4.748 (0.282)*</td>
<td>-3.523 (-0.186)</td>
<td>15.065 (0.084)</td>
<td>21,381 (0.207)*</td>
<td>17.000 (0.187)*</td>
<td>-23.371 (-0.101)</td>
<td>1.541 (0.104)</td>
</tr>
<tr>
<td>Model 2b</td>
<td>5.021 (0.298)*</td>
<td>-4.151 (-0.219)*</td>
<td>21,807 (0.118)</td>
<td>14,702 (0.142)</td>
<td>18.393 (0.202)*</td>
<td>2.769 (0.251)*</td>
<td>18.275 (0.264)*</td>
</tr>
<tr>
<td>Model 3b</td>
<td>4.453 (0.265)*</td>
<td>-4.022 (-0.212)*</td>
<td>19,012 (0.102)</td>
<td>18,363 (0.177)</td>
<td>17.000 (0.187)*</td>
<td>-105.493 (-0.374)**</td>
<td></td>
</tr>
<tr>
<td>Model 4b</td>
<td>5.113 (0.304)*</td>
<td>-3.096 (-0.163)</td>
<td>16,442 (0.088)</td>
<td>17,959 (0.174)</td>
<td>18.393 (0.202)*</td>
<td>2.769 (0.251)*</td>
<td>18.275 (0.264)*</td>
</tr>
<tr>
<td>Model 5b</td>
<td>4.574 (0.272)*</td>
<td>-3.895 (-0.205)*</td>
<td>16,878 (0.090)</td>
<td>19,654 (0.190)</td>
<td>18.393 (0.202)*</td>
<td>2.769 (0.251)*</td>
<td>18.275 (0.264)*</td>
</tr>
<tr>
<td>Model 6b</td>
<td>4.813 (0.285)*</td>
<td>-3.139 (-0.165)</td>
<td>16,787 (0.090)</td>
<td>16,854 (0.190)</td>
<td>18.393 (0.202)*</td>
<td>2.769 (0.251)*</td>
<td>18.275 (0.264)*</td>
</tr>
</tbody>
</table>

* \( p<0.05; \) test of significance based on 20,000 permutations
** \( p<0.01; \) test of significance based on 20,000 permutations

The standardized regression coefficient is presented in brackets.

---

710 Own calculations.

711 Own calculations.
As regards the ego-network measures included in the models, the robustness checks basically confirm the results for the full models. There are only two exceptions, in which ego-network measures are statistically significant in the additional models while they were not in the full model: 'Tie strength' shows statistically significant results in model 2b and 'betweenness centrality' shows statistical significance in model 5c. Otherwise, the results for the additional models are similar to the ones for the full models. This applies to the direction of the signs as well as to the statistical significance of the variables.

More concretely, 'tie strength', with the only exception mentioned above, shows positive regression coefficients and no statistical significance in all models. 'Effective size' shows positive regression coefficients when included, being statistically significant at the level of \( p<0.05 \). The direction of the sign (negative) and the statistical significance for 'constraint' is confirmed as well. In the model for the time period 1998-2001, results are even statistically significant at the level of \( p<0.01 \).

With respect to the total network measures, i.e., betweenness centrality and multiconnectivity, the results are largely confirmed by the regression models calculated for the robustness checks. The variable 'betweenness centrality' shows positive regression coefficients but is statistically insignificant at the conventional levels. The only exception is model 5c, in which the variable shows statistical significance at the level of \( p<0.05 \).

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\(^{712}\) Own calculations.
'Multiconnectivity' is statistically highly significant in all models, either at the level of $p<0.05$ (models 6a and 6b) or at the level of $p<0.01$ (model 6c).

Overall, the models calculated as robustness checks are similar in terms of $R^2$ and adjusted $R^2$: Models are statistically not significant when either only the firm attributes are included, or when 'tie strength' or 'betweenness centrality' are included. Statistically significant at the level of $p<0.05$ are those models when either 'effective size', 'constraint', or 'multiconnectivity' is included. The level of the $R^2$ and the adjusted $R^2$ is also approximately the same, except for models 4c and 6c (models on the subsample of VCs). Here, the $R^2$ and the adjusted $R^2$ is slightly higher as in the other models, increasing to 27.1% (adjusted 18.2%) in model 4c ('constraint'), and to 30.8% (22.3% adjusted) in model 6c ('multiconnectivity').

Summarizing it can be stated that, abstaining from few exceptions, the results for the full models on deal flow quantity have largely been confirmed by the models performed as robustness checks. Additional regression models as robustness checks on further subsamples for VCs have also been calculated (not reported), which do not materially alter the conclusions that will be derived in later sections.713

6.3.4 Connection between Independent Variables and Deal Flow Quality

6.3.4.1 Effect of Firm Attributes and Ego-Network Measures on Deal Flow Quality

As in the previous sections, the independent variables regarding the ego-network measures include the average tie strength, the effective size, and the constraint. The results of multiple regression analyses are illustrated below. Four models have been calculated, model 9 has the best goodness-of-fit.

713 Further subsamples include those groups of VCs that have an industry focus, those that have no focus on investment phases, and those that do have a focus on investment phases.
Results of the Empirical Study

<table>
<thead>
<tr>
<th></th>
<th>Model 7</th>
<th>Model 8</th>
<th>Model 9</th>
<th>Model 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>0.109 (0.296)*</td>
<td>0.117 (0.317)*</td>
<td>0.101 (0.273)*</td>
<td>0.100 (0.271)*</td>
</tr>
<tr>
<td>Age</td>
<td>0.019 (0.039)</td>
<td>0.013 (0.026)</td>
<td>0.010 (0.021)</td>
<td>0.034 (0.071)</td>
</tr>
<tr>
<td>Offices</td>
<td>-0.133 (-0.048)</td>
<td>-0.198 (-0.071)</td>
<td>-0.132 (-0.048)</td>
<td>-0.071 (-0.026)</td>
</tr>
<tr>
<td>Deal flow measurement</td>
<td>0.563 (0.205)*</td>
<td>0.467 (0.170)</td>
<td>0.445 (0.162)</td>
<td>0.516 (0.188)*</td>
</tr>
<tr>
<td>Tie strength</td>
<td>1.130 (0.167)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective size</td>
<td></td>
<td></td>
<td></td>
<td>0.129 (0.257)*</td>
</tr>
<tr>
<td>Constraint</td>
<td>-0.102</td>
<td>-1.303</td>
<td>0.3</td>
<td>-2.090 (-0.240)*</td>
</tr>
<tr>
<td>R(^2)</td>
<td>0.155*</td>
<td>0.181*</td>
<td>0.217*</td>
<td>0.210*</td>
</tr>
<tr>
<td>Adjusted R(^2)</td>
<td>0.104*</td>
<td>0.122*</td>
<td>0.161*</td>
<td>0.153*</td>
</tr>
<tr>
<td>N</td>
<td>88</td>
<td>88</td>
<td>88</td>
<td>88</td>
</tr>
</tbody>
</table>

* \(p<0.05\); test of significance based on 20,000 permutations
** \(p<0.01\); test of significance based on 20,000 permutations
The standardized regression coefficient is presented in brackets

Table 6.15: Regression models for ego-network measures on deal flow quality\(^{714}\)

While model 7 represents the base case for the regressions on the dependent variable 'deal flow quality', models 8-10 show the results if one additional ego-network measure is included in the model. As to the firm attributes, while the variable 'employees' is positive and statistically significant \((p<0.05)\), although 'deal flow measurement' is also positive, it is only statistically significant in models 7 and 10. 'Age' and 'offices' are both statistically not significant in any of the models. With respect to the ego-network measures, again, 'tie strength' shows a positive regression coefficient but the result is statistically not significant at the conventional levels. Both variables, 'effective size' and 'constraint' are statistically significant at the level of \(p<0.05\), with 'effective size' being positively related to deal flow quality, and 'constraint' being negatively related to it.

Overall, all four models show statistically significant results at the level of \(p<0.05\). The base case model (model 7) has an R\(^2\) of 15.5\% (adjusted 10.4\%). Of models 8-10, model 9 has the best goodness-of-fit with an R\(^2\) of 21.7\% (adjusted 16.1\%). Model 10 shows slightly lower results with an R\(^2\) of 21.0\% (adjusted 15.3\%).

\(^{714}\) Own calculations and illustration.
6.3.4.2 Effect of Firm Attributes and Total Network Measures on Deal Flow Quality

As before, the total network measures include the independent variables 'betweenness centrality' and 'multiconnectivity'. The results of the multivariate regression models are presented below. Three models have been calculated, model 12 has the best fit.

<table>
<thead>
<tr>
<th></th>
<th>Model 7</th>
<th>Model 11</th>
<th>Model 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>0.109 (0.296)*</td>
<td>0.101 (0.274)*</td>
<td>0.097 (0.263)*</td>
</tr>
<tr>
<td>Age</td>
<td>0.019 (0.039)</td>
<td>0.009 (0.018)</td>
<td>0.032 (0.065)</td>
</tr>
<tr>
<td>Offices</td>
<td>-0.133 (-0.048)</td>
<td>-0.137 (-0.049)</td>
<td>-0.091 (-0.033)</td>
</tr>
<tr>
<td>Deal flow measurement</td>
<td>0.563 (0.205)*</td>
<td>0.442 (0.161)</td>
<td>0.474 (0.173)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Betweenness centrality</td>
<td></td>
<td>0.408 (0.239)*</td>
<td></td>
</tr>
<tr>
<td>Multiconnectivity</td>
<td></td>
<td>0.523 (0.283)**</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.102</td>
<td>-0.031</td>
<td>-1.406</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.155*</td>
<td>'0.209*</td>
<td>0.232**</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.104*</td>
<td>0.151*</td>
<td>0.176**</td>
</tr>
<tr>
<td>$N$</td>
<td>88</td>
<td>88</td>
<td>88</td>
</tr>
</tbody>
</table>

* $p<0.05$; test of significance based on 20,000 permutations
** $p<0.01$; test of significance based on 20,000 permutations

The standardized regression coefficient is presented in brackets

Table 6.16: Regression models for total network measures on deal flow quality

While model 7 represents the base case and, of course, shows the same results as presented in the previous section, models 11 and 12 include 'betweenness centrality' and 'multiconnectivity', respectively. In both models 11 and 12, while again the variable 'employees' is statistically significant ($p<0.05$), no other firm attributes are. However, 'age' shows slightly positive regression coefficients as was the case for the regressions including the ego-network measures. While regression coefficients for 'offices' are negative, those of 'deal flow measurement' are positive. In models 11 and 12, both 'betweenness centrality' (model 11) and 'multiconnectivity' (model 12) show high statistical significance ('betweenness centrality' at the $p<0.05$ level, 'multiconnectivity' at the $p<0.01$ level). Overall, while model 11 is able to explain 20.9% (adjusted 15.1%) of the variance of deal flow quality, model 12 even can explain 23.2% (adjusted 17.6%).

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715 Own calculations and illustration.
6.3.4.3 Robustness Checks on Deal Flow Quality

As was the case for deal flow quantity, also for deal flow quality several additional regression models have been calculated in order to test for the robustness of the results found. Again, for all variables, multivariate regressions have been performed for the time period from 1998-2001, for the time period from 2002-2005, as well as for a subsample of the VCs included in the network. Analogously to the previous procedure, the subsample has been selected based on a segmentation of the VCs according to their foci on industries and investment phases. 716

As regards the firm attributes, 'employees' shows similar results in the additional models as compared to the full models. The variable shows positive regression coefficients in all models, being statistically significant at the level of $p<0.05$. In contrast to the results in the full models, the variable 'age' still shows slightly negative regression coefficients in the models for the time period from 1998-2001. However, for the time period from 2001-2002 and for the subsample of VCs, the regression coefficients are, just as in the full models, slightly positive and statistically insignificant. The general tendency of a sign shift from negative to positive for the models on deal flow quantity versus the ones on deal flow quality can therefore be observed. The results in the additional models for the variable 'offices' confirm the results found for the full models: The regression coefficients are negative and statistically insignificant. In the full models, the variable 'deal flow measurement' showed positive regression coefficient and was largely statistically insignificant. This is different for the additional models: While still showing positive regression coefficients, the 'deal flow measurement' often shows statistically significant results at the level of $p<0.05$.

With respect to the ego-network measures, i.e., tie strength, effective size, and constraint, results based on the robustness checks are basically in line with the ones found in the full models. 'Tie strength' shows positive but statistically insignificant results. There is only one exception to this, which is model 8c (subsample of VCs), in which the variable is statistically significant at the level of $p<0.05$. 'Effective size' shows positive regression coefficients and is statistically significant at the level of $p<0.005$ in all additional models.

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716 For the segmentation, refer back to section 3.4.5.3 and see section 6.3.5.1 further below.
where used. ‘Constraint’, as in the full models, shows highly negative regression coefficients and is statistically significant at the level of $p<0.01$ in models 10a and 10c, and at the level of $p<0.05$ in model 10b. Based on these results, the directionality of the signs as well as the statistical (in)significance of the ego-network measures included has largely been confirmed, so that the results of the full models can be considered robust.

The standardized regression coefficient is presented in brackets.

Table 6.17: Robustness check for 1998-2001 on deal flow quality

<table>
<thead>
<tr>
<th>Model 7a</th>
<th>Model 8a</th>
<th>Model 9a</th>
<th>Model 10a</th>
<th>Model 11a</th>
<th>Model 12a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>0.111 (0.305)*</td>
<td>0.116 (0.317)*</td>
<td>0.104 (0.286)*</td>
<td>0.0946 (0.259)*</td>
<td>0.107 (0.293)*</td>
</tr>
<tr>
<td>Age</td>
<td>-0.052 (-0.093)</td>
<td>-0.053 (-0.095)</td>
<td>-0.070 (-0.125)</td>
<td>-0.051 (-0.091)</td>
<td>-0.054 (-0.097)</td>
</tr>
<tr>
<td>Offices</td>
<td>-0.103 (-0.039)</td>
<td>-0.172 (-0.065)</td>
<td>-0.102 (-0.038)</td>
<td>-0.012 (-0.004)</td>
<td>-0.111 (-0.042)</td>
</tr>
<tr>
<td>Deal flow measurement</td>
<td>0.583 (0.200)*</td>
<td>0.516 (0.177)*</td>
<td>0.434 (0.149)</td>
<td>0.513 (0.176)*</td>
<td>0.503 (0.173)*</td>
</tr>
<tr>
<td>Tie strength</td>
<td>0.953 (0.121)</td>
<td>0.249 (0.289)*</td>
<td>-2.647 (-0.277)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective size</td>
<td>0.267 (0.146)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constraint</td>
<td>Multiconnectivity</td>
<td>0.711 (0.251)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.078*</td>
<td>0.159*</td>
<td>0.224*</td>
<td>0.218*</td>
<td>0.166*</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.086*</td>
<td>0.143*</td>
<td>0.086*</td>
<td>0.130*</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>68</td>
</tr>
</tbody>
</table>

* $p<0.05$; test of significance based on 20,000 permutations
** $p<0.01$; test of significance based on 20,000 permutations

Table 6.18: Robustness check for 2002-2005 on deal flow quality

<table>
<thead>
<tr>
<th>Model 7b</th>
<th>Model 8b</th>
<th>Model 9b</th>
<th>Model 10b</th>
<th>Model 11b</th>
<th>Model 12b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>0.191 (0.315)*</td>
<td>0.191 (0.315)*</td>
<td>0.163 (0.269)*</td>
<td>0.195 (0.322)*</td>
<td>0.173 (0.286)*</td>
</tr>
<tr>
<td>Age</td>
<td>0.079 (0.149)</td>
<td>0.079 (0.148)</td>
<td>0.062 (0.118)</td>
<td>0.073 (0.139)</td>
<td>0.044 (0.083)</td>
</tr>
<tr>
<td>Offices</td>
<td>-0.421 (-0.081)</td>
<td>-0.415 (-0.080)</td>
<td>-0.321 (-0.062)</td>
<td>-0.659 (-0.127)</td>
<td>-0.353 (-0.068)</td>
</tr>
<tr>
<td>Deal flow measurement</td>
<td>0.615 (0.214)*</td>
<td>0.607 (0.212)*</td>
<td>0.538 (0.188)*</td>
<td>0.540 (0.188)*</td>
<td>0.575 (0.201)*</td>
</tr>
<tr>
<td>Tie strength</td>
<td>0.073 (0.008)</td>
<td>0.154 (0.235)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective size</td>
<td>Constraint</td>
<td>-2.221 (-0.225)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiconnectivity</td>
<td>0.216 (0.236)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.091*</td>
<td>0.074</td>
<td>0.131*</td>
<td>0.128</td>
<td>0.129*</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.129*</td>
<td>0.150*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td>58</td>
<td>58</td>
</tr>
</tbody>
</table>

* $p<0.05$; test of significance based on 20,000 permutations
** $p<0.01$; test of significance based on 20,000 permutations

The standardized regression coefficient is presented in brackets.

Table 6.18: Robustness check for 2002-2005 on deal flow quality

717 Own calculations.

718 Own calculations.
### Results of the Empirical Study

#### Table 6.19: Robustness check for subsample of VCs on deal flow quality

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 7c</th>
<th>Model 8c</th>
<th>Model 9c</th>
<th>Model 10c</th>
<th>Model 11c</th>
<th>Model 12c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>0.087 (0.279)*</td>
<td>0.090 (0.287)*</td>
<td>0.079 (0.252)*</td>
<td>0.077 (0.244)*</td>
<td>0.078 (0.250)*</td>
<td>0.073 (0.233)*</td>
</tr>
<tr>
<td>Age</td>
<td>-0.001 (-0.003)</td>
<td>0.003 (0.007)</td>
<td>0.013 (0.032)</td>
<td>0.023 (0.055)</td>
<td>0.007 (0.017)</td>
<td>0.028 (0.067)</td>
</tr>
<tr>
<td>Offices</td>
<td>-0.191 (-0.036)</td>
<td>-0.177 (-0.034)</td>
<td>-0.453 (-0.087)</td>
<td>-0.456 (-0.087)</td>
<td>-0.346 (-0.066)</td>
<td>-0.564 (-0.108)</td>
</tr>
<tr>
<td>Deal flow measurement</td>
<td>0.243 (0.096)</td>
<td>0.082 (0.032)</td>
<td>0.131 (0.051)</td>
<td>0.239 (0.094)</td>
<td>0.135 (0.053)</td>
<td>0.162 (0.064)</td>
</tr>
<tr>
<td>Tie strength</td>
<td>-0.036 (-0.003)</td>
<td>0.003 (0.007)</td>
<td>0.013 (0.032)</td>
<td>0.023 (0.055)</td>
<td>0.007 (0.017)</td>
<td>0.028 (0.067)</td>
</tr>
<tr>
<td>Effective size</td>
<td>-0.191 (-0.036)</td>
<td>-0.177 (-0.034)</td>
<td>-0.453 (-0.087)</td>
<td>-0.456 (-0.087)</td>
<td>-0.346 (-0.066)</td>
<td>-0.564 (-0.108)</td>
</tr>
<tr>
<td>Constraint</td>
<td>0.167 (0.317)*</td>
<td>-2.561 (-0.313)**</td>
<td>-0.191 (-0.036)</td>
<td>-0.177 (-0.034)</td>
<td>-0.453 (-0.087)</td>
<td>-0.456 (-0.087)</td>
</tr>
</tbody>
</table>

#### Total Network Measures

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 12c</th>
<th>Model 12b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betweenness centrality</td>
<td>0.462 (0.269)*</td>
<td>-2.561 (-0.313)**</td>
</tr>
<tr>
<td>Multiconnectivity</td>
<td>-0.191 (-0.036)</td>
<td>0.167 (0.317)*</td>
</tr>
</tbody>
</table>

#### R^2 and Adjusted R^2

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 12c</th>
<th>Model 12b</th>
</tr>
</thead>
<tbody>
<tr>
<td>R^2</td>
<td>0.462 (0.269)*</td>
<td>-2.561 (-0.313)**</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td>0.003 0.058 0.083*</td>
<td>-2.561 (-0.313)**</td>
</tr>
<tr>
<td>N</td>
<td>54 54 54 54 54 54</td>
<td></td>
</tr>
</tbody>
</table>

*p < 0.05; test of significance based on 20,000 permutations

**p < 0.01; test of significance based on 20,000 permutations

The standardized regression coefficient is presented in brackets.

Regarding the total network measures, both variables included, i.e., 'betweenness centrality' and 'multiconnectivity', show positive regression coefficients and statistical significance in all models. 'Betweenness centrality' is statistically significant at the level of p<0.05 in all models where used. 'Multiconnectivity' is statistically significant at the level of p<0.01 in models 12a and 12c, and at the level of p<0.05 in model 12b. Therefore, also the results for the total network measures based on the full models can be considered robust.

With respect to the overall results for the additional models, the values for the R^2 and the adjusted R^2 are in line with the results for the full models. The maximum R^2 reached in the additional models is 24.8% (adjusted 15.6%) in model 12c, in which 'multiconnectivity' is included as network measure.

Based on the robustness checks on deal flow quality, the results for the full models can be considered robust. Deviating results for single variables exist, however, they do not materially affect the conclusions that will be drawn based on the results for the full models. In addition, deviations that exist largely refer to firm attributes, not to the network measures included. Therefore, conclusions drawn based on the results for the network measures can be regarded robust. Again, additional regression models as robustness checks on further subsamples of the VCs have also been calculated (not

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719 Own calculations.
which do not significantly alter the conclusions that will be derived in later sections. As stated earlier, the robustness tests based on different time periods also minimize the potential problem of the endogeneity of variables.720

6.3.5 Role Analysis

6.3.5.1 Segmentation of Venture Capital Firms

In this section it will be shown, how many companies fall into which category based on the dimensions 'industry focus' and 'focus on investment stages'. In the questionnaire, the VCs have been asked to provide information on which industries and on which investment stages they focus (if they have a focus in these dimensions). A cut-off value had to be selected to decide whether VCs rather take a generalist or a specialist approach in each of the dimensions. The firms were categorized to have no focus in the case that they have actually answered to not focus on industries or investment stages, or, if they have answered to focus on more industries/investment stages than the median value.721 The VCs are allocated to the 2x2-matrix presented earlier.722

<table>
<thead>
<tr>
<th>Industry focus</th>
<th>Investment stage focus</th>
<th>Industry specialist</th>
<th>Stage specialist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>General VC</td>
<td>Stage specialist</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>33</td>
<td>21</td>
</tr>
</tbody>
</table>

Figure 6.1: Allocation of VCs to industry-investment stage matrix (N=88)723

720 Refer to section 5.2.3.2.
721 For example, the question regarding the industry focus provided ten different industries the VCs could select from. If a VC has answered to focus on eight out of the ten, it was decided to categorize this VC as having no focus with respect to the industry.
722 Since the multivariate regression models are calculated including the firm attributes and also, of course, including the dependent variables, the same outliers have been eliminated from this analysis. No further outliers could be identified, so that the number of firms analyzed remains 88.
723 Own calculations and illustration.
6.3.5.2 **Effect of Roles on Deal Flow Quantity**

As explained, the different roles included are 'gatekeeper', 'consultant', and 'liaison'. The results of the multivariate regression models are presented below. Three additional models have been calculated, model 13 has the best fit.

Model 1 is already known and, of course, shows the same results as presented before, overall not being statistically significant. Of the new models 13-15, only model 13 is statistically significant at the level of $p<0.05$. In that model, only the variable 'gatekeeper' is statistically highly significant at the level of $p<0.01$. In models 14 and 15, while the variables 'employees', 'age', and 'deal flow measurement' show statistical significance ($p<0.05$), the network measures do not. Overall, models 14 and 15 are statistically not significant. Therefore, model 13 including the variable 'gatekeeper' has the best goodness-of-fit, being able to explain 23.7% (unadjusted, adjusted 18.1%) of the variance of deal flow quantity.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 13</th>
<th>Model 14</th>
<th>Model 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>3.170 (0.270)*</td>
<td>2.405 (0.205)</td>
<td>3.157 (0.269)*</td>
<td>3.157 (0.269)*</td>
</tr>
<tr>
<td>Age</td>
<td>-2.835 (-0.183)*</td>
<td>-2.015 (-0.130)</td>
<td>-2.980 (-0.193)*</td>
<td>-2.835 (-0.183)*</td>
</tr>
<tr>
<td>Offices</td>
<td>3.536 (0.040)</td>
<td>-0.161 (-0.002)</td>
<td>3.203 (0.036)</td>
<td>3.450 (0.039)</td>
</tr>
<tr>
<td>Deal flow measure</td>
<td>16.040 (0.184)*</td>
<td>9.038 (0.104)</td>
<td>15.788 (0.181)*</td>
<td>16.170 (0.186)*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Model 14</th>
<th>Model 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gatekeeper</td>
<td>46.481 (0.361)**</td>
<td></td>
</tr>
<tr>
<td>Consultant</td>
<td>22.098 (0.161)</td>
<td></td>
</tr>
<tr>
<td>Liaison</td>
<td>-1.547 (-0.014)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>22.780</td>
<td>21.222</td>
</tr>
<tr>
<td>R²</td>
<td>0.120</td>
<td>0.237*</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.068</td>
<td>0.181*</td>
</tr>
<tr>
<td>N</td>
<td>88</td>
<td>88</td>
</tr>
</tbody>
</table>

* $p<0.05$; test of significance based on 20,000 permutations
** $p<0.01$; test of significance based on 20,000 permutations

The standardized regression coefficient is presented in brackets.

Table 6.20: Regression models for role measures on deal flow quantity

724 Own calculations and illustration.
6.3.5.3 Effect of Roles on Deal Flow Quality

Analog to the analysis presented in the previous section, it is now tested for the effect of role measures on deal flow quality. The regression results are presented below. Three further models have been calculated, model 17 has the best fit.

Model 7 is already known, overall being statistically significant ($p<0.05$) and showing an $R^2$ of 15.5% (10.4% adjusted). While all other models 17-19 are overall statistically significant ($p<0.05$), the increase in $R^2$ in models 18 and 19 is marginal. In contrast, in model 17, in which 'gatekeeper' is included, the $R^2$ significantly increases to 21.4% (15.7% adjusted). Also, in model 17, 'gatekeeper' shows statistical significance at the level of $p<0.05$.

<table>
<thead>
<tr>
<th></th>
<th>Model 7</th>
<th>Model 17</th>
<th>Model 18</th>
<th>Model 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>0.109 (0.296)*</td>
<td>0.092 (0.250)*</td>
<td>0.109 (0.295)*</td>
<td>0.114 (0.308)*</td>
</tr>
<tr>
<td>Age</td>
<td>0.019 (0.039)</td>
<td>0.037 (0.076)</td>
<td>0.016 (0.032)</td>
<td>0.019 (0.039)</td>
</tr>
<tr>
<td>Offices</td>
<td>-0.133 (-0.048)</td>
<td>-0.216 (-0.078)</td>
<td>-0.140 (-0.051)</td>
<td>-0.102 (-0.037)</td>
</tr>
<tr>
<td>Deal flow measurement</td>
<td>0.563 (0.205)*</td>
<td>0.406 (0.148)</td>
<td>0.557 (0.203)*</td>
<td>0.517 (0.189)*</td>
</tr>
<tr>
<td>Gatekeeper</td>
<td>1.039 (0.256)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consultant</td>
<td></td>
<td>0.486 (0.112)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liaison</td>
<td></td>
<td></td>
<td>0.547 (0.153)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.102</td>
<td>-0.137</td>
<td>-0.245</td>
<td>-0.366</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.155*</td>
<td>0.214*</td>
<td>0.167*</td>
<td>0.177*</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.104*</td>
<td>0.157*</td>
<td>0.107*</td>
<td>0.118*</td>
</tr>
<tr>
<td>N</td>
<td>88</td>
<td>88</td>
<td>88</td>
<td>88</td>
</tr>
</tbody>
</table>

* $p<0.05$; test of significance based on 20,000 permutations

** $p<0.01$; test of significance based on 20,000 permutations

The standardized regression coefficient is presented in brackets.

Table 6.21: Regression models for role measures on deal flow quality

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725 Own calculations and illustration.
Discussion of the Results and Implications for Management and Research

In this chapter, the results reported in chapter six are discussed (section 7.1) and summarized (section 7.2). Furthermore, implications for the management of VCs (section 7.3) and implications for research (section 7.4) are derived.

7.1 Discussion of the Results

7.1.1 General Importance of the Contact Network and of Other Venture Capital Firms as Source of Deal Flow

The statistics explained above are now used to test hypotheses HI 1 through HI 6. HI 1 stated that, based on deal flow quantity, the percentage of investment opportunities received from a network contact (A) is higher than the percentage received unsolicited (B), so that A>B. A verification of HI 1 would mean that the contact network is important for the deal flow of VCs because it delivers many investment opportunities (more than come unsolicited). Looking at the data, it is obvious that this hypothesis cannot be confirmed, because both percentages are approximately the same (mean value of 55% for measure A compared to 45% for measure B). To check whether the difference is statistically significant, a t-test has been performed with the null hypothesis stating that the mean of A is equal to 50%, i.e., \( H_0 = \mu_A = 50\% \). Based on the t-test, the null hypothesis could not be rejected at a confidence level of 99% (\( \alpha = 0.01 \)).

This is surprising to some extent, since theory would predict the percentage of investment opportunities received out of the contact network to be higher. The result is basically in line with previous empirical findings, which range between 50% for the German market\(^{726}\) and around 60-65% for the US market\(^{727}\). However, previous studies did not differentiate between deal flow quantity and deal flow quality, or they only took the former into account. The implications of the findings are that (a) the results on German VCs are corresponding to previous research on German VCs and to results found for


other regions, (b) the contact network of VCs delivers a significant part of the investment opportunities the firms can select from, and (c) although being a significant source, investment opportunities received unsolicited represent a source nearly equally as large.

Hypothesis HI 2 stated that, based on deal flow quality (funded investment opportunities), the percentage of investment opportunities received from a network contact \( (A') \) is higher than the percentage received unsolicited \( (B') \), so that \( A'>B' \). The results strongly support HI 2, with \( A' \) being equal to 85% (with the median of 90%) versus \( B' \) being equal to 15% (median of 10%). A t-test has been performed with the null hypothesis stating that the mean of \( A' \) is equal to 50%, i.e., \( H_0=\mu_A=50\% \). Based on the test, the null hypothesis was rejected at a confidence level of 99% \( (\alpha=0.01) \). This result indicates that 85% of the investment opportunities, which have been funded by VCs, were referred to them by some contact out of their network. The results are in line with those found for the US market.\(^728\) Also, the results show that the contact network of VCs is more important for the reception of high-quality investment opportunities, compared to those received unsolicited. That, in turn, implies that VCs should put considerably more effort in establishing and maintaining network contacts, compared to effort invested in marketing activities that might foster the reception of unsolicited deal proposals.

However, what also is of importance, is the comparison between the results for deal flow quantity and quality, which has been operationalized in hypothesis HI 3.

In order to evaluate whether the contact network of VCs is of higher importance for the generation of deal flow quantity or for deal flow quality, HI 3 has been set up. HI 3 stated that, based on deal flow quality, the percentage of investment opportunities received out of the network \( (A') \) is higher than the same percentage based on deal flow quantity \( (A) \), so that \( A'>A \). Looking at the data, HI 3 is strongly supported with \( A' \) being equal to 85%, and \( A \) equaling 55%. A t-test has been performed with the null hypothesis stating that the mean of \( A' \) is equal to 55%, i.e., \( H_0=\mu_A=55\% \). The null hypothesis was rejected at a confidence level of 99% \( (\alpha=0.01) \). That means, although the contact network of VCs is also important because it generates deal flow quantity (55%), above all, the contact

\(^{728}\) Fried/Hisrich (1994) found that most funded deals come by referral. See Fried/Hisrich (1994), pp. 31 f.
network is important because it delivers the high-quality deals. Even stronger than derived based on HI 2, the recommendation for VCs based on HI 3 is that, in order to get the 'right' deals (those that meet their investment criteria), they need to focus on their network contacts.

In hypothesis HI 4 (and HI 5) it has been formulated that, based on deal flow quantity (quality) and based on the various sources within the contact network, other VCs, i.e., measure C (C') accounts for the largest percentage, so that C (C') exceeds any other of the sources. However, in order to evaluate the percentage of investment opportunities that comes from other VCs relative to the other sources, the percentages of the other sources need to be described as well. Recall that the percentage of investment opportunities received from other VCs (out of the contact network), based on deal flow quantity, is 35% (measure C), while the one based on deal flow quality is 42% (measure C'). The descriptive statistics for the other sources, based on deal flow quantity and deal flow quality, look as follows:

<table>
<thead>
<tr>
<th>Deal flow quantity</th>
<th>Deal flow quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universities/Research centers</td>
<td>Banks/Investment Banks</td>
</tr>
<tr>
<td>Mean</td>
<td>9</td>
</tr>
<tr>
<td>Median</td>
<td>9</td>
</tr>
<tr>
<td>Minimum</td>
<td>0</td>
</tr>
<tr>
<td>Maximum</td>
<td>60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Universities/Research centers</th>
<th>Banks/Investment Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>9</td>
</tr>
<tr>
<td>Median</td>
<td>9</td>
</tr>
<tr>
<td>Minimum</td>
<td>0</td>
</tr>
<tr>
<td>Maximum</td>
<td>60</td>
</tr>
</tbody>
</table>

Table 7.1: Descriptive statistics for deal flow sources (N=125)²²⁹

Looking at the results for the other sources of deal flow within the contact network of VCs, it becomes obvious that both hypotheses, HI 4 and HI 5, are strongly supported. For both, measures C and C', a t-test has been performed with the null hypotheses stating that the mean of C (C') is equal to 20%, i.e., \(H_0=\mu_C=20\%\) and \(H_0=\mu_{C'}=20\%\). The null hypotheses in both cases were rejected at a confidence level of 99% (\(\alpha=0.01\)). With respect to deal flow quantity, the mean value of measure C (35%) is larger than any other single source of deal flow. On average, universities/research centers account for 9% of the investment opportunities, banks/investment banks account for 28%, private contacts

²²⁹ Own calculations and illustration, excluding the source ‘Other VCs’.
represent 9%, and other sources represent 19%. Comparisons to previous research are limited, since most studies did not measure deal flow at all or did not differentiate between deal flow quantity and quality. For the US market, Wells (1974) found that 61% of the proposals the VCs received came from network contacts and out of those, about half of those referrers were other VCs (approximately 30%). Tyebjee and Bruno (1984) found a similar result with 65% coming from network contacts and more than half of them stemming from professional sources such as other VCs. Although Tyebjee/Bruno include 'other VCs' in a group called 'professional contacts', the results are similar to those of Wells. Since in both studies, only deal flow quantity has been measured, the corresponding result of the present study is the multiplication of the percentage stemming from the network and the percentage stemming from 'other VCs', i.e., 55% x 35%, equaling approximately 19%. This is a bit lower compared to the studies of Wells and Tyebjee/Bruno. One explanation for this difference could be that the studies of Wells and Tyebjee/Bruno have been performed in the 1970's and 1980's. Another explanation could be the different characteristics and developments of the US and the German venture capital markets. It is well-known that in the US, venture capital financings are much more established than they are in Europe and especially in Germany. For the German market, Vater (2002) found two contradictory results: On the one hand side, the source 'Other VCs' delivered only about 13% of the investment opportunities, on the other hand, VCs considered this source to be very important to generate deal flow. The results of the present study support the second part of Vater's findings, with other VCs being the largest source for deal flow quantity, compared to all other sources within the contact network. For VCs this implies that focusing on network contacts to other VCs is beneficial because they deliver many investment opportunities.

730 The fairly high percentage for the source 'other sources' of 19% is not surprising, since it comprises sources such as consultants, lawyers, etc., which are frequently mentioned in studies on the sources of deal flow. However, based on the feedback of VCs in the pretest performed and in order to keep the analysis focused on the syndication network of VCs, in this study these sources are included in the single source 'other sources'.


Discussion of the Results and Implications for Management and Research

With respect to the quality of investment opportunities, the difference between the source 'Other VCs' and all other sources is even larger with measure C' being equal to 42% and no other source alone accounting for more than 25% (banks/investment banks). Universities/research centers represent only 5%, private contacts account for 8%, and other sources represent 21%. These results imply that, not only is the source 'Other VCs' important to generate deal flow quantity, it also delivers the high-quality investment opportunities.

Hypothesis HI 6 holds that the percentage of investment opportunities referred to by other VCs is higher based on deal flow quality (measure C') than it is based on deal flow quantity (measure C). Seeing the results (C' equaling 42% vs. C equaling 35%), HI 6 is supported. A t-test has been performed with the null hypothesis stating that the mean of C' is equal to 35%, i.e., \( H_0 = \mu_C = 35\% \). The null hypothesis was rejected at a confidence level of 95% (\( \alpha = 0.05 \)). The implication of this result for VCs has been stated in the previous paragraph and is therefore not repeated. One more aspect is worth highlighting: When comparing the change of the percentages from 'based on deal flow quantity' to 'based on deal flow quality' for the other sources, one can observe that all sources (except 'Other sources') experience a decline: The value for universities/research centers declines from 9% to 5%, the value for banks/investment banks lowers from 28% to 25%, and the value of private contacts decreases from 9% to 8%. Only the category 'Other sources' increases from 19% to 21%. This shows that, when it comes to the funding of investment opportunities, prospective deals referred to by these sources seem to be perceived as being of lower quality. In contrast, VCs in Germany seem to rely on investment opportunities that they receive from other VCs.

An overview of the hypotheses and corresponding results is presented below:
<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Expectation</th>
<th>Empirical Finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI 1</td>
<td>A&gt;B</td>
<td>Not confirmed</td>
</tr>
<tr>
<td>HI 2</td>
<td>A'&gt;B'</td>
<td>Confirmed</td>
</tr>
<tr>
<td>HI 3</td>
<td>A'&gt;A</td>
<td>Confirmed</td>
</tr>
<tr>
<td>HI 4</td>
<td>C&gt;any other source</td>
<td>Confirmed</td>
</tr>
<tr>
<td>HI 5</td>
<td>C'&gt;any other source</td>
<td>Confirmed</td>
</tr>
<tr>
<td>HI 6</td>
<td>C&gt;C</td>
<td>Confirmed</td>
</tr>
</tbody>
</table>

Table 7.2: Hypotheses and results on the importance of the contact network

Summarizing the results on the general importance of the contact network for the deal flow generation of VCs in Germany, the following can be stated: First, in terms of deal flow quantity, there is only a slight difference as to the number of investment opportunities received out of the network and those received unsolicited. However, with respect to deal flow quality, more investment opportunities receive funding that come from a network contact. Therefore, in order to receive higher deal flow quality, VCs should focus on using their network contacts. Second, within the contact network, the source 'Other VCs' accounts for a large percentage of investment opportunities received (deal flow quantity), but it also accounts for an even larger percentage of those investment opportunities that receive funding (deal flow quality). Therefore, in order to increase deal flow quality, VCs should not only concentrate on establishing contacts to any group within the contact network. The results clearly show that, in terms of deal flow quantity and, above all, deal flow quality, contacts to other VCs are most rewarding.

Overall, it can be stated that social capital in the form of values and norms inherent in the contact network and, above all, among the contacts of VCs serves as underlying basis that makes the exchange of information on potential investment opportunities possible. By heavily using the contact network and the contacts to other VCs, they put trust in the judgment of others, thereby drawing on what has been theoretically described as form of social capital.

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734 Own illustration.
The implication for VCs is clear: In order to generate deal flow quantity, the contact network but above all the contacts to other VCs are of major importance. This is even more the case regarding deal flow quality: The more VCs use other VCs as source of deal flow, the higher, on average, will be the quality of the deals they receive.

As mentioned in the introductory section of this study, the analysis regarding goal (a) can be seen as the starting point or the justification for performing the network analysis on the VCs' syndication network (goal (b)). In this section, it could be shown that the contact network and the contacts among VCs are vital to generate deal flow quantity and quality. In the following sections, the contacts among VCs (in the form of syndication relationships) will therefore be analyzed in more detail.

7.1.2 Connection between Independent Variables and Deal Flow Quantity

In this section, the effects of the firm attributes, of the ego-network measures, as well as of the total network measures on deal flow quantity are discussed. Multiple regression models have been used to detect the influences of each variable on the explained variance of deal flow quantity. The results of the regression analyses that have been reported in chapter six will now be discussed and interpreted in detail.

7.1.2.1 Effect of Firm Attributes and Ego-Network Measures on Deal Flow Quantity

With respect to models 1-4, model 1 can be considered the base case. In this model, only the firm attributes are included. Models 2-4 then each contain one ego-network measure in addition to the firm attributes in order to identify the additional explanatory power of each ego-network measure. It will first be looked at the firm attributes, then the ego-network measures are examined.

Looking at the results for the firm attributes in models 1-4, there are several aspects that deserve highlighting. The regression coefficients for the variable 'employees' are positive and statistically significant \((p<0.05)\) in all models. This is an expected result, which

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735 Refer back to section 6.3.3.1.
indicates that an increase in the number of employees leads to an increase in the average number of investment opportunities received from other VCs. The result makes sense because more people can simply identify and screen more investment opportunities than fewer people can. While this result could be expected, it has a significant implication for VCs: It clearly carries the message that, in order to increase the number of investment opportunities received from other VCs, VCs simply need to employ more people.

A result that also is striking regarding the firm attributes is the result for the variable 'age'. Indicating the age of the firm in years, the variable's regression coefficients are negative in all models, and they are statistically significant at the $p<0.05$ level in models 1-3. The negative coefficient implies that an increase in age is associated with a decrease in the number of investment opportunities received from other VCs in the syndication network. This result is counterintuitive because the expectation would be that it takes time and effort to establish and maintain relationships in the network, which also yields benefits in terms of information on investment opportunities. Also, in their study Hochberg, Ljungqvist and Lu (2007) find that a VC’s experience is positively related to its financial performance. Although the authors only show the results for experience as measured by the total dollar amount invested by the VC until that point in time, they explain that the results are similar when using the VCs’ age as variable.\footnote{See Hochberg/Ljungqvist/Lu (2007), p. 263, p. 268 and p. 271.}

In the syndication network analyzed in the present study though, this does not seem to hold in the case of deal flow quantity. One potential explanation for this could be that, because younger firms might not have established a clear firm profile or because their profile is not very widely known (when they are young), they get many referrals from other firms that do actually not meet their investment criteria. However, this is only one potential explanation and it can finally not be determined for sure, what the exact reasons for this negative relationship are. An interesting question for the further course of this study will be, whether this negative relationship also occurs in the regressions on deal flow quality, or whether it even reverses to a positive relationship (indicating that older firms might have a lower deal flow quantity but have a higher deal flow quality).
Discussion of the Results and Implications for Management and Research

With respect to 'offices', the positive regression coefficients are statistically not significant in any of the models. This implies that the number of offices does not affect a firm's ability to generate deal flow quantity from other VCs.

Nearly the same is the case for 'deal flow measurement'. Except for a statistically significant regression coefficient in model 1 ($p<0.05$), the variable shows statistically insignificant results (models 2-4).

Models 2-4 represent the ones that need to be compared to model 1. In model 2, 'tie strength' has been added as explanatory variable. As hypothesized in HII 1, it is expected that, based on the theory of weak ties, the relationship between tie strength and deal flow quantity should be negative. However, first, the variable does not show statistical significance at the level of $p<0.05$. And second, although statistically not significant, the regression coefficient is positive, which goes against theoretical prediction. Therefore, hypothesis HII 1 is not supported by the results. It seems that (if at all) stronger ties are beneficial for a VC to receive more investment opportunities from other VCs in the network. Since this result does not seem to support the theory on the strength of weak ties in the given context, it might rather be that, just the opposite, it is the stronger ties that yield the necessary trust to exchange information on potential investment opportunities. Still, it has to be kept in mind, that the regression coefficient, although positive, is statistically not significant, so that definite conclusions can actually not be drawn based on these results. In their study, Hochberg, Ljungqvist and Lu (2007) apply degree centrality as one network measure and found a positive connection to the VCs’ financial performance. However, the authors used a measure that counts the total absolute number of relationships a VC has. Since in this study, the objective is to capture the notion of tie strength, the average degree had to be calculated, so that the measure used in the

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737 In order to test for the robustness of the results presented, in addition to the used measure for tie strength, an alternative measure has been calculated and applied. Based on the degree calculated on the valued dataset, the VCs have been divided into two groups, those with a degree above the median, and those with a degree below the median. The means for deal flow quantity for both groups have been compared. However, results for the alternative measure of tie strength were not different from those found with the originally used measure. This shows that the results found and presented above are robust.

738 Refer to section 3.4.5.1.1.
present study is different from the one applied in the paper of Hochberg, Ljungqvist and Lu (2007).\textsuperscript{739}

The story is different for the other two ego-network measures, i.e., effective size and constraint. Recall that effective size captures the notion of having access to non-redundant contacts and therefore to \textit{different} sources of information. It has been hypothesized in HII 3 that a larger effective size positively affects deal flow quantity. This hypothesis is confirmed by the results, with the regression coefficient for 'effective size' being positive and statistically significant at the level of $p<0.05$. The result supports the rationale that firms, which are located in network positions characterized by many non-redundant syndication contacts, have benefits in terms of access to information. The absolute regression coefficient indicates that a one unit increase in effective size is associated with an increase in the number of investment opportunities of 3.526, received from other VCs in the network. Therefore, the economic significance of a one unit increase in effective size is fairly large.

More concretely applied to the syndication context considered, this result implies that VCs should syndicate with those other VCs that represent non-redundant contacts. According to the previously explained concept of non-redundancy, for example, VC B is a non-redundant contact to VC A, the fewer syndication relationships B has with A's other syndication partners. Therefore, it is important for A to pay attention to the fact, with whom his syndication partners themselves co-invest with. The more they syndicate with A's partners, the worse for A (in terms of deal flow quantity). Such an example can, of course, also be found in the real VCs' syndication network. The ego-networks of VC#043 and VC#067 are presented below:

\textsuperscript{739} If the simple measure of degree was applied in the present study, also a highly significant positive relationship between degree and deal flow quantity would result. However, since this measure does not capture the notion of tie strength of the individual relationships, the average degree has been applied as explained above.
Considering the two ego-networks of VC#043 and of VC#067, the first thing to notice is that both have invested with four different other VC: VC#043 has invested with VC#100, VC#007, VC#187, and VC#389. VC#067 has invested with VC#195, VC#402, VC#004, and with VC#391. However, on the first view one can also see that in the ego-network of VC#043 fewer ties are actually present as compared to in the ego-network of VC#067. Actually, in the ego-network of VC#067, all VCs are connected to each other, i.e., all possible ties are also present. As to the effective size of the ego-networks, there is a great difference between the two focal VCs. Recall that the effective size is the degree minus the average degree of ego's alters. VC#043 has an effective size of \(4 - \frac{6}{4} = 2.5\). In contrast, VC#067 has an effective size of \(4 - \frac{12}{4} = 1\). Since effective size is a measure for the number of different sources of information that an actor has access to in his ego-network, the difference between the two VCs in the example becomes obvious. Because the other VCs in the ego-network of VC#067 are all connected to each other, the extent to which VC#067 has access to non-redundant information might be limited. The other VCs in the ego-network of VC#043 are not that densely connected with each other and therefore might be better sources for new information. Considering the focal VC's deal flow quantity, VC#043 has a value of 120 while VC#067 has 68. That is, from other VCs, VC#043 receives 120 investment opportunities on average per year, while VC#067 only receives 68 investment opportunities from other VCs, which brings the importance

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740 Own calculations and illustration.

741 In further multivariate regressions (not shown) it has been tested whether the ego-network density affects deal flow quantity. However, no statistically significant results could be observed.
of non-redundant contacts to daylight. In practice this means for the management of VCs that they need to pay attention with which other VCs their syndication partners co-invest on their side. That is, the less the own syndication partners co-invest with each other, the higher the deal flow quantity (investment opportunities received from other VCs) will be. These findings represent an extension of previous research because existing studies so far focused on the centrality of an actor’s network position while neglecting other important dimensions such as the effective size.

Strikingly, model 1 is statistically not significant overall, while model 3 \( (p<0.05) \) is. Compared to a (statistically non-significant) \( R^2 \) of 12.0\% (adjusted 6.8\%) in model 1, the \( R^2 \) in model 3 is 16.6\% (adjusted 10.6\%). That is, overall, model 3 is able to explain 16.6\% (10.6\%) of the variance of deal flow quantity received from other firms in the network. The additional explanatory power gained by adding 'effective size' equals 4.4 percentage points.

Examining model 4, which contains the ego-network measure 'constraint' as further independent variable, the results are even clearer. The overall \( R^2 \) is 18.0\% \( (p<0.05) \), the adjusted \( R^2 \) is 12.1\%. Comparing the latter to the base case (model 1), the explained part of the variance in deal flow quantity has roughly doubled (adjusted \( R^2 \)). Looking at the single variables in model 4, it becomes obvious that the variable 'constraint' has the strongest influence on deal flow quantity. The negative regression coefficient is statistically highly significant \( (p<0.01) \), supporting hypothesis HII 5, which stated that a higher constraint will negatively affect deal flow quantity. HII 5 is thereby strongly supported. The standardized regression coefficient (presented in brackets) is larger than it is for the other variables in model 4, indicating the relatively larger explanatory power of 'constraint'.

Again, the implications for VCs, in a structural sense, are that they need to pay attention to the fact with whom they syndicate and with whom their syndication partners co-invest on their side. More concretely, as has been explained in the description of the measure and also in the derivation of hypothesis HII 5, \(^{742}\) the constraint that a VC B exerts on VC A very much depends on the effort that a VC C (to whom A is also connected) puts into

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\(^{742}\) Refer back to sections 3.4.5.1.2 and 4.2.1.3.
the relationship with VC B. Based on the algorithm and the formula for constraint, in the context of the VCs' syndication network this means that the constraint on A through B will decrease, the better C is connected to other VCs (D, E, F, etc.), to whom A is not directly connected.\footnote{743}

Looking at the VCs' network structure, an example of two individual VCs' ego-network structure illustrates this point. In the following figure, the ego-networks of the VCs with VC#095 and VC#225 are presented:

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{ego-networks.png}
\caption{Ego-networks for VC#095 and VC#225}\footnote{744}
\end{figure}

As can be seen, the ego-networks of VCs VC#095 and VC#225 look exactly the same. Both VCs have a degree of two. However, when calculating their constraint, VC#095 shows a value of 0.55, while the one for VC#225 is 0.84. Given that the measure ranges between 0 and 1, this is a significant difference. The reason for this difference is to be found in the fact that the direct contacts of the two focal VCs are differently connected themselves:

\footnote{743}{If these further VCs (D, E, F, etc.) were actors, to whom A is also connected, the measure 'constraint' will decline at a decreasing rate, which is due to the formula's set-up. See Burt (1992), pp. 57 f.}

\footnote{744}{Own calculation and illustration.}
While both direct syndication contacts of VC#095 are very well-connected, VC#034, the direct contact of VC#225, is well-connected as well, but not to as many other VCs as the direct contacts of VC#095 are. In addition, VC#145, the other direct contact of VC#225, is not connected to any other VC. This is the effect that lets the measure constraint for VC#095 be significantly lower than for VC#225. This result simply implies that VCs should focus on being connected to well-connected other VCs in order to increase deal flow quantity. Since Burt’s measure for constraint has not been applied in network

745 Own calculation and illustration.
746 Own calculation and illustration.
studies on VCs and has not been interpreted in this way, these results represent an extension of current research. This interpretation also represents a potential answer to one question for future research Hochberg, Ljungqvist and Lu (2007)\(^{747}\) formulated, i.e., how VCs form relationships with influential VCs. The results for constraint indicate that the analysis of this measure in a VC’s ego-network makes possible the identification of influential VCs. Influential in the sense of potentially delivering information on many investment opportunities are those VCs that have many syndication contacts, to which the focal VC did not have access to before. From a theoretical viewpoint, this interpretation contributes to the discussion on how social capital inherent in network positions can explain the performance differences of individual actors.

Looking at the results of models 3 and 4, also in comparison to model 1, the implications are clear. For VCs, the results imply that it might make sense to (a) focus on the structure of the syndication network, (b) analyze their network to examine, in a structural sense, whom they are connected to and to whom these others are connected to, and (c) strategically think about whom they would have to be connected to in order to optimize their deal flow quantity received from other VCs in the network. More concretely, the results indicate that it is important for VCs to have *non-redundant* syndication contacts and to have syndication relationships to those other firms, that do not constrain them in the sense of that *they are themselves well-connected* to many other VCs. That is, in terms of non-redundancy of syndication contacts and in order to increase deal flow quantity, VCs want to syndicate with those other VCs that do not co-invest with each other. In terms of constraint and in order to increase deal flow quantity, VCs want to syndicate with those other VCs that are themselves well-connected to many other VCs (the focal VC has not syndicated with yet).

Overall, relating the results to the idea of social capital, it can be stated that differences in the amount of social capital (inherent in the VCs' network position) significantly affect the VCs' ability to generate deal flow quantity. The more social capital a VC has (in the sense of structural embeddedness in the ego-network) the higher the deal flow quantity. More

Discussion of the Results

precisely, the higher the effective size of a VC’s ego-network and the lower the VC’s constraint, the more social capital this VC has and the higher his deal flow quantity will be. Overall, these results complement current research and, as could be shown, carry important implications for the academic debate and for practitioners.

7.1.2.2 Effect of Firm Attributes and Total Network Measures on Deal Flow Quantity

As in the previous section, 'employees' shows statistical significance in both models 5 and 6 \((p<0.05)\). This again highlights the importance of the aspect that a larger number of employees goes along with more investment opportunities received from other VCs. While the regression coefficient for 'age' is negative in both models 5 and 6, the variable shows statistical significance in model 5 only \((p<0.05)\). This result is in line with the one in the previous section, indicating that younger firms tend to have a quantitatively higher deal flow as compared to older firms. Potential explanations for this phenomenon have been discussed above and are therefore not repeated at this point. Both variables 'offices' and 'deal flow measurement' show positive regression coefficients, but are statistically insignificant at the conventional levels. These results are in line with previous ones discussed above, indicating that both, the number of offices and the fact whether VCs measure their deal flow systematically do not significantly affect deal flow quantity (in a statistical sense). Nevertheless, especially regarding the systematic measurement of deal flow, the general tendency of a positive association with deal flow quantity can be observed. That might indicate that a systematic measurement of deal flow generally supports the identification of investment opportunities. In this context, it will be interesting to take into account the results for this variable with respect to deal flow quality, which will be discussed further below.

The first notable result regarding the total network measures is that, based on the embeddedness of VCs in the overall network structure, 'betweenness centrality' does not have any statistically significant effect on deal flow quantity. Based on the theoretical explanations it was expected that firms with high scores on betweenness centrality might have advantages in terms of information on potential investment opportunities. However, this does not seem to hold in the case of the analyzed syndication network of VCs in
Germany with regard to deal flow quantity. This implies that holding network positions, which yield the potential to broker contacts and control the information flow between two other VCs, does not increase the average number of investment opportunities received per year from other VCs. Although the regression coefficient for the variable 'betweenness centrality' is positive (in line with hypothesis HII 7), there is no statistical significance so that this result cannot be assumed to be safe. Therefore, hypothesis HII 7 is not supported. In their study, Hochberg, Ljungqvist and Lu (2007) also use betweenness centrality as independent variable to explain the financial performance of VCs. The authors find a highly significant positive relationship between these variables. Of course, one potential explanation could be that the authors used a different dependent variable, i.e., financial performance measured by successful exits. However, taking these results one step further, this could mean that deal flow quantity and financial performance are not connected. Therefore, it will be interesting to see whether the result for betweenness centrality in this study is positive and statistically significant in the case of deal flow quality. If this was the case, this could be an indication that deal flow quality and financial performance might be positively connected.

In contrast, and in line with theoretical predictions, higher scores in multiconnectivity have a positive effect on deal flow quantity. Recall that multiconnectivity is the point connectivity of an actor, and measures the number of nodes that would have to be removed in order for the focal actor to become disconnected from the network. The higher the score, the more nodes would have to be removed (on average) from the network in order for the focal firm to not be able to reach another firm. In other words, the measure indicates the extent to which a VC has multiple alternative options to receive information from other VCs, indicating that VCs with higher scores on multiconnectivity are less dependent on contacts to specific other VCs. The networks of those VCs are,

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748 The two other firms, of course, can still be connected by some path length, i.e., a path length greater than 2. The focus here though is on the notion of geodesic paths, i.e., the shortest connection between two nodes that go through the focal actor.


750 The measure is calculated for each actor in relation to each other actor, i.e., for the focal actor it is measured (vis-à-vis each other actor in the network), how many nodes would have to be removed for the focal actor not to be able to reach the other actor. The result of this algorithm is an actor-by-actor matrix. Taking the sum of each row then gives the sum of nodes that would have to be removed in order for one actor to become disconnected from the network.
overall, less vulnerable. The results for 'multiconnectivity' deliver support for hypothesis HII 9, which stated that higher scores in multiconnectivity will positively affect deal flow quantity. The absolute regression coefficient indicates that for a one unit increase in the multiconnectivity score, the average number of investment opportunities received from other firms in the network also increases by 14.986. While it is fairly difficult to assess what it means that one more node could be removed (this would be equal to a one unit increase),\textsuperscript{751} the standardized regression coefficient (0.255) shows that the explanatory power of 'multiconnectivity' is larger than that of any other variable.

The concrete implication for VCs is that, in order to augment their multiconnectivity (and thereby their deal flow quantity), they need to syndicate, above all, with different other VCs. Also in light of the result that the tie strength does not affect deal flow quantity, it is beneficial for VCs to invest with different other VCs, rather than to invest multiple times with the same other VC.

Looking at model 6 in comparison to model 1, the explained variance of deal flow quantity increased significantly from 12.0% (adjusted 6.8%) in model 1 to 18.3% (adjusted 12.4%) in model 6. Based on the adjusted $R^2$, the explained part of the variance of deal flow quantity has roughly doubled. The implications of these results are the following: For VCs, as was the case for the ego-network measures, it might make sense to not only focus on the traditionally looked-at measures such as the number of employees (in order to increase deal flow quantity), but to strongly take into account their embeddedness in the overall network structure of VCs.

Overall, when referring to the concept of social capital, also the overall embeddedness of a VC in the syndication network yields insights on the amount of social capital inherent in the network position. The higher the amount of social capital in the form of structural embeddedness in the overall network, the higher the deal flow quantity would be.

\textsuperscript{751} That it is difficult to assess is due to the fact that a network with many actors is a quite complex graph (see also the figure showing the main component of the syndication network). Removing one node directly triggers a 'chain reaction' of nodes becoming disconnected from the network, and with them being disconnected also leaving again others disconnected. Therefore, a one unit increase or decrease in the score on multiconnectivity is difficult to evaluate.
Discussion of the Results and Implications for Management and Research

7.1.2.3 Comparison of the Effects of the Independent Variables on Deal Flow Quantity

Models of both groups of network measures (ego-network measures and total network measures) deliver a similar explanatory power, with model 6 explaining slightly more of the variance in deal flow quantity compared to model 4 (adjusted $R^2$ of 12.4% in model 6 compared to an adjusted $R^2$ of 12.1% in model 4). In both models, 'employees' shows statistically and economically significant results. However, a significant increase of the explained part of the variance of deal flow quantity can be achieved by adding network measures to the model. Above all, having non-redundant syndication relationships, being connected (based on syndicated investments) to well-connected other VCs, and having invested with different other firms seem to be characteristics of a VC's network position, which is beneficial to generate deal flow quantity.

What might be an important result for future research is that, in this case, it is possible to explain nearly the same part of the variance of the dependent variable based on ego-network measures only. This implies that, it might not even be necessary to collect data on the entire network but that it might be sufficient to gather data on the ego-networks of the actors. This point, however, needs to be verified when looking at the explanatory power of ego-network measures vs. total network measures with respect to deal flow quality, following in the next sections.

7.1.3 Connection between Independent Variables and Deal Flow Quality

Analog to section 7.1.2, in this chapter, the effects of the firm attributes, of the ego-network measures, as well as of the total network measures on deal flow quality are discussed. Multiple regression models have been used to detect the influences of each variable on the explained variance of deal flow quality. The results of the regression analyses that have been reported in chapter six will now be discussed and interpreted in detail.
7.1.3.1   Effect of Firm Attributes and Ego-Network Measures on Deal Flow Quality

Examining the firm attributes, again, 'employees' is statistically significant in all models. The absolute regression coefficient, ranging between 0.100 (model 10) and 0.117 (model 8) is much lower compared to those in the regressions on deal flow quantity. However, this is due to the fact that deal flow quantity and quality are measured differently. While deal flow quantity is the absolute number of investment opportunities received from other firms in the network,\textsuperscript{752} deal flow quality is the same number but multiplied with the deal rate of the specific VC. The median of the deal flow quality measure is 0.9,\textsuperscript{753} which means that the typical number of investment opportunities received from other VCs and finally invested in, equals ~1. For a one unit increase in the number of employees (one more employee), the deal flow quality measure increases approximately by 0.1. In other words, one more employee leads to a ~10\% increase in the number of high-quality investment opportunities received from other VCs, which is a significant economic impact.

As to 'age', although the regression coefficients are statistically insignificant, they changed from showing a negative sign (in the regressions on deal flow quantity) to being slightly positive. That is, while in the case of deal flow quantity it seemed that the younger the firm, the more investment opportunities they receive (from other VCs), this does not seem to hold for deal flow quality anymore. For deal flow quality it seems that (if at all) the older the firm, the more high-quality deal proposals they receive. While it has to be kept in mind that (a) the results for 'age' are statistically not significant at the conventional levels, and that (b) the economic significance is fairly low, expressed by and absolute regression coefficient ranging between 0.01 (model 9) and 0.034 (model 10), these results indicate a general tendency that gives rise to a need for future research.

In further studies a focus could be to analyze the quantity and quality of deal flow of VCs in the German market as a function of their age or other indicators of a VC’s experience. In this context, also aspects such as the experience and professional background of the VC’s management team could be taken into account. What is noticeable though is the change of the sign in the light of the results that Hochberg, Ljungqvist and Lu (2007) have found. The authors found that a VC’s experience is positively related to its financial

\textsuperscript{752} Referring to the investment stages 'early stage' to 'later stage', excluding buyouts.

\textsuperscript{753} Refer back to section 6.3.1.2.
performance.\textsuperscript{754} While statistically not significant in the present study, this could indicate that deal flow quality and financial performance might be connected as well. Another indicator to answer this question will be the results for the regressions including betweenness centrality and deal flow quality, which are explained further below.

The variable 'offices' is statistically not significant in any of the models. However, interesting to notice is that the sign changed from positive (in all models on deal flow quantity) to negative (in all models on deal flow quality). Although statistically not significant, this general tendency could be an indicator that, while it might be beneficial to have more offices to generate deal flow quantity, it seems that it could be advantageous to have less offices in order to receive high-quality investment opportunities. Potentially, it might be more valuable for a VC, to have offices in the 'right' cities or regions, instead of just having more offices (for a higher deal flow quality). In future research it might therefore be worthwhile to look at the geographic distribution of the offices of the firms and to examine whether there are differences regarding deal flow quantity and deal flow quality.

With respect to 'deal flow measurement', results are positive in all models 7-10, but statistically significant only in models 7 and 10. The statistical non-significance in models 8 and 9 is due to the slight correlation with the (in these models) added variables 'tie strength' (model 8) and 'effective size' (model 9). Referring back to the correlation matrix, the correlation between 'deal flow measurement' and 'tie strength' and between 'deal flow measurement' and 'effective size' is nearly the same (0.175 vs. 0.176). Nevertheless, the results clearly imply that putting effort into a systematic measurement and tracking of deal flow might be a valuable undertaking in order to increase the number of high-quality investment opportunities received from other VCs.

Analyzing the ego-network measures, again, 'tie strength' does not show a statistically significant result. As was the case in the regressions on deal flow quantity, the regression coefficient is positive. In HII 2, it has been hypothesized, based on the theory on the strength of weak ties, that weak ties should also yield a higher deal flow quality. However, this hypothesis cannot be confirmed by the results. Quite the opposite, while

\textsuperscript{754} See Hochberg/Ljungqvist/Lu (2007), p. 271.
Discussion of the Results

not being statistically significant, the regression coefficient is positive, which weakly indicates a positive connection between tie strength and deal flow quality. That is, the theory on the benefits of weak ties does not seem to hold in the context of syndicated venture capital investments and deal flow. While the positive regression coefficient in both cases (deal flow quantity and quality) implies that it is rather the stronger ties that yield benefits in terms of deal flow quantity and quality, it remains to be seen whether the weakness/strength of ties at all is a good predictor when compared to the other independent variables.

As regards model 9, 'effective size' has been added to the base case model. The regression coefficient is positive and statistically significant ($p<0.05$). This again implies that having non-redundant syndication relationships to other firms seems to convey a significant competitive advantage in terms of receiving information on high-quality investment opportunities from other VCs. A one unit increase in an ego-network's effective size leads to an increase in the number of high-quality deal proposals received from other VCs of 0.129 (the median increases from 0.90 to 1.03). The economic significance is comparable to the one for the variable 'employees' (see above). An example from the VCs' syndication network illustrates this point once more:

![Ego-network for VC#384 and VC#265](image)

Figure 7.5: Ego-network for VC#384 and VC#265

Both VCs, VC#384 and VC#265, have invested with four other VCs. However, the effective size of VC#384 is $4 - (2/4) = 3.5$. Effective size for VC#265 is $4 - (12/4) = 1$. The value for deal flow quality for VC#384 is 2.2, while it is only 0.6 for VC#265. The

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755 Own calculation and illustration.
reason for the difference in effective size, of course, is that VC#265's direct syndication partners are also syndicating with each other. The chance that new information about high-quality investment opportunities enters the network in the case of a densely coupled network (VC#265) is lower than in the case, in which VC#384 has access to non-redundant other VCs that do not share investment relationships among each other.

This shows fairly well the impact of adding non-redundant contacts to an ego-network. Based on the results, hypothesis HII 4 is strongly supported, which stated that a larger effective size will positively affect deal flow quality. Overall, adding 'effective size' to the base case model, increases the explained variance of deal flow quality from 15.5% (adjusted 10.4%) in model 7 to 21.7% (adjusted 16.1%) in model 9. Because it has already been explained for the case of deal flow quantity, it will not be repeated in detail that these results extend current research in the academic discussion on the syndication network of VCs as well as on the effects of social capital on individual performance.756

As to model 10, in which 'constraint' has been added as independent variable, the results indicate that also 'constraint' affects the reception of high-quality investment opportunities. As expected, the regression coefficient is negative and statistically significant (p<0.05). That is, the higher the constraint that the relationship structure of the focal VC's direct contacts exerts on him, the lower the number of high-quality investment opportunities received from other VCs. The economic significance is difficult to assess only based on the absolute regression coefficient. However, the standardized coefficient indicates that the relative explanatory power of that variable is only slightly lower than the one for the variable 'employees' (see above). Since this is consistent with theoretical predictions and the derived hypothesis HII 6, this hypothesis is strongly confirmed.

Since the result shows the same direction and significance as in the case with deal flow quantity, the interpretation stays the same: In order for VC A to be less constrained by VC B, VC C (to whom A is also connected) needs to be well-connected. The following examples, taken from the VCs' syndication network, illustrate this point. Again, both focal VCs that are shown, i.e., VC#095 and VC#071, have two direct syndication contacts, however they differ significantly regarding their measure for constraint and

756 Refer to section 7.1.2.1.
Discussion of the Results

their measure for deal flow quality. This is due to the fact that their syndication partners themselves are connected differently:

Figure 7.6: Ego-network for VC#071 and ego-networks of its direct contacts\(^{757}\)

Figure 7.7: Ego-network for VC#095 and ego-networks of its direct contacts\(^{758}\)

The constraint for VC#071 is 0.72, the constraint for VC#095 is 0.55, which, as mentioned before, is a significant difference given that the measure ranges from 0 to 1. The deal flow quality for VC#071 is 0.2, while deal flow quality for VC#095 is 1.5. That

\(^{757}\) Own calculations and illustration.

\(^{758}\) Own calculations and illustration.
is, by being connected to well-connected others, a VC will benefit in terms of high-quality investment opportunities.

Again, as was the case for deal flow quantity, these results and the new interpretation of Burt’s measure are an extension of current research since they shed light on the question posed in the paper of Hochberg, Ljungqvist and Lu (2007), how VCs can form relationships with influential VCs.\textsuperscript{759}

The overall model 10 shows an $R^2$ of 21.0\% (adjusted 15.3\%), which is slightly lower than the explanatory power of model 9 (including 'effective size'). But still, the results represent a 5.5 percentage point increase in the explained part of the variance of deal flow quality based on the $R^2$.

Overall, drawing on the concept of social capital, it becomes obvious that the amount of social capital inherent in the structural network position of VCs is a relevant predictor of the VCs' deal flow quality. The more social capital a VC has based on its network position (effective size, constraint), the higher its deal flow quality. Therefore, VCs should aim at increasing their amount of social capital by analyzing their individual network structure and the network structure of their syndication partners. By doing this, and in terms of deal flow quality, VCs enable themselves to strategically monitor and influence their network position and thereby increase the number of high-quality investment opportunities.

\textbf{7.1.3.2 Effect of Firm Attributes and Total Network Measures on Deal Flow Quality}

Examining the results for the firm attributes in models 11 and 12, an already known picture is drawn. While 'employees' positively affects deal flow quality ($p<0.05$), none of the other firm attributes show statistical significance at the conventional levels. Again, while 'age' is slightly positively associated with deal flow quality, the slightly negative regression coefficients for 'offices' are statistically not significant in both models. This supports the conclusions for future research on this aspect, as already discussed above.

\textsuperscript{759} Refer to section 7.1.2.1.
The statistical insignificance of 'deal flow measurement' in models 11 and 12 can be explained by the slight correlations of this variable with 'betweenness centrality' (0.192) and 'multiconnectivity' (0.136).\textsuperscript{760}

As to model 11, it shows that adding 'betweenness centrality' to the model significantly increases the $R^2$ from 15.5\% (adjusted 10.4\%) in model 7 to 20.9\% (adjusted 15.1\%; $p<0.05$). According to theoretical predictions, this result implies that the embeddedness of VCs in the overall network structure in terms of betweenness centrality is important with respect to the reception of high-quality investment opportunities from other VCs. Firms that more often lie on the geodesic path connecting two other firms, seem to be able to (maybe unconsciously) benefit from that structural position by receiving more high-quality deal proposals. Hypothesis HII 8, which exactly predicted the empirical finding, is therefore confirmed. The absolute regression coefficient indicates that for a one unit increase in 'betweenness centrality', the number of high-quality investment opportunities received from other VCs increases from the median of 0.90 to ~1.31. To make it more concrete, what this finding implies for VCs, an example is provided.

However, since betweenness centrality is a total network measure, it is calculated based on all VCs in the network, i.e., for each VC, the algorithm counts the number of times that this VC lies on the geodesic path between any pair of two other VCs in the network. Since this cannot be made visible for the entire graph, a hypothetical example is chosen and it is only referred to the ego-network of the actors to illustrate the idea. Assume that VC A has previously invested one time each with firms B, C, D, and E (as in the example above). A is 'between' the pairs of actors that have not jointly invested, i.e., A is between (on the geodesic (shortest) path) BC and CD.\textsuperscript{761} That is, A’s score on betweenness centrality is 2 (case 1):

\textsuperscript{760} Refer back to the correlation matrix in section 6.3.2.3.

\textsuperscript{761} Assuming an undirected network, i.e., since here the ties are assumed to be symmetric, the equivalent other pairs (CB, DC) are not counted. Also, since A is not alone on the geodesic path between B and E, this is not counted.
Discussion of the Results and Implications for Management and Research

Now assume that A intends to jointly invest with firm F. Whether A's score on betweenness centrality increases through this joint investment, depends on the relationship structure F has with A's other direct contacts (B, C, D, E). If F has co-invested with B, C, D, and E, adding F as a new syndication contact would not increase A's betweenness centrality (case 2). But if the adding of F to the contact network of A through a joint investment puts A in the position to (more often than before adding F) be 'between' two other firms (case 3), then, as the regression results show, A will benefit from this position and will receive more high-quality investment opportunities from other VCs in the network. In case 3, adding contact F will put A between F and all other direct contacts of A, thereby increasing A's betweenness centrality from 2 to 6.

On the level of the ego-network, as presented in these hypothetical examples, this would imply that a VC A should only invest with those other VCs that are not also investing with A's other syndication partners. That result is not different from the one found for effective size. The difference for betweenness centrality is that the measure is calculated for the entire network structure. That means, in the overall network structure, VC A is in an advantaged position, the more often he lies on the shortest path between two other VCs. More concretely, the more often VC A would be the connecting link between other firms, the higher A is betweenness centrality and the higher A's deal flow quality.

Overall, based on a comparison of the values for $R^2$ of models 11 and 7, it becomes obvious that the adding of 'betweenness centrality' significantly increases the explained

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762 Own examples and illustration.

763 On the contrary, actually A's betweenness centrality would decrease from 2.0 to 1.17, since in case 2 there are more geodesic paths between BC and CD. This is because F was added to the network and also builds a geodesic path between BC and CD (and therefore lies on that geodesic path).
Discussion of the Results

part of the variance of deal flow quality (from 15.5% (adjusted 10.4%) to 20.9% (adjusted 15.1%)). This equals an increase of 5.4 (unadjusted) and 4.7 percentage points (adjusted) from model 7 to model 10.

Also, this result is significant in another context: Hochberg, Ljungqvist and Lu (2007) found that a VC’s betweenness centrality and its financial performance are positively connected. Since deal flow can be seen as an important prerequisite for the business model of VCs to function and because betweenness centrality and deal flow quality as well as betweenness centrality and financial performance are positively connected, this could indicate that also deal flow quality and financial performance are positively connected. The results and these implications also show that the present study represents an important step towards a better understanding of the VCs’ syndication network on the one hand, and of the key success factors of a VC’s business model on the other. If the conclusions as explained above are correct, better networked VCs will have a higher deal flow quality and a better financial performance. However, in order to verify this conclusion, further research is necessary.

Looking at model 12, the statistical and economic significance of adding 'multiconnectivity' as explanatory variable is even higher. The regression coefficient is positive and statistically significant, as hypothesized in HII 10. Therefore, HII 10 is strongly confirmed. The results imply that having a syndication network, which is invulnerable to the removal of nodes (taking away actors from the network) is beneficial for the reception of high-quality investment opportunities. Consider the following examples, which again, as in the case with betweenness centrality, are based on the limited structure of the ego-networks. Although the measure is calculated based on the entire network structure, this is being done for reasons of clearness. Assume that A has jointly invested one time each with firms B, C, D, and E (case 1 of the figure below).

---

Now suppose that firm D were removed from the network and compare what has changed for VCs A and B (case 2). A is still in direct contact with B, C, and D. Except for the fact that D is not part of the network anymore, A's network structure has not suffered. The situation is different for firm B. In case 1, for example, B could reach E via the contacts to A or via the contact to D. Now that D is not part of the network anymore, B can contact E only via A and is therefore fully dependent on A. B's network is therefore more vulnerable with respect to the removal of nodes than A's network is. Although this is a very simple example, for a larger and more complex network structure as that of the VCs' syndication network, the idea is the same. The results of the regression model therefore imply that syndication relationships should be established with \textit{different} other firms (instead of the same ones again and again). However, as could be shown before,\textsuperscript{766} syndicating with firms that have previously syndicated with all of the focal firm's other syndication partners (direct contacts), will reduce the ego-network's effective size. Therefore, in terms of multiconnectivity, it makes sense to syndicate with those other different firms that are well-connected to firms, the focal firm has not had previously invested with.

Overall, model 12 can best explain the variance of deal flow quality, expressed by an $R^2$ of 23.2\% (adjusted 17.6\%), being statistically significant at the level of $p<0.01$. In comparison to model 7 (base case), this is an increase in terms of $R^2$ of 7.7 (unadjusted) and 7.2 (adjusted) percentage points.

\textsuperscript{765} Own examples and illustration.

\textsuperscript{766} See the discussion of the results for 'effective size' on deal flow quality.
In summary, the models including total network measures can explain a significant part of the variance in deal flow quality. It became obvious that the embeddedness of a VC in the overall structure of the syndication network is important with respect to reception of high-quality investment opportunities.

Again, when relating the results to the concept of social capital, it becomes obvious that more social capital (in the form of embeddedness in the overall network structure) enables VCs to generate a higher deal flow quality. More precisely, the higher the value for betweenness centrality and the higher the value for multiconnectivity, the more social capital a VC has and the higher his deal flow quality will be. This shows, that the idea of social capital with its underlying theories is a relevant concept to explain the economic outcomes of VCs in terms of deal flow quality.

7.1.3.3 Comparison of the Effects of the Independent Variables on Deal Flow Quality

The models containing the ego-network measures and the ones containing the total network measures do not differ significantly in their explanatory power. While 'tie strength' does not have an effect on deal flow quality, the other network measures (effective size, constraint, betweenness centrality, multiconnectivity) show statistically and economically significant effects on the dependent variable. The standardized regression coefficients of those variables are fairly equally distributed, ranging from 0.239 to 0.283 (in absolute values).

Combining the results for ego-network measures and total network measures, the implications for VCs are clear: In order to receive more high-quality investment opportunities from other VCs in the network, syndication relationships should be established with firms that (a) are non-redundant to the own ego-network and thereby increase the ego-networks effective size, (b) do not constrain the focal firm with the structure of their relationships in the sense of that they are themselves well-connected to other VCs, (c) put the focal VC into positions located between other firms, and (d) represent different firms (different from the firms that has been invested with before).

For researchers, the results convey the following potential conclusions: While model 12, containing a total network measure, had the best fit ($R^2$ of 23.2%), model 9, containing an
ego-network measure, was also able to explain 21.7% of the variance of deal flow quality. That means, based on measuring the ego-network alone, an already significant part of the explanatory power that total network measures have, could be explained. While it might always be better to have data on an entire network, this shows that it might be valid to also just survey the ego-networks of actors and thereby be able to derive valid statements on the benefits of individual actor's network positions. The advantage lies in the fact that surveys on ego-networks might require much less effort in terms of data collection. However, when doing this, certainly more enhanced statistical methods and sampling techniques would be required, which is a cutting-edge topic in today's research on social network analysis.

7.1.4 Comparison of the Effects of the Independent Variables on Deal Flow Quantity and Quality

Comparing the results of the regressions with respect to deal flow quantity and quality, several aspects deserve accentuation, which relate (a) to the importance of the firm attributes, (b) to the importance of the network measures used, and (c) to the overall explanatory power of the models.

As to the firm attributes and as expected, the number of employees positively affects both, deal flow quantity and deal flow quality. While the age of the firms showed to be negatively associated with deal flow quantity, no statistically significant effect could be identified as regards deal flow quality. Nevertheless, the negative sign (as to deal flow quantity) disappeared in the regressions on deal flow quality, i.e., the regression coefficients turned slightly positive. This could be an indicator that, although younger firms might have more investment opportunities they can select from, it might be the older firms that have investment opportunities of higher quality.

As regards the variable 'offices', in the regressions on deal flow quantity a statistically insignificant but positive relation occurred. The sign of the regression coefficients turned into negative ones in all regressions on deal flow quality (although also statistically not significant at the conventional levels). Nevertheless, this could indicate that, intuitively, while more offices lead to a higher deal flow quantity, fewer offices lead to a higher deal flow quality. A potential explanation for this phenomenon could be that having offices in
Discussion of the Results

the 'right' places (cities or regions) might be better to identify high-quality investment opportunities compared to just having many offices. However, examining the effects of the geographic distribution of firm offices on the quantity and quality of deal flow would go beyond the scope of this study and therefore has to be left for future research. A possible approach for such a research effort would be to bring together data on the deal flow of VCs (quantity and quality) with data on where exactly the VC is located, i.e., in which cities the VC has offices.

With respect to the variable 'deal flow measurement', although in all models (on deal flow quantity and quality), the regression coefficients were positive, they were statistically significant in only three models (1.7,10; $p<0.05$). While this is too weak of a proof to conclude that 'deal flow measurement' is a good predictor of deal flow quantity and quality, the constantly positive signs and the significances, which often were slightly above the conventional level of $p<0.05$ roughly indicate that measuring deal flow systematically and, for example, tracing back from which sources investment opportunities came, in which also finally has been invested in, might be a worthwhile effort.

As to the ego-network measures and the total network measures, a very consistent picture is drawn when comparing their effects on deal flow quantity and quality. 'Tie strength' did not show to be a statistically significant predictor, neither for deal flow quantity nor for deal flow quality. Quite the opposite, while it was expected that 'tie strength' would negatively affect deal flow quantity and quality, the variable turned out to show statistically insignificant positive effects in both cases. A potential explanation for the positive signs could be that stronger ties convey trust and that this is needed as basis for exchanging information on deal proposals. However, overall the results indicate that it is not the strength/weakness of ties that influences deal flow quantity and quality. Rather, structural measures of network position have a stronger influence:

The variables 'effective size' and 'constraint' carry a clear message. When used, they showed to have statistically and economically significant effects on both, deal flow quantity and quality. The signs of the regression coefficients were as expected (positive for 'effective size', negative for 'constraint') so that no further comments on these variables are necessary at this point.
Of the total network measures, 'betweenness centrality' turned out to only affect deal flow quality. Nevertheless, the positive effect, especially on deal flow quality, was according to theoretical predictions. In contrast, 'multiconnectivity' showed the (expected) strong statistical and economical significance for deal flow quantity and quality. Also in this case, no further comments are required at this point.

Regarding the overall models, in which network measures have been used, all models are statistically significant except for models 2 and 5. As presented above, the explained portion of the variances in deal flow quantity and quality could significantly be increased using network measures as independent variables (except for when using 'tie strength'). Compared to the base cases (models 1 and 7), which had an $R^2$ of 12.0% (adjusted 6.8%) for deal flow quantity and of 15.5% (adjusted 10.4%) for deal flow quality, these values increased to 18.0% (adjusted 12.1%) for deal flow quantity and to 23.2% (adjusted 17.6%) for deal flow quality, when network measures were included.

7.1.5 Role Analysis

In the following sections, it is referred to the results for the role analysis as presented in chapter 6.3.5. Several regression models have been calculated, including the variables 'gatekeeper', 'consultant', and 'liaison'.

7.1.5.1 Effect of Roles on Deal Flow Quantity

Most strikingly, the only regression model that shows statistical significance overall, is model 13 which includes the variable 'gatekeeper'. Both other models that include 'consultant' and 'liaison' do neither show statistical significance overall, nor for the individual network measures. Recall what the variables measure: 'Gatekeeper' measures the extent to which a VC has syndicated with a member of his own subgroup and a member from a different subgroup. 'Consultant' measures the extent which a VC has co-invested with VCs that belong to one different subgroup and 'liaison' measures the extent to which a VC has syndication relationships with members from two different subgroups (himself belonging to a third different subgroup).
Discussion of the Results

The results for 'consultant' and 'liaison' imply that only syndicating with members of too many other subgroups does not increase deal flow quantity. Rather, a VC benefits from syndicating with members of his own subgroup, while at the same time having syndication relationships with a member of another subgroup. To put that into an example, what situations (if occurring more often) that do not increase deal flow quantity of VC B are (focal VC is VC B, ellipses indicating subgroup membership):

In contrast, the more often the following constellation of syndication relationships occurs, the higher the deal flow quantity for VC B:

Since the ellipses denote subgroup membership, and since the subgroups are set up based on the VCs' focus on industries and on investment stages, the results imply the following: Simply syndicating more often only with VCs from other subgroups (industry/stage

767 Own illustration.
768 Own illustration.
focus) does not increase deal flow quantity. But syndicating more often with VCs from the own subgroup and also syndicating with VCs from a different subgroup does increase deal flow quantity. That shows that, based on the categorization of the VCs, being positioned more often at the boundary of the own subgroup and having syndication relationships to the inside of the own subgroup and to other subgroups fosters the reception of information on investment opportunities. Based on these results, hypothesis HII 11 is confirmed, while HII 13 and HII 15 have to be rejected.

Now, there is one factor that could potentially have influenced this result: The effect could have appeared because it might just be helpful for a VC to co-invest with members from his own subgroup, and that syndicating with VCs from a different subgroup does not deliver any additional benefit. That is, since the measure 'gatekeeper' (in contrast to the other two measures 'consultant' and 'liaison') includes syndication relationships with VCs of the same subgroup (in the figure above it is the contact of VC B to VC C), the effect could just be due to the contact to VC C. To account for that effect, another role measure is being included that only counts the number of times that a VC is mediating a relationship within its own subgroup. The measure 'coordinator' has been presented earlier (again, VC B is the focal actor).769

![Coordinator](image)

Figure 7.12: Role of coordinator770

By including both, 'coordinator' and 'gatekeeper' in the regression model, it is possible to detect whether the syndication relationships to VCs of other subgroups are still important

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769 Refer back to section 3.4.5.3.
770 Own illustration.
for increasing deal flow quantity, or whether the positive effect is due to syndication contacts with members of the own subgroup alone. The results of the regression model are presented below:

<table>
<thead>
<tr>
<th>Model 16</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees</td>
<td>2.389 (0.204)</td>
</tr>
<tr>
<td>Age</td>
<td>-2.299 (-0.149)</td>
</tr>
<tr>
<td>Offices</td>
<td>-1.161 (-0.013)</td>
</tr>
<tr>
<td>Deal flow measurement</td>
<td>9.562 (0.110)</td>
</tr>
<tr>
<td>Coordinator</td>
<td>23.965 (0.261) *</td>
</tr>
<tr>
<td>Gatekeeper</td>
<td>31.669 (0.246) *</td>
</tr>
<tr>
<td>Constant</td>
<td>22.115</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.291**</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.231**</td>
</tr>
<tr>
<td>N</td>
<td>88</td>
</tr>
</tbody>
</table>

* $p<0.05$; test of significance based on 20,000 permutations
** $p<0.01$; test of significance based on 20,000 permutations
The standardized regression coefficient is presented in brackets

Table 7.3: Regression model for 'coordinator' vs. 'gatekeeper' on deal flow quantity

The results show that, while the overall model is highly significant ($p<0.01$), both measures, i.e., 'coordinator' and 'gatekeeper' xare statistically significant ($p<0.05$). The overall model also shows a significant increase of the explanatory power with an $R^2$ of 29.1% (adjusted 23.1%) compared to the base case model (model 1) with a statistically insignificant $R^2$ of 12.0% (adjusted 6.8%). Compared to all other models considered so far, model 13 is the one with the largest explanatory power. That is, the combination of being more often between two members within the own subgroup and at the same time syndicating with a member from a different subgroup should yield significant benefits in terms of deal flow quantity.

Probably one could say, more simply, that VCs should stick to co-investing with VCs that have the same foci (industry/stage), while at the same time they should also try to build links to other subgroups in order to receive new information on potential investment opportunities.

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771 The correlation between 'coordinator' and 'gatekeeper' is 0.434, so multicollinearity is not an issue and they can both be included in one regression model. Also, the collinearity between 'coordinator' and the firm attributes is low, ranging between 0.03 and 0.09.

772 Own calculations and illustration.
Summarizing, the results show that a larger amount of social capital in the form of relationships that span structural holes is highly beneficial for VCs in terms of deal flow quantity. The larger the amount of social capital, the higher the deal flow quantity will be.

7.1.5.2 Effect of Roles on Deal Flow Quality

The results for deal flow quality are similar to those for deal flow quantity, while the additional explanatory power for deal flow quantity was slightly higher. But still, the results imply that those VCs receive more high-quality investment opportunities, that do both, syndicating with members of the same subgroup, while at the same time co-investing with members of different subgroups. Analog to the analysis in the previous section, the additional effect of being in a gatekeeper position could also be due to simply more often syndicating with members of the own subgroup. To account for that effect and to determine whether it is more beneficial for a VC to build the link between members of the own subgroup (that is what 'coordinator' measures) or whether syndication contacts to members of other subgroups are more beneficial, both, 'coordinator' and 'gatekeeper' are included in the following regression model:

Table 7.4: Regression model for 'coordinator' vs. 'gatekeeper' on deal flow quality

773 Own calculations and illustration.
Discussion of the Results

As becomes obvious, the overall $R^2$ does not increase (21.4% unadjusted), but the adjusted $R^2$ decreases to 14.7% due to one more variable being included that has no additional explanatory effect, i.e., 'coordinator' statistically is not significant at the conventional levels. The variable 'gatekeeper' still is, which shows that, in order to increase deal flow quality, syndication contacts to members of other subgroups are vital. Simply spoken and analog to the implications for deal flow quantity: VCs should stick to syndicating with other VCs that belong to the same industry/stage subgroup, while at the same time it is vital to also co-invest with VCs that belong to a different subgroup, in order to increase the number of high-quality investment opportunities received. Based on these results, hypothesis HII 12 is confirmed, while HII 14 and HII 16 have to be rejected.

Overall, again, the amount of social capital in the form of relationships that represent a link to another subgroup (together with relationships into the own subgroup) has an effect on the economic outcome for the VCs. That is, the larger the amount of social capital in the form of syndication relationships described above, the higher the deal flow quality will be. An overview of the hypothesis, together with the empirical findings is presented below:

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Expected sign (hypothesis)</th>
<th>Observed sign (hypothesis), status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Deal flow quantity</td>
<td>Deal flow quality</td>
</tr>
<tr>
<td>Ego-network measures</td>
<td>Tie strength</td>
<td>- (HII 1)</td>
</tr>
<tr>
<td></td>
<td>Effective size</td>
<td>+ (HII 3)</td>
</tr>
<tr>
<td></td>
<td>Constraint</td>
<td>- (HII 5)</td>
</tr>
<tr>
<td>Total network measures</td>
<td>Betweenness centrality</td>
<td>+ (HII 7)</td>
</tr>
<tr>
<td></td>
<td>Multi-connectivity</td>
<td>+ (HII 9)</td>
</tr>
<tr>
<td>Role analysis</td>
<td>Gatekeeper</td>
<td>+ (HII 11)</td>
</tr>
<tr>
<td></td>
<td>Consultant</td>
<td>+ (HII 13)</td>
</tr>
<tr>
<td></td>
<td>Liaison</td>
<td>+ (HII 15)</td>
</tr>
</tbody>
</table>

= Hypothesis confirmed

Table 7.5: Hypotheses and results on network measures and deal flow

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774 Own illustration.
7.2 Summary of the Results

This study delivers valuable insights for the German venture capital market with respect to the VCs' contact network, their syndication network, and the generation of deal flow quantity and quality. In addition, the results and implications significantly contribute to the current academic discussions on the topics of syndicated venture capital investments, the deal flow quantity and quality as well as on the topic of social capital. In a theoretical sense, it became obvious that (a) social capital in the form of values and norms as underlying basis that makes exchange possible is prevalent in the VCs contact and syndication network, and that (b) social capital inherent in the network position of actors can explain differences in economic outcomes (deal flow quantity and quality).

While the contact network accounts for a significant portion of all investment opportunities received, above all, it delivers the high-quality investment opportunities. Analogously, with respect to the single sources within the contact network, the relationships to other VCs not only deliver the most investment opportunities, but they most notably deliver those ones that VCs often invest in.

With respect to the VCs' network position within the syndication network, several clear messages could be derived.

In contrast to theory, the number of times that a VC invests with another VC (average tie strength) does neither affect deal flow quantity nor deal flow quality. That is, for the number of investment opportunities received and also with respect to their quality, it is irrelevant whether VCs, on average, invest multiple times with the same other VCs or only once.

More important though is the VCs' embeddedness in the structure of syndication relationships in their direct neighborhood, and also their embeddedness in the overall network structure.

Regarding the relationship structure in their direct neighborhood, it is vital for a VC to syndicate with those that do not also syndicate with its other syndication partners. These non-redundant syndication contacts deliver the benefit of receiving new information. While having non-redundant syndication contacts is important to generate deal flow
quantity, it also increases deal flow quality, i.e., non-redundant syndication partners deliver high-quality investment opportunities. Also, within the relationship structure, it is important for a VC to have contacts to those other VCs that are themselves well-connected. This well-connectedness of syndication partners delivers both, a high deal flow quantity and quality. Bringing these two arguments together, the implication for VCs is that it is beneficial in terms of deal flow quantity and quality to invest with non-redundant contacts to other VCs that are themselves well-connected.

With respect to the VCs' embeddedness in the overall network structure, being in a network position that represents the link between to other firms is beneficial. However, this is only the case regarding deal flow quality. It is difficult for a VC to directly and consciously manage his betweenness in the overall network. A thorough analysis of an individual VC's position in the network would have to be performed in order to identify those other VCs that the focal VC would have to syndicate with in order to increase his betweenness and thereby augment his deal flow quality. Also, since in a previous study betweenness centrality and financial performance of a VC were found to be positively connected, this could be an indicator for a potentially positive relation between deal flow quality and financial performance. However, certainly this question can only be answered in future research.

In contrast, the message based on the results for multiconnectivity is clear: VCs need to invest with different other firms. This result supports the insignificance of the results for tie strength. It is not important how many times a VC invests with the same other VCs, but it is important to invest with different other VCs in order to get access to deal flow quantity and quality. The difference of this results as compared to the result regarding effective size is the following: The implication of the results for effective size are that it is beneficial in terms of deal flow to invest with those other VCs that do not invest with each other. In contrast, the notion of multiconnectivity neglects the idea whether the own syndication partners also syndicate with each other. Instead, the results for

775 Refer to section 7.1.2.1.
multiconnectivity emphasize that it is more beneficial for VCs to syndicate with different other VCs rather than multiple times with the same VC.

Additional insights could be derived by analyzing the different roles that VCs play with respect to subgroups based. Based on a classification regarding industry focus and focus on investment stages it could be shown that for both, deal flow quantity and quality, it is vital to be in a position that represents a link between members of the own subgroup and members of another subgroup. Thereby, VCs benefit in terms of information received on potential investment opportunities and they benefit from such structural positions because they receive more high-quality deals.

7.3 Implications for the Management of Venture Capital Firms

As could be shown in this study, the analysis of the VCs' syndication network delivers valuable insights on the ability of the firms to generate deal flow quantity and quality. Thereby, this study contributes to the current status of academic research on the syndication network of VCs. VCs need to be aware that the contact network (and also the syndication network) is of considerable importance for the identification of investment opportunities. However, besides several implications derived based on the results for the firm attributes, a general recommendation would be that VCs might want to put a stronger focus on the structural characteristics of their contact network, and especially on the question, how they are embedded in the local (ego-network) and the overall network structure (based on total network measures). This study revealed that, in order to generate deal flow quantity and quality, it is important (in a structural sense), (a) to whom the firms are connected to (based on syndicated investments), and (b) with whom the firms they have invested with, are themselves connected to (based on syndicated investments).

In the following, first, it is referred to implications derived based on the results for the general importance of the contact network. Then, concrete recommendations will be deduced based on the results for the firm attributes as well as for the network measures.
Implications for the Management of Venture Capital Firms

With respect to the number of investment opportunities that VCs receive from network contacts compared to those received unsolicited, it could be shown that both sources of deal flow approximately deliver 50%. That is, as regards deal flow quantity, there is no difference between the number of investment opportunities referred to the VC by a network contact and those received unsolicited. However, when taking deal flow quality into consideration, things are different. A much higher percentage of those investment opportunities gets financed that were received from a network contact (85%). For VCs, as discussed earlier, it is a trade-off decision between deal flow quantity and deal flow quality: On the one hand side, they need to have many investment opportunities so that they can select those ones that are most promising. On the other hand, a VC has limited capacity and resources to screen and evaluate investment opportunities for their quality. In the end though, considering both aspects, VCs should probably be more interested in increasing their deal flow quality because those deals are the ones they finally invest in. Bringing these thoughts together with the results referred to above, the implication for the management of VCs is clear: In order to increase deal flow quality, they should focus their resources on establishing and maintaining network contacts because they are the ones that deliver high-quality investment opportunities.

When considering the various potential groups within the contact network, the results also convey a clear message: The group that delivers the most and, in a qualitative sense, the best deal opportunities, are other VCs. Consequently, when concentrating their resources and capacity on establishing and maintaining network contacts, VCs should focus on other VCs. By doing so, VCs will not only increase the mere number of investment opportunities they receive, but, and this is even more important, they will increase the number of high-quality investment opportunities they receive.

With respect to the firm attributes, also several implications for the management of VCs can be derived. First, regarding the number of employees, the simple and clear message is that VCs need to hire more employees in order to increase their deal flow. This applies to both, deal flow quantity and quality. While this result is intuitive, the implication for VCs is significant: In contrast to, for example, marketing activities that only have an indirect impact on deal flow (VCs can control the marketing activities but not the actual reaction or response of potential founders and entrepreneurs to these activities), employing more
people that actively search for investment opportunities seems to be a much more direct approach to control and increase deal flow quantity and quality.

Regarding the age of the VC, a striking result was found that gives rise to further research. While the age of the VC was negatively associated with deal flow quantity, the sign changed into positive for deal flow quality (although statistically not significant for deal flow quality). This general tendency, i.e., that younger firms tend to have a higher deal flow quantity while older firms tend to have a higher deal flow quality, also carries a clear message, especially for younger VCs: In order to increase deal flow quality, they need to get into contact with those older VCs that have a similar investment focus. By doing this, the younger firms can potentially benefit from offers to syndicate, given to them by the older firms.

With respect to the number of offices, an interesting tendency could be observed: While statistically not significant at conventional levels, the sign of the regression coefficients changed from positive for deal flow quantity to negative for deal flow quality. This general tendency might indicate that, in order to generate deal flow quantity, it is beneficial to have many offices. In contrast, in order to increase deal flow quality, it might be beneficial to have less offices. The implication for the management of VCs could simply be that it is irrelevant in terms of deal flow quality, how many offices the VC has. Rather, it could be that it is much more important that the office(s) the VC has, need(s) to be in the 'right' locations. Again, however, in a statistical sense, these conclusions can only be assumed that need to be statistically verified in future research, analyzing the potential connection between the number and exact distribution of the offices of VCs and the respective deal flow quantity and quality.

As to the systematic measurement of deal flow, also a clear recommendation for the management of VCs can be derived. While the regression coefficients for this variable are consistently positive in all models, they are statistically significant only in several models on deal flow quality. Still, the general message is that it is beneficial for VCs, above all in terms of deal flow quality, to systematically track (a) how many investment opportunities they receive, (b) from which sources they received these investment opportunities, and (c) from which sources they received those investment opportunities they finally invest in. Of course, the logical recommendation then is that VCs do not only
track these information, but that they try to optimize their deal flow generating activities based on their findings.

On the level of the results for the network measures, several recommendations can be derived. First, in terms of ego-network measures, the strength of a syndication relationship, i.e., the number of times a VC syndicated with the same other VC, does not significantly affect the focal VC’s deal flow. While this applies to deal flow quantity and quality, the implication for the management of VCs is clear: When it comes to selecting syndication partners, and in order to increase deal flow quantity and quality, a VC’s focus should not be to co-invest with the same other VCs multiple times. Rather, a VC should focus on other structural characteristics, which will be referred to below.

With respect to the effective size of a VC’s ego-network, the implication for the management of VCs is obvious: In order to increase both, deal flow quantity and quality, it is important for VCs to syndicate with firms that represent non-redundant contacts. The non-redundancy of a new syndication partner is higher, the fewer of the focal firm's previous syndication partners the new partner also has invested with. More simply spoken, the recommendation to VCs is the following: Syndicate with those VCs that do not also co-invest with your other syndication partners. The result of this strategy to select syndication partners will be that the VC receives more new information on potential investment opportunities.

Another recommendation based on the ego-network measures is that joint investments should be entered with those firms, the relationship structure of which does not exert a constraint on the focal firm. More concretely, this means that it should ideally be syndicated with those firms that are themselves well-connected to many other VCs the focal firms has no syndication relationships with. The result of this strategy is that the focal VC is not constrained by single other VCs. In contrast, the chance that structural holes are spanned is higher, yielding benefits in terms of both, deal flow quantity and quality.

With respect to the embeddedness of VCs in the overall network structure (total network measures), also several clear implications can be derived. First, based on the results for the network measure betweenness centrality, the results show that those VCs have advantages in deal flow quality that more often sit 'between' two other VCs. The
Discussion of the Results and Implications for Management and Research

Recommendation to the management of a VC is that, in order to increase his deal flow quality, he first needs to identify his specific network position. Then, he needs to check, with which other VCs he has to syndicate with in order to more often get into network positions 'between' two other VCs. By being more often in such positions, the VC would strategically optimize his network position with the result that he should more often hear of high-quality investment opportunities.

As regards the multiconnectivity of a VC, it is important that he invests with different other VCs in order make himself independent of single other VCs within the network. Thereby, the VCs also makes himself invulnerable vis-à-vis the removal of nodes within the network, i.e., in other words, taking away syndication relationships does not severely affect the VC’s opportunities in terms of deal flow quantity and quality.

In addition, from a subgroup perspective (industry-/investment stage-allocation), it is beneficial for VCs to syndicate with other VCs from the own subgroup. However, in order to increase deal flow quantity and quality, a large part of the added value comes from syndication relationships with those other VCs that belong to a different subgroup. Therefore, the recommendation for VCs is to analyze their syndication network and determine, to which VCs from other subgroups it would make sense to co-invest with. VCs from other subgroups that it would make sense to invest with would be those that most likely hear of investment opportunities that meet the own investment criteria but that do not (or not entirely) meet theirs. While this final recommendation based on subgroups lacks practical concreteness, it is as concrete as it can be in a general sense. In order to derive more practical recommendations for individual VCs, i.e., with which other VC it would make sense to syndicate with, a thorough analysis of their individual network position with respect to syndicate with, a thorough analysis of their individual network position with respect to subgroups needs to be performed.

7.4 Implications for Research

In this section, two topics are addressed: First, it will be discussed how the present study fits into the stream of academic research. Also, it will be highlighted, which aspects of this study are equal to already existing research, which aspects are extensions, and what the learnings in a theoretical sense are. Second, it will be explained what the limitations
of the present study are and which potential questions can be identified for further research.

As became obvious in this study, by the help of formal methods of social network analysis, i.e., the consideration of the structure of a social system, statements can be derived on economic outcomes of the actors. This shows once more that the application of network analysis in the area of economics is a worthwhile effort that delivers valuable insights, which could not have been achieved by the mere analysis of actor attributes alone.

From a theoretical perspective, this study analyzes the benefits of network positions on the level of individual actors and is rooted in the argument that network openness (weak ties/structural holes) leads to advantages for the individual actors. Based on the typology of network studies developed in section 3.2.5.2, the analyses thereby clearly relate to explaining performance variation in the sense of deal flow quantity and quality. By focusing on the analysis of the structure of the syndication network and its connection to deal flow, the relational and the cognitive dimensions of social capital have largely been excluded.

When comparing this study to already existing research, several similarities can be found: Already in previous studies, the sources of deal flow have been analyzed. Also, however only in very few examples, the separation between deal flow quantity and quality has been addressed. While only in one study (Vater (2002)) this distinction is being clearly made (incl. partial measurement), in most studies (if at all) these dimensions are mentioned but not measured. In terms of network analysis, only few examples exist that examine the VCs’ syndication network. However, previous research focused on one or one group of network measures, namely centrality measures, but excluded other important dimensions of a network structure.

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776 Refer back to section 3.3.4.

777 The relational dimension has partially and indirectly been covered in this study by analyzing the general importance of the contact network for the generation of deal flow quantity and quality. However, the relational as well as the cognitive dimension could certainly be examined in much more detail, then drawing on aspects such as various forms of trust, sanctions, expectations, and obligations that exist among VCs in the market. Furthermore, topics in the cognitive dimension such as shared languages, codes, and narratives could be analyzed.
Therefore, this study is unique in several dimensions, thereby delivering valuable extensions to the present academic discussion: First, in this work two sets of data have been brought together, i.e., data on the syndication network and data on the deal flow quantity and quality as well as on firm attributes. Second, a clear separation has been made between the quantity and quality of deal flow, and both dimensions have been measured. Third, not only one aspect of network structure has been analyzed. In contrast to existing research, the VCs’ network structure has comprehensively been analyzed by looking separately at ego-network measures and total network measures. Fourth, this study is based on a theoretical framework, which, in the context of syndicated venture capital investments and deal flow quantity and quality, has not been applied before. Fifth, the study contributes to answering a concrete question posed by previous research in this area. Sixth, a role analysis has been performed to derive additional insights on the potential advantages that come from contacts to different subgroups.

In terms of learnings for theory and future research, various aspects deserve accentuation. First, as this study shows, it makes sense to distinguish between the quantity and quality of deal flow. This was indicated in previous research, however, only a few studies have attempted at all to measure both. Since quantity and quality of deal flow determine a VC's investments in portfolio companies, both dimensions have to be considered separately. As could be seen in this study, another reason for a necessary distinction is the fact that firm attributes as well as network measures yield differential effects for deal flow quantity and deal flow quality. Second, it obviously is reasonable to analyze ego-network measures and total network measures separately since they capture different aspects of the network structure. While ego-network measures look at the local network structure, total network measures characterize the actor's embeddedness in the entire network. Third, based on this study's finding that the analysis of ego-network measures already could explain a fairly large part of the variance of the dependent variables, it has to be thought about whether it makes sense to not collect data on the entire network but to just survey the ego-networks of the actors. If it is possible to derive statements based on the ego-network structure that are also valid for the full network, studying ego-networks might imply significantly less data collection effort as compared to analyzing entire networks. However, following this approach would certainly entail to make use of more sophisticated statistical methods, referring to sampling and modeling techniques.
Based on the present study, several limitations have to be mentioned. First, this study focuses on the German venture capital market only. This selection has been made for two reasons: First, the data available on investments in portfolio companies does not allow for an individual matching of VCs and portfolio companies, as explained in section 5.1.1.2.1. Second, from the authors' perspective, since the field of social capital research is developing rapidly, it is better to sharply focus the study on a certain geographic area to exclude unobservable effects due to international differences. Based on this argument, derived conclusions gain in objectivity and impact. Second, this study focuses on venture capital investments only. While this is certainly a limitation, other investment types such as buyout investments needed to be excluded because the deal flow generation process is supposedly different from the one with regard to venture capital investments. Third, the time period considered ranges from 1998-2005. During this time, the German venture capital market has experienced a fairly volatile development. However, due to several reasons, this selection had to be made and represents a valid basis for analysis: In order to derive valid conclusions based on a network analysis, a long enough time period needs to be considered. In addition, the German venture capital market took up speed especially from 1998 onwards. Before that time, venture capital investments in Germany lagged behind those in other regions such as the UK or the US.

Another limitation is that the study does not measure the relationships between VCs on the level of individuals. However, it appeared that there is no systematic way how to capture the personal relationships in the venture capital industry. This certainly represents an area for future research.

With respect to future research, several concrete questions can be derived that might deliver further valuable insights. One question relates to the relationship between the VCs' age and its deal flow quantity and quality. Although statistically only partially significant in this study, the results indicate the tendency that age might be negatively associated with deal flow quantity, and positively related to deal flow quality. Future research could take up this aspect and try to examine the exact determinants of this relationship.

778 Hochberg/Ljungqvist/Lu (2007) faced the same challenge and chose the same approach as applied in the present paper.
Another question refers to the number of offices and the relation of this variable to deal flow quantity and quality. The results of this study show the tendency that, while having more offices leads to a higher deal flow quantity, having fewer offices leads to a higher deal flow quality. In future research this contradictory phenomenon might be explored in more detail. In addition to the mere number of offices, it could be analyzed from a geographical perspective, whether their location is associated with the VCs’ deal flow quantity and quality.

Furthermore, another field of research in the given context could be an even more detailed analysis of the subgroups of VCs. Here, aspects such as hierarchies within a network structure or the belonging to certain cliques could be approaches that might deliver valuable insights on deal flow quantity and quality. However, since this topic actually is an own and extensive area within social network analysis, only one aspect of this interesting field has been covered in the present study.

There are also more general research questions that can be derived as basis for future research. In this study it could be shown that the position of VCs in the syndication network can explain a certain portion of the variance in deal flow quantity and quality. Logical next questions include the following: First, it might be asked what efforts and activities are being performed by VCs that bring them into the network position they hold. The actual question being asked in this context would be with which activities VCs actually try to 'invest' in their social capital and whether these investments lead to advantageous positions within the syndication network. Also relevant in this context would be the question what the optimal size of a VC’s ego-network would be, since establishing and maintaining a contact network also implies costs.

Second, it could be interesting to analyze, to what extent and in what dimensions VCs, which hold comparable network positions, are similar. This would be classical study in the research area of homophily. Relevant questions in this context could be whether VCs that focus on the same industries are also similar in terms of network measures (for example betweenness centrality). Another example would be whether VCs, the offices of which are located in the same city or region also tend to invest with each other. Third, it could be examined, whether and to what extent network measures are also able to explain the economic success of VCs. A challenge in this context would certainly be the
collection of reliable data on the economic success of the firms because, understandably, VCs are fairly hesitant in disclosing such information. Fourth, since the relational (partially) and the cognitive dimension of social capital have been excluded within the present study, these could be aspects to be highlighted in future research. In this context, for example the aspects of shared languages, codes, and narratives could be the basis for analyses. Fifth, research effort could be spent on developing a standardized 'tool' that allows the systematic identification of VCs, the contact to whom would improve the focal firm's network position with respect to deal flow quantity and quality. Sixth, since this study focuses on the German venture capital market, it would be interesting to analyze whether similar results can be found for other regions such as other European countries (for example the UK or France) or for the US.
Summary of the Study

This dissertation represents a thorough empirical study on the importance of the VCs' contact and syndication network and of the VCs' network position for the generation of deal flow quantity and quality. The objective of the study was two-fold: (a) Evaluation of the importance of the general contact network and of the VCs' syndication network for the generation of deal flow quantity and quality. (b) Analysis of the individual VCs' network position within the syndication network, and determination of the effect of network position on the VCs' deal flow quantity and quality.

In order to accomplish these goals, in chapter two an overview has been presented of the topics of venture capital and deal flow. It could be shown that there is a considerable stock of uninvested capital in the German venture capital market, and that one challenge for VCs to overcome is to identify promising investment opportunities.

In chapter three, the theoretical foundation for this study has been laid out. In contrast to the theories commonly applied to financial markets, social network analysis and the concept of social capital including its underlying theories represent a sound basis to analyze the benefits of networks in general, and to examine the benefits of individual actor's network positions in specific. Based on the theories on the trust in the prevalence of norms, the theory on the strength of weak ties, and the theory on structural holes, theoretically founded implications for the importance of the VCs' network and network position could be derived. In the last section of this chapter, a research design has been set up, reflecting the two goals of the study as well as the theoretically derived implications.

In chapter four, these theoretically derived implications have been formulated in specific hypotheses, which are categorized according to the two goals: Six hypotheses refer to goal (a), i.e., to the examination of the general contact network and of the VCs' syndication network for the generation of deal flow quantity and quality. 16 hypotheses relate to goal (b), i.e., the analysis of the individual VCs' position within the syndication network and its effects on deal flow quantity and quality. Within the 16 hypotheses, the last six refer to the potential benefits that VCs might have based on playing certain roles with respect to linking subgroups of VCs in the network.
Chapter five contains a description of the data used, the data collection process, as well as of the methods applied in this study.

While in chapter six the descriptive statistics and the results of the regressions have been reported and described, in chapter seven these results have been discussed and interpreted. According to the two goals, first, the importance of the general contact network and of the VCs’ syndication network for the generation of deal flow quantity and quality has been evaluated. Second, the VCs’ network position within the syndication network has been thoroughly analyzed, and the effects of the network position on deal flow quantity and quality have been detected. Also, a role analysis with respect to subgroups of VCs has been performed.

In addition, several concrete and practical implications for the management of VCs and for future research have been derived. In addition, the limitations of this study have been discussed. Based on the implications, (a) VCs are able to improve their deal flow quantity and, above all, their deal flow quality, and (b) scientists in the field of network analysis and entrepreneurial research are provided concrete ideas for future research.

Based on existing work in this field, the present study significantly contributes to the research on syndicated venture capital investments, the topic of deal flow quantity and quality as well as to the discussion on the benefits of social capital inherent in social network structures.
Appendix

Questionnaire of the empirical study
Hintergrund der Forschungsarbeit

"Die Bedeutung des Kontaktnetzwerks für den Deal Flow von Beteiligungskapitalgesellschaften"

Eine wesentliche Voraussetzung für die Geschäftstätigkeit von Beteiligungskapitalgesellschaften (BKG) ist die Schaffung eines stetigen Stroms qualitativ hochwertiger Beteiligungsgelegenheiten (Beteiligungsanträge bzw. Deal Flow).

Beteiligungsanträge können BKG aus unterschiedlichen Quellen erreichen: Zum einen als Fremdzuschrift des Kapital suchenden Unternehmens, zum anderen durch eine Information oder Empfehlung eines Kontakts aus dem Netzwerk der BKG (beruflicher oder privater Kontakt).

In zahlreichen wissenschaftlichen Studien und empirischen Umfragen wurde gezeigt, dass das Netzwerk der BKG eine wichtige Rolle für die Generierung von Deal Flow, d.h. die Identifikation von Beteiligungsanträgen spielt.


Hinweise zum Inhalt und zum Ausfüllen des Fragebogens

áticas zur Verfügung. Er ist telefonisch unter +49 175 318 7190 erreichbar.

Bitte senden Sie den ausgefüllten Fragebogen per Fax an +49 221 208 7191 oder per Post an: Prof. Malte Brettel (z. Hd. Ingo Böhner), RWTH Aachen, Lehrstuhl WIN, Templergraben 64, 52062 Aachen

Vielen Dank für Ihre Unterstützung!
Teil 1: Angaben zum Deal Flow Ihrer Gesellschaft

**Deal Flow:** Strom an Investitions- bzw. Beteiligungsgelegenheiten. Beteiligungsanträge von Kapital suchenden Personen oder Unternehmen.

*"Alle" Investitionsgelegenheiten:* Anzahl aller Beteiligungsanträge, die Ihre Gesellschaft initial zur Auswahl hat, bevor eine Selektion oder Beurteilung (Due Diligence) stattfindet.

**Fremdzuschriften:** Beteiligungsanträge, die Ihnen von Kapital suchenden Firmen unauflauffordert zugesandt werden bzw. die Sie nicht über einen Kontakt aus Ihrem Netzwerk identifiziert haben.

**Netzwerk:** Gesamtheit der Kontakte, d.h. private Kontakte wie z.B. Familie oder Freunde und berufliche Kontakte wie z.B. Kontakte zu anderen BKG, Banken, Rechtsanwälten, Steuerberatern, etc.

<table>
<thead>
<tr>
<th>1a. Durchschnittliche Anzahl aller Investitionsgelegenheiten bzw. Beteiligungsanträge, die an Ihre Gesellschaft pro Jahr herangetragen wurden</th>
<th>O/Jahr ca.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1b. Von dieser Anzahl (nicht Volumen) entfielen im Durchschnitt auf…</td>
<td>ca</td>
</tr>
<tr>
<td>-…Early Stage, Expansion, Later Stage (inkl. Seed, Start-up, First-Third Stage)</td>
<td>%</td>
</tr>
<tr>
<td>-…Buyouts (inkl. MBO, MBI, LBO)</td>
<td>%</td>
</tr>
<tr>
<td>Σ</td>
<td>100 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Welchen Anteil aller Beteiligungsanträge, die an Ihre Gesellschaft herangetragen wurden, erhielten Sie ursprünglich…</th>
<th>ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>-…über einen Kontakt aus Ihrem Netzwerk (z.B. Information von anderen BKG oder Geschäftsfreunden, Angebote zur Syndizierung, etc.)?</td>
<td>%</td>
</tr>
<tr>
<td>-…als Fremdzuschrift (unauflauffordert durch das Kapital suchende Unternehmen)</td>
<td>%</td>
</tr>
<tr>
<td>Σ</td>
<td>100 %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. Die Beteiligungsanträge, die über einen Kontakt aus Ihrem Netzwerk an Ihre Gesellschaft herangetragen wurden, stammten aus folgenden Quellen:</th>
<th>ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Andere BKG (Geschäftsfreunde in anderen VC- bzw. PE-Gesellschaften)*</td>
<td>%</td>
</tr>
<tr>
<td>- Universitäten/Forschungseinrichtungen</td>
<td>%</td>
</tr>
<tr>
<td>- Banken/Investmentbanken</td>
<td>%</td>
</tr>
<tr>
<td>- Private Kontakte (ausschl. privat (Familie/Freunde), keine sog. 'Geschäftsfreunde')</td>
<td>%</td>
</tr>
<tr>
<td>- Sonstige Kontakte (bitte spezifizieren):</td>
<td>%</td>
</tr>
<tr>
<td>Σ</td>
<td>100 %</td>
</tr>
</tbody>
</table>

* Inkl. erhaltener Einladungen zur Syndizierung (Co-Investment)

<table>
<thead>
<tr>
<th>4. In wieviel Prozent aller Investitionsgelegenheiten bzw. Beteiligungsanträge, die an Ihre Gesellschaft herangetragen wurden, …</th>
<th>ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a. …waren Ihre grundsätzlichen Anforderungen für Investitionen hinsichtlich Branchen-, Finanzierungsphasen und geographischem Fokus erfüllt?</td>
<td>%</td>
</tr>
<tr>
<td>4b. …hat Ihre Gesellschaft ein Investitionsangebot gemacht (d.h. Kriterien aus Frage 4a sowie alle weiteren (Qualitäts-)Anforderungen an Investitionen waren erfüllt)?</td>
<td>%</td>
</tr>
<tr>
<td>4c. …hat Ihre Gesellschaft letztlich tatsächlich investiert?</td>
<td>%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5. Von den Investitionsgelegenheiten, in die Ihre Gesellschaft tatsächlich investiert hat, entfielen im Durchschnitt auf…</th>
<th>ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>-…Early Stage, Expansion, Later Stage (inkl. Seed, Start-up, First-Third Stage)</td>
<td>%</td>
</tr>
<tr>
<td>-…Buyouts (inkl. MBO, MBI, LBO)</td>
<td>%</td>
</tr>
<tr>
<td>Σ</td>
<td>100 %</td>
</tr>
</tbody>
</table>
1998-2005

<table>
<thead>
<tr>
<th>6. In wieviel Prozent der Investitionsgelegenheiten, in die Ihre Gesellschaft <strong>tatsächlich investiert</strong> hat, war Ihre Gesellschaft…</th>
</tr>
</thead>
<tbody>
<tr>
<td>- …alleiniger Investor (keine Syndizierung)</td>
</tr>
<tr>
<td>- …Lead- oder Co-Investor (syndiziertes Investment)</td>
</tr>
<tr>
<td>ca. %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7. Welchen Anteil der Beteiligungsanträge, in die Ihre Gesellschaft <strong>tatsächlich investierte</strong>, erhielten Sie ursprünglich…</th>
</tr>
</thead>
<tbody>
<tr>
<td>- …über einen Kontakt aus Ihrem Netzwerk (z.B. Informationen von anderen BKG oder Geschäftsfreunden, Angebote zur Syndizierung, etc.)</td>
</tr>
<tr>
<td>- …als Fremdzuschrift (unaufgefordert durch das Kapital suchende Unternehmen)</td>
</tr>
<tr>
<td>ca. %</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8. Die Beteiligungsanträge, die <strong>über einen Kontakt aus Ihrem Netzwerk</strong> an Ihre Gesellschaft herangetragen wurden <strong>und</strong> in die sie <strong>tatsächlich investierte</strong>, stammten aus folgenden <strong>Quellen</strong>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Andere BKG (z.B. Geschäftsfreunde in anderen VC- bzw. PE-Gesellschaften)*</td>
</tr>
<tr>
<td>- Universitäten/Forschungseinrichtungen</td>
</tr>
<tr>
<td>- Banken/Investmentbanken</td>
</tr>
<tr>
<td>- Private Kontakte (ausschl. privat (Familie/Freunde, keine sog. Geschäftsfreunde)</td>
</tr>
<tr>
<td>- Sonstige Kontakte (bitte spezifizieren):</td>
</tr>
<tr>
<td>ca. %</td>
</tr>
</tbody>
</table>

* Inkl. erhaltener Einladungen zur Syndizierung (Co-Investment)

<table>
<thead>
<tr>
<th>9. Existiert in Ihrer Gesellschaft eine <strong>systematische</strong> bzw. <strong>standardisierte Erfassung des Deal Flow?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>9a. Erfassung der <strong>Anzahl</strong> der Investitionsgelegenheiten, die an Ihre Gesellschaft herangetragen werden</td>
</tr>
<tr>
<td>9b. Zuordnung <strong>aller</strong> erhaltenen Investitionsgelegenheiten bzw. Beteiligungsanträge zu ihren <strong>ursprünglichen</strong> Deal Flow Quellen</td>
</tr>
<tr>
<td>9c. Zuordnung der letztlich <strong>getätigten Investitionen</strong> zu ihren <strong>ursprünglichen</strong> Deal Flow Quellen</td>
</tr>
<tr>
<td>Ja</td>
</tr>
</tbody>
</table>
## Teil 2: Generelle Angaben zu Ihrer Gesellschaft

<table>
<thead>
<tr>
<th>10. Bitte geben Sie das <strong>Gründungsjahr</strong> Ihrer Gesellschaft an. (Format: JJJJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>11. Bitte geben Sie die <strong>durchschnittliche Anzahl der Mitarbeiter</strong> Ihrer Gesellschaft an (nur Deutschland, nur Professionals, kein Support). im Ø ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998-2005</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12. Bitte geben Sie an, wie die <strong>durchschnittliche Nettorendite für Ihre Investoren (IRR)</strong> in etwa ausfiel.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5%</td>
</tr>
<tr>
<td>1998-2005</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13. In wie viel Prozent <strong>aller syndizierten Investitionen</strong> (Co-Investitionen), an denen Ihre Gesellschaft <strong>beteiligt war</strong>, hat Ihre Gesellschaft…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998-2005</td>
</tr>
<tr>
<td>- …die „Einladung“ zur Syndizierung an andere BKG ausgegeben</td>
</tr>
<tr>
<td>- …die „Einladung“ zur Syndizierung von anderen BKG erhalten</td>
</tr>
<tr>
<td>Σ</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>14. In wie viel Prozent <strong>aller syndizierten Investitionen</strong> (Co-Investitionen), an denen Ihre Gesellschaft <strong>beteiligt war</strong>, war Ihre Gesellschaft…</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998-2005</td>
</tr>
<tr>
<td>- …Lead-Investor</td>
</tr>
<tr>
<td>- …Co-Investor</td>
</tr>
<tr>
<td>Σ</td>
</tr>
</tbody>
</table>

<table>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>15a. Durchschnittliches Fondsvolumen (insgesamt zur Verfügung stehendes Kapital, in Mio. EUR)</td>
</tr>
<tr>
<td>1998-2005</td>
</tr>
<tr>
<td>ca</td>
</tr>
<tr>
<td>15b. Durchschnittlich investiertes Kapital (in Mio. EUR)</td>
</tr>
<tr>
<td>ca</td>
</tr>
<tr>
<td>15c. Durchschnittliche Anzahl Portfoliounternehmen</td>
</tr>
<tr>
<td>ca</td>
</tr>
<tr>
<td>15d. Anzahl Büros in Deutschland</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>16. Bitte geben Sie an, auf welche <strong>Finanzierungsphase</strong> sich Ihre Gesellschaft fokussiert. (Zutreffendes bitte ankreuzen)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed/Start-up</td>
</tr>
<tr>
<td>ca</td>
</tr>
</tbody>
</table>

Unsere Gesellschaft strebt keinen Schwerpunkt in einer bestimmten Finanzierungsphase an
17. Bitte geben Sie an, auf welche **Branche** sich Ihre Gesellschaft fokussiert.
(Zutreffendes bitte ankreuzen)

<table>
<thead>
<tr>
<th>Maschinen-/ Anlagenbau</th>
<th>Chemie/ Werkstoffe related</th>
<th>Computer- Kommunik.- Bio- technologien technologie</th>
<th>Nahrung/ Medizin</th>
<th>Verkehr/ Logistik</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Handel/ Konsumgüter</th>
<th>Elektro- Finanz- Sonstige</th>
<th>technik   dienstleist.</th>
<th></th>
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</tbody>
</table>

Unsere Gesellschaft strebt keinen Schwerpunkt in einer bestimmten Branch an.

18. Bitte geben Sie an, welcher **Anteil des investierten Kapitals** Ihrer Gesellschaft…

<table>
<thead>
<tr>
<th>- …in deutsche Portfoliounternehmen investiert wurde</th>
<th>1998-2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>ca</td>
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<td>Σ</td>
<td>100 %</td>
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</tbody>
</table>

19. Wie **zufrieden** sind Sie hinsichtlich der **Entwicklung des wirtschaftlichen Erfolgs** Ihrer Gesellschaft im Zeitraum 1998-2005 gegenüber…

<table>
<thead>
<tr>
<th>1= Gar nicht zufrieden</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7= Sehr zufrieden</th>
</tr>
</thead>
<tbody>
<tr>
<td>19a. …Ihren Erwartungen</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>19b. …der Entwicklung von Wettbewerbern</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Vielen Dank für Ihre Unterstützung!**

Sofern Sie an den Ergebnissen dieser Studie interessiert sind, geben Sie bitte hier Ihren Namen, Ihre E-Mail Adresse und Ihre Telefonnummer an:

Vorname:  
Nachname:

E-mail Adresse:

Telefon-Nr.:
Bibliography


Bibliography


Bibliography


Bibliography


Bibliography


Bibliography


World Bank (2005), World Development Indicators Database, The World Bank.


Bibliography


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