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Unravelling cohort effects in consumption of living space by German households

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ABSTRACT

In recent decades, both mean dwelling sizes and per-capita living space have significantly increased worldwide. With dwelling size being the main determinant of private households' residential energy demand, these increases are major drivers of residential energy consumption. This article quantitatively analyses housing consumption in order to gain a better understanding of the factors behind risen dwelling sizes and per-capita living space. One of its focuses is on the differences between year-of-birth cohorts. We analysed data from the German Socio-Economic Panel (SOEP), using descriptive and econometric analyses. The results show that after controlling for covariates such as wealth, household size and age, more recent birth cohorts consume significantly more per-capita living space than previous cohorts. Although significant, cohort differences appear to be declining. This cohort effect, which goes beyond wealth accumulation and changing household structures, is primarily caused by heightened space expectations. It is accompanied by an increasingly unequal distribution of per-capita living space within cohorts in West Germany.

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Introduction

In recent decades, dwelling sizes and per-capita living space have increased significantly in most countries throughout the world (Ellsworth-Krebs, 2019) and in particular in Germany, where they have reached a high in 2021 (47.7 m^2) (Federal Statistical Office, 2022). Ever greater dwelling sizes and per-capita living space have various implications for sustainable urban development (McKinlay *et al.*, 2019), which have been addressed by several research disciplines.

Frequently studied and discussed in this context are the environmental impacts of the consumption of living space. With size of living space being the main determinant of a household's residential energy demand (Huebner & Shipworth, 2017), the increase of per-capita living space is a major driver of residential energy consumption (Lorek & Spangenberg, 2019). The rise in living space per capita, especially

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in wealthy countries, is cancelling out energy savings gained as a result of more energy-efficient construction methods and greener regulations (Clune *et al.*, 2012; Viggers *et al.*, 2017; Wilson & Boehland, 2005).

In order to make wise decisions in view of limited resources and the goals of climate change mitigation, researchers therefore call for per-capita living space in high-income countries, which is substantially higher than that typically found in developing countries, to stabilize at current levels (Grubler *et al.*, 2018) or even decrease (Cohen, 2021; Lorek & Spangenberg, 2019). Discussions about the issue of how much living space is enough are thus conducted under the keyword of sufficiency and space justice. Space justice refers to the equality of distribution of living space which is under threat owing to overcrowding problems for some segments of the population, even in high-income countries where per-capita living space is increasing overall. Hence, promoting a universal paradigm of 'less is more' with regard to living space would be an inadequate oversimplification of the issue and fails to offer a genuine solution for what is a more complex problem.

This applies in particular because housing is not just a consumer good, but also a financial asset. Consequently, a body of research and discussion in economics centres the development of homeownership rates, as it is closely linked to the distribution of wealth. In the advanced economies, young adults recently face challenges in homeownership access and might have worse housing as well as economic outcomes in later life, since homeownership constitutes an essential element in life-cycle investment strategies of individuals (for example Arundel, 2017; Arundel & Doling, 2017; Howard, 2025; Smith *et al.*, 2022). Accordingly, housing studies analysing this issue emphasize economic and social implications of housing rather than the ecological ones for sustainable development.

Dealing with an increasing consumption of living space confronts policymakers with complex problems. In order to identify possible starting points for action, it seems necessary to first understand the factors influencing the consumption of living space as thoroughly as possible. This article therefore analyses the drivers of, and barriers to, the consumption of living space.

An emphasis of our article is on differences between birth cohorts because these appear to be crucial in order to better anticipate future developments. We wonder whether housing research's prevailing perspective on housing in the advanced economies as on object of inter-generational inequality, which can be broken down to 'previous cohorts have had it better than recent cohorts', also applies to the consumption of living space. Concurrently, we aim to investigate intra-generational divergences in the allocation of living space as well, linking our analysis to discourses on space justice.

We focus on Germany, which once proclaimed itself to have a pioneering role in global climate change mitigation under the banner of energy transition, but is now falling behind in this respect, and is in need of new levers to further reduce energy consumption. Private households and their patterns of domestic energy consumption – and thus their consumption of living space – may be key in this context. At the same time, previously mentioned inter-generational divergences are prevalent in Germany (Dustmann *et al.*, 2022; Dewilde, 2020). We will therefore, on the one hand, interpret the results with regard to the environmental footprint of the household sector. On the other hand, we will also take the socio-economic implications into account when interpreting our analysis.

The following section reviews the existing literature on factors influencing the consumption of living space and differences in housing consumption between cohorts. It also yields the principal research questions. We then go on to describe the methods and data on which the analysis was based. Finally, we present and discuss the results.

Theory, German housing context and research questions

Literature review

Previous research has identified demographic change as a key driver of housing consumption. Household sizes have been shrinking globally for decades (Bradbury *et al.*, 2014). As household members share space, declining household sizes lead to higher levels of per-capita living space. Amongst drivers of this trend are falling birth rates (Bongaarts, 2001; Ivanova & Büchs, 2022), increasingly high standards of living (Keilman, 2003), and a liberalization from norms, including women's emancipation (Lesthaeghe, 1995; Verdon, 1998). In addition, ageing populations further drive shrinking household sizes. On the one hand, this is because they lead to children not living with their parents (or vice versa) for a longer period of time – during this period, they predominantly form small (single or two-person) households. On the other hand, it is caused by the lower life expectancy of men, in combination with age differences between spouses often resulting in widows remaining in large dwellings for a longer period of time (Keilman, 2003).

The influence of demographics on the consumption of living space has also been a matter for research within housing economics. Pitkin & Myers (1994) emphasize the importance of distinguishing age and cohort effects when studying housing consumption: age effects encompass all the effects that explain how the consumption of living space develops over the course of one's life regardless of the year of birth – i.e. independently of cohort membership. Cohort effects, on the other hand, explain why different cohorts behave differently when they reach the same age.

Green & Lee (2016) show, that socio-economics (such as income, wealth accumulation and education) affect living space consumption of households as well as inter-generational divergences.

Another factor influencing housing consumption is tenure status. Owner-occupiers often live in single-family houses, which typically have larger floor areas than rental apartments (Deschermeier & Henger, 2015; Weber, 2020). Moreover, owners tend to be less willing to move, which leads to high levels of per-capita living space, especially in old age, when couples or widowed persons remain in large family dwellings (Karlen *et al.*, 2022; Robison & Moen, 2000; Zimmerli, 2016).

Owing to their high levels of per-capita living space, the willingness of older people to move is the focus of various studies. In general, strong attachment to the home and neighbourhood and the fear of being unable to maintain familiar routines all lower the willingness of older people to move (Löfqvist *et al.*, 2013; Peace *et al.*, 2011), and this is further inhibited by the time and financial costs of moving (Karlen *et al.*, 2022; Weber, 2020). In the case of renters, the willingness of senior citizens to move decreases even further if, as a result of a gap between rental rates for new

contracts and rates in existing contracts, the supply of available small and affordable dwellings is scarce and thus housing costs would actually increase even if they moved in order to downsize (Karlen *et al.*, 2022; Zimmerli, 2016). More broadly, rising prices can also result in renters (whether old or young) being forced out of larger dwellings, especially households with low economic means (Haacke *et al.*, 2019). Accordingly, prices can influence the consumption of living space in two ways: first, high prices can lead to households limiting (perhaps involuntarily) the size of their living space when relocating (renters) or purchasing a new home (owner-occupiers); second, a large discrepancy between existing rental rates and those negotiated in new housing contracts negatively impacts residential mobility and thus households' propensity to downsize, even if they are willing to move from dwellings they perceive as being too large to smaller ones (applies to renters only).

A consequence of this is a partial imbalance between housing supply and housing demand: small households often end up living in large dwellings (Weber, 2020; Wulff *et al.*, 2004). This imbalance also reflects persistent housing preferences, which in turn fuel the consumption of living space. Foye (2021) shows how increases of mean living space consumption go along with higher expected levels of living space. Clark *et al.* (1984) and Delbiaggio *et al.* (2018) find a general preference for larger dwellings which is also apparent among younger generations, who often define the dwelling in which they grew up as the minimum standard for them regarding dwelling size (Frank, 2020). A general preference for larger homes can also be explained by dwellings functioning as a status symbol, which links the size of a dwelling with higher subjective well-being, especially among men (Foye, 2017). High space expectations are also explained by social norms, according to which detached or semi-detached houses with private gardens are regarded as the ideal form of housing for families with children (Kooiman, 2020; Lauster, 2010; Mulder, 2013). Being widespread among younger generations, the preference for single-family homes is likely to persist in the future (Frank, 2020). Changes in the spatial organization of work, for example those attributable to increased working from home, also influence space expectations and the consumption of living space. For example, households in which members work from home more often occupy single-family houses or apartments with more rooms than other households (Moos & Skaburskis, 2008; Qin *et al.*, 2021).

However, despite a persistent preference for single-family homes, later-born and more precarious households in particular have recently had reduced access to home ownership being rooted in labour and housing market transformations (Arundel & Doling, 2017; Howard, 2025; Smith *et al.*, 2022). These falling ownership rates are accompanied by increasing inequality in the distribution of housing outcomes among later-born generations, as shown by studies using the example of living space consumption (measured as number of rooms per person) in England and Wales (Tunstall, 2015) or housing wealth in the UK (Arundel, 2017). Consequently, existing research points to both inter- and intra-generational inequalities in the distribution of living space and housing wealth.

German housing context

Germany is also referred to as a 'country of renters' since the proportion of the population living in rented accommodation is the highest in the EU at 52.4%

(Eurostat, 2024). Due to distinct historical contexts, regional disparities exist between West Germany and East Germany (former territory of the German Democratic Republic). Although living conditions have become more equal since reunification, socio-economic differences persist, with income and wealth accumulation, for example, being lower in East Germany. The East German housing stock is characterized by over 30 years of socialist housing policies and therefore smaller average dwelling sizes. A special feature of German housing policy is rent control, which regulates rent increases on existing contracts in more than 400 cities (Federal Institute for Research on Building, Urban Affairs and Spatial Development, 2024). The regulations only apply to existing contracts, not to those negotiated in new contracts.

With regard to the development of living space consumption, increases in per-capita living space were accompanied by an unequal distribution of living space. While older households in particular have very high levels of per capita living space in Germany (Weber, 2020), 11.4% of Germany's population lived in overcrowded dwellings in 2023 (Federal Statistical Office, 2024). Since German rent control regulates rents in existing contracts but not in new contracts, it amplifies the emergence of a gap between rental rates in existing and new contracts (Kholodilin, 2024b). This gap reduces residential mobility and intensifies the misallocation of housing, an unintended effect of German rent control (Kholodilin, 2024b). Additionally, despite shrinking household sizes, the average floor area of new-build dwellings increased until the Great Financial Crisis began in 2007 in Germany (Weber, 2020; Kholodilin, 2024a). Although the size of new-build dwellings has fallen since 2008, in 2021 it is still 10 m^2 larger (102 m^2) than Germany's average size of dwelling in already existing buildings (92 m^2).[1] Deschermeier & Henger (2015) forecasted a rise in consumption of living space per person from 46.2 m^2 in 2013 to 51.5 m^2 in 2030, with cohort effects being identified as the main driver this increase.

Research gap and research questions

This paper follows on from Deschermeier & Henger (2015), whose study looked more closely at differences between birth cohorts with regard to their consumption of living space in Germany using data of the German Socio-Economic Panel (SOEP). Deschermeier and Henger (2015) fitted a time series model to forecast the per-capita living space up to the year 2030 subsequently decomposing the forecast into three components: a cohort effect, an age distribution effect and a quantity effect. The cohort effect was identified as primary driver of the projected rise in per-capita living space, with changes in population's age distribution also contributing to this increase. According to their study, cohort and age distribution effects will outweigh quantity effects of a growing overall population, which mitigates the projected rise in per-capita living space.

While Deschermeier & Henger (2015) examined these differences *via* an aggregated cohort effect which is presumably caused by various processes (e.g. positive development of wealth acquisition, changing housing preferences), we break cohort effects down further. This aims at quantifying potential differences between birth cohorts after controlling for wealth, socio-demographics and additional socio-economic characteristics. To our knowledge, existing analyses of cohort effects in housing

consumption do not include net wealth, but instead use proxies such as education level or income (e.g. Green & Lee 2016). Wealth, on the other hand, includes properties, financial assets and consumer debts.

We therefore analyse the SOEP data applying a 'within–between' model, modelling 'within' and 'between' effects of living space consumption on the household level simultaneously. Investigating within effects helps us to better understand when and why households change their size of living space, whereas analysing between effects enables us to carve out differences in mean living space consumption between households. While investigating cohort effect relates to the between effects, we also model the within effects to exploit the panel structure of the SOEP data gaining a more comprehensive understanding of living space consumption.

Overall, this article furthers our knowledge of how individuals and households consume living space, by focusing on the following research questions:

- How does the living space consumption of different birth cohorts in Germany differ from each other in quantitative terms? Is the distribution of livings space within birth cohorts getting more equal or more unequal over time?
- What are the within and between effects of the main predictors of household size of living space?
- Do we still see differences in size of living space between cohorts when wealth accumulation and other key influencing factors (such as household size, income, housing costs) are controlled for?
- How can these remaining differences be explained?

Data, methods and variables

Data

For our analysis of housing consumption, we used data from the German SOEP.[2] The SOEP is a yearly microdata panel which has been conducted in annual interviews of individuals and households since 1984 in West Germany and since 1990 in East Germany. A detailed description of the SOEP survey method and the core dataset (SOEP-Core v35) used in the analyses can be found in Goebel *et al.* (2019). The SOEP contains a wealth module that includes data on net wealth at household and personal level for the years 2002, 2007, 2012 and 2017. Methodological features of the module (processing and imputation) are described in Frick *et al.* (2013).

In order to adjust monetary variables of the SOEP data to inflation, we used consumer price indices measured as the year-on-year change by the Federal Statistical Office of Germany, with 2018 as the base year.[3]

In addition to the individual and household data, the SOEP also provides spatial and regional information. In this dataset, the surveyed households are linked to a classification of municipalities (*siedlungsstrukturelle Gemeindetypen*) developed by the German Federal Institute for Research on Building, Urban Affairs and Spatial Development. The classification is based on different attributes of settlement structure (e.g. population, population density and density of public amenities). Furthermore,

municipalities are grouped according to the degree of urbanization of the region they are located in resulting in a differentiation between 17 types of municipalities.[4] We included this classification in our analyses.

Since wealth was surveyed in only four SOEP waves between 2002 and 2017 (2002, 2007, 2012 and 2017), we created two samples: one without information on household wealth, but containing all 35 waves from 1984 to 2018 (the full sample); and one consisting of the four waves including wealth data (the wealth sample). Table 1 summarizes descriptive statistics of both samples.

Methods

As the first step, we conducted a descriptive analysis of the SOEP regarding the relationship between living space, age and year of birth at the individual level (per-capita living space) and at the household level (household living space). To examine whether differences between cohorts are accompanied by changes in the distribution of living space within cohorts, we calculated Gini coefficients for each survey year and for different age groups. All descriptive analyses differentiate between East and West Germany due to the disparities evident in the housing markets.

After this descriptive analysis of inter- and intra-generational divergences, we applied econometrics to better understand cohort changes in living space consumption. Generally, analysing cohort effects involves the problem that these are structurally related to age and period effects. In distinction to cohort and age effects already introduced, period effects refer to periods of time that are characterized by particular social, technical or environmental factors or events. Our sample (survey years 1984–2018) covers events such as the German reunification, the 2007–2008 Great Financial Crisis and the implementation of German rent control, all of which are likely to have an impact on living space consumption. Thus, it will be subject to period effects as well.

Generally, the linear dependency of cohort, age and period (cohort = age - period) leads to an identification problem. In order to separate cohort effects from age and period effects, our modelling approach is to regress size of living space on the year of birth and age of the SOEP participants while controlling for period effects *via* covariates. By the way we generated age and year-of-birth variables, we mitigated the identification problem (see 'variables' section). However, due to the structural interrelationship of cohort, age and period, the identification problem can never be resolved completely (Yang & Land, 2013).

According to our research focus, our analysis framework consists of two different levels: (a) within-household variations in living space, which in the majority of cases represent relocations, some possible exceptions being extensions or downsizing of dwellings; (b) between-household variations in living space, which refer to differences in the average living space between the observed households over the observation period. Figure 1 visualizes these two levels of analysis.

Fixed-effect models and random-effects models represent typical panel data models (e.g. Wooldridge, 2010). Since analysing cohort differences requires to account for between-unit variation, the fixed-effect model, which provides estimates of within effects only, would be an inappropriate choice. Random-effects models enable us to

Table 1. Descriptive statistics of the variables used. *Source*: SOEP v35, authors' calculations.

	Full sample ($N = 299{,}393$)				Wealth sample ($N = 35{,}744$)			
Variables	Mean	SD	Min	Max	Mean	SD	Min	Max
Size of living space (m^2)	92	42	6	938	94	43	9	838
Natural log of size of living space	4.4	0.45	1.8	6.8	4.5	0.44	2.2	6.7
Age	53	17	19	103	56	16	19	102
(Grouped)	*(Distribution)*				*(Distribution)*			
… 19–30	*9%*				*6%*			
… 31–40	*17%*				*15%*			
… 41–50	*19%*				*19%*			
… 51–60	*18%*				*20%*			
… 61–70	*17%*				*19%*			
… 71–80	*14%*				*15%*			
… 81 and older	*6%*				*6%*			
Year of birth	1952	19	1893	1998	1954	16	1909	1998
Years born before 1998	46	19	0	105	44	16	0	89
Years born before 1998 (squared)	2,479	1,837	0	11,025	2,172	1,433	0	7,921
ISCED educational level	*(Distribution)*				*(Distribution)*			
General elementary	*12%*				*10%*			
Middle vocational	*53%*				*52%*			
Vocational and Abi	*5%*				*5%*			
Higher vocational	*9%*				*9%*			
Higher Education	*20%*				*23%*			
Inadequately	*1%*				*1%*			
Migration background *(1= migration background; 0 = no migration background)*	0.14	0.34	0	1	0.12	0.33	0	1
No. of household members	2.1	1.2	1	17	2.0	1.1	1	13
HH located in East Germany *(1 = located in East Germany; 0 = located in West Germany)*	0.15	0.36	0	1	0.2	0.4	0	1
Income (€)	2,614	2,546	13	1,023,999	2,705	1,998	13	217,800
Tenure status *(1 = owner; 0 = tenant)*	0.44	0.5	0	1	0.48	0.5	0	1
Local housing cost level (€/ m^2)	5.7	1.4	0.83	10	6.2	1.2	0.83	10
Actual-to-median rent ratio (-)	1	0.28	0.002	11	1	0.24	0.03	6
Wealth (€1000s) *(grouped)*	–	–	–	–	188	621	−4,152	80,421
					(Distribution)			
… 50 or less					*47%*			
… 50–200					*24%*			
… 200–500					*21%*			
… 500–1000					*6%*			
… More than 1000					*2%*			

Note: The values in italics describe the frequency distributions of ordinal or nominal-scaled variables for which no min, max and SD values can be calculated.

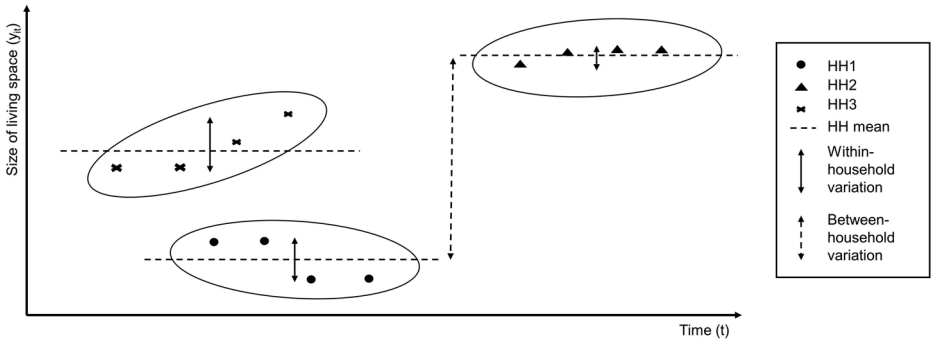


Figure 1. Multilevel analysis framework with within-household and between-household variations in living space. Source: Authors' tabulation.

investigate between and within effects simultaneously. Mundlak (1978) introduced a formulation of the random-effects model of which we fitted a rearranged formulation also referred to as the 'within-between model' (Allison, 2009; Bell & Jones, 2015):

$$y_{it} = \beta_0 + \beta_1 \left(x_{it} - \overline{x}_i \right) + \beta_2 \overline{x}_i + \gamma z_i + u_{0i} + \epsilon_{it} \tag{1}$$

Households $i = 1, \ldots, n$ are observed at times $t = 1, \ldots, T$ where t represents the different waves (years) of the SOEP data. The dependent variable y_{it} is household i living space at time (year) t. Time-varying independent variables x_{it} and time-invariant independent variables z_i are included separately in the model with $\overline{x}_i$ representing the household mean for time-varying variables, which is needed to model the within and between effects of these variables. Furthermore, the model consists of estimates for:

- the intercept β_0;
- β_1, representing the effect of within-entity (within-household) deviations of x on deviations of y (within effects);
- β_2, representing the between-household effect of $\overline{x}_i$; and
- γ, representing the between-household effect of z_i.

The within effect of a time-varying variable such as income thus describes whether changes in income are accompanied by increases or decreases in living space. The between effect of income, on the other hand, would reflect the extent to which the income of the households averaged over the survey period explains living space differences between households averaged over the survey period. The random intercept u_{0i} estimated for each i and the idiosyncratic error ϵ_{it} represents the 'random' part of the model. Both u_{0i} and ϵ_{it} are assumed to be normally distributed.

As summarized by Bell & Jones (2015), the within–between model has some advantages over Mundlak's original formulation. It increases the stability and precision of estimates (Raudenbush, 1989) and clearly separates within and between effects, facilitating interpretation (Snijders & Bosker, 2012). However, as a random-effects model, the within–between approach is subject to a potential

heterogeneity bias, since it does not control out unit-specific unobserved heterogeneity when estimating between effects (β_2 and γ) (Bell *et al.*, 2019; Bell & Jones, 2015). That the unobserved time-invariant heterogeneity of the observation units (u_{0i}) is assumed to be normally distributed means, it must not be correlated with the independent variables, an assumption which is rarely fulfilled and thus very constraining (e.g. Wooldridge, 2010). Without normality of the random coefficients the between effects' estimates (β_2 and γ) can be biased. However, based on simulations, Bell *et al.* (2019) present compelling rationale that the extent of this bias in the context of linear models should be modest and unproblematic. Even though the model we fitted should be subject to non-normal random effects, we do not expect potential non-normality to be a source of crucial additional identification issues, referring to Bell *et al.* (2019, p. 1067) who conclude that "[…] a badly specified random distribution may result in some biases, but these are usually small enough not to worry the applied researcher." In the case of the within-effects' coefficients (β_1), the within–between approach models out all unit-specific heterogeneity (Bell *et al.*, 2019; Bell & Jones, 2015).

To fit the model, we applied the software *R* using the *panelr* package (Long, 2020).

Since after reunification, the East German housing market was characterized by very poor housing conditions and extremely low rents and mortgage rates (Wießner, 2004), we checked for robustness of our models. We did so by comparing the estimates of models that were fitted on both East and West German households to models that were fitted only on households located in East Germany and by reviewing the plausibility of the estimates. As a result, we excluded East German households until the 1997 survey wave in order to stabilize our models. The appendix contains the models used to test robustness.

Variables

In line with our study focus, household living space represented the dependent variable in our analysis. We used the natural logarithm of living space (m^2), which originally was not normally distributed, to transform it into a suitably normally distributed variable for the econometric analyses.

To be able to distinguish cohort effects from age effects, we included age and year of birth in our analyses. To minimize possible multicollinearity, we followed Bell (2014) who proposes centring the year-of-birth variable around its mean. In addition to this linear year-of-birth variable, we included the quadratic term 'years born before 1998 (squared)' to test whether a non-linear link might better describe cohort differences. We tested different versions of squared year-of-birth variables. However, referencing the squared term to 1998 (the most recent year of birth in our sample) gave the best fitting model. Yang & Land (2013) recommend grouping at least one of the variables, age, cohort (or period), in order to mitigate the identification error. We therefore created seven age groups using 19-to-30-year olds as reference. Since households can consist of several members, we used the mean age and mean year of birth of the adult household members (excluding adult children still living with their parents when calculating the means).

Wealth was included in the modelling as another variable of interest owing to its intermingling with cohort effects. Specifically, we used the household's net overall

wealth, which considers properties (the household's main residence and other), financial assets, private insurances, business assets, tangible assets, and consumer debts (Frick *et al.*, 2013). Since model versions in which we grouped the households' net wealth had a better fit than those with a linear wealth variable, we formed five groups. Households that are in debt, or whose inflation-adjusted wealth is less than €50,000 form the reference category.

We additionally included educational levels according to the International Standard Classification of Education (ISCED) by generating a household variable that considers the highest educational qualification of the adult household members (again excluding adult children still living with their parents), as educational attainment works as proxy for wealth or anticipated wealth (Woessmann, 2016).

From existing research, various other influencing factors can be derived, which we modelled *via* covariates. The number of household members was included *via* dummy variables determining whether a household had a second, third or fourth member. Furthermore, the households' inflation-adjusted income (€000s) and a dummy variable for tenure status were included. In order to capture the influence of rental rates and home prices, we inserted two variables: 'local housing cost level' and 'actual-to-median rent ratio'.

We computed inflation-adjusted rent levels (€/m^2) as well as inflation-adjusted levels of mortgage and interest payments (€/m^2) for each survey year using information on household housing expenditures in the SOEP data based on the municipality types. The levels were calculated as the median of all reported rents (rent levels) and all reported mortgage and interest payments (levels of mortgage and interest payments) per survey year within a type of municipality, with a further differentiation between East and West Germany. We then computed the 'local housing cost level' variable assigning these rent levels to the renting households of our sample, depending on the municipality type they live in, and the corresponding level of mortgage and interest payments to all owner-occupiers. We inserted the 'local housing cost level' to approximate whether the municipality a household is located in is characterised by high or low housing costs and also to control for changes of rental rates and home prices over time.

Additionally, we generated the variable 'actual-to-median rent ratio' computed as ratio of the households' inflation-adjusted rent (€/m^2) and the local rent level (€/m^2) (for renting households). The calculated 'actual-to-median rent ratio' whose natural logarithm gave the best fitting models, was included to control whether a household lives in a pricier or a cheaper dwelling compared to the median level of its municipality type. As the amount of monthly mortgage and interest payments of owner-occupiers depends on many factors that we cannot control with the SOEP data (such as equity ratio and mortgage duration), we decided to include actual housing expenditures only for renting households in order not to confound our variable. Thus, the mortgage and interest payments of all owner-occupiers were set to median level when computing the 'actual-to-median rent ratio' variable.

Regarding potential period effects, we assumed that, in the cases of the Great Financial Crisis and implementation of German rent control, our covariates capture most effects on living space consumption. In order to control for possible confounding effects arising from German reunification, we additionally included a dummy variable representing whether a household was located in East or West Germany when surveyed.

Results

Results of the descriptive analyses

Figure 2 shows the evolution of living space with age for different year-of-birth cohorts in East and West Germany. People in East Germany consume less living space per capita than West Germans. Besides that, both figures clearly display the trends mentioned above: as people grow older, their per-capita living space increases, with the increase being strongest in the age range 19–30 and from the age of 40 onward. Between the ages of 31 and 40, the average per-capita living space of persons located in West Germany either increases just barely or stabilizes, depending on the cohort. The overall shape of the evolution of per-capita living space throughout different stages of life is very similar across most cohorts for both East and West Germany.

Furthermore, it is evident that at the same age, cohorts born later consume more per-capita living space on average than cohorts born earlier (the cohort effect). For example, in West Germany a 31- to 40-year-old person born between 1979 and 1988 on average has 9.3 m^2 more living space per capita than a 31- to 40-year-old born 40 years earlier. For 61-to 70-year olds, the increase of per-capita living space between those born between 1909 and 1918 and those born between 1949 and 1958 is on average 11.4 m^2 in West Germany. Similar trends can be observed in East Germany.

However, it is also apparent that the differences in living space consumption per capita between the later-born cohorts (1959–68, 1969–78 and 1979–88) are smaller or even disappear in some cases in both East and West Germany.

Figure 3 shows the consumption of living space at the household level, and also clearly illustrates corresponding age and cohort effects. Households increase their living space until the mean age of the adult members reaches 41–50 years. After that, the size of the household's living space declines (for West German cohorts born longer ago) or stabilizes at this level (for remaining cohorts in East and West Germany). Most meaningful differences between living space levels of the different birth cohorts (cohort effects) occur once the age of 40 is exceeded. In the age group 71–80 years, the difference between the cohorts born earliest (1899–1908) and latest

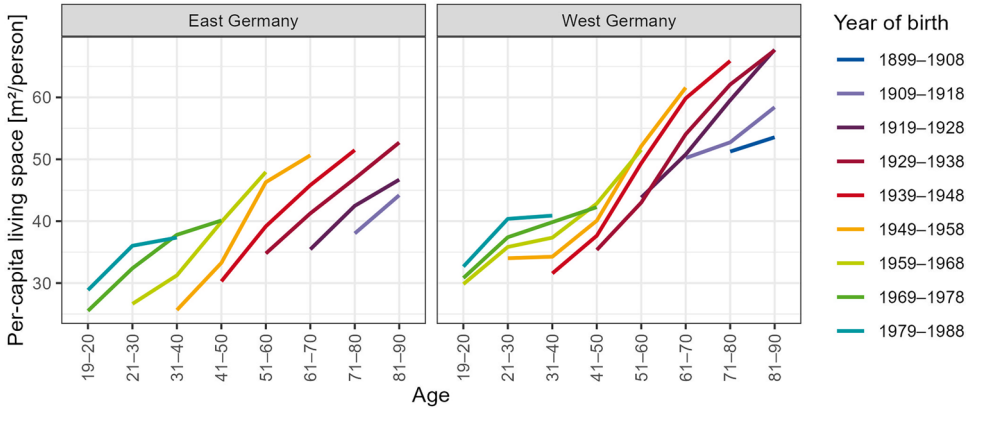


Figure 2. Per-capita living space across age ranges by year of birth in East and West Germany between 1984 and 2018. Source: SOEP v35, authors' calculations.

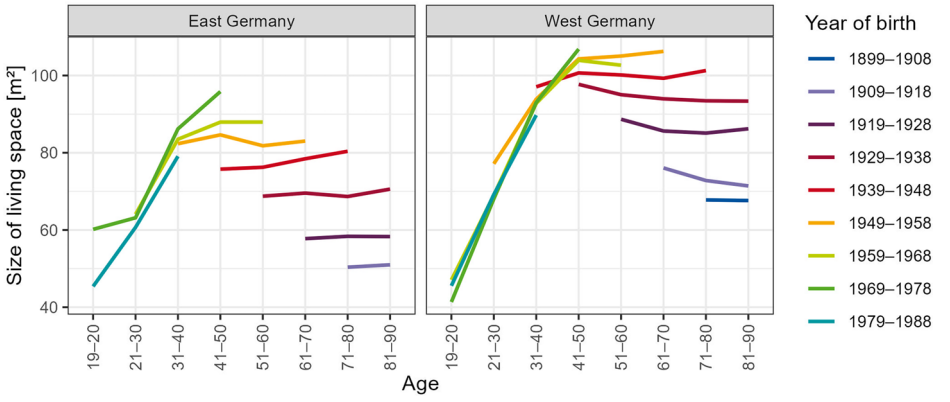


Figure 3. Living space across age range by year of birth (mean of the adult HH members) in East and West Germany between 1984 and 2018. Source: SOEP v35, authors' calculations.

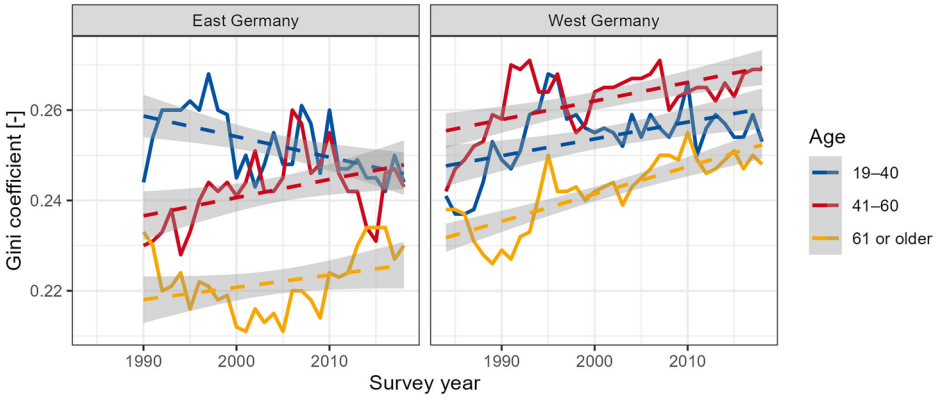


Figure 4. Gini coefficients of living space consumption per capita across SOEP survey years by age groups in East and West Germany between 1984 and 2018 with linear trends (dashed) and 95% confidence intervals.
Source: SOEP v35, authors' calculations.

(1939–48) among the analysed cohorts is on average a remarkable 33.5 m². The same pattern is evident in East Germany.

With regard to intra-generational divergences, we focus on the distribution of living space within cohorts and its variance over time (see Figure 4). In West Germany, there is increasing disparity in the distribution of living space per capita within the three age groups analysed (persons aged 19–40, 41–60 and 61 or older). The observation that living space is allocated less equal over time within these groups indicates an intra-generational increase in inequality as well, with cohorts born later exhibiting a greater degree of inequality than those born earlier. In contrast to the trend observed in West Germany, the distribution within the youngest age group analysed (19–40 years old) displayed a decrease in inequality in Eastern Germany. Thus, between the ages of 19 and 40, cohorts born later exhibited a greater evenness in the allocation of available living space. For the older age groups (aged 41–60, or 61 or older), no significant trend over time is discernible in East

Germany. The unequal distribution is less pronounced among those aged 61 or older than among the younger age groups in both East and West Germany.

Results of the within–between models

The econometric analysis consists of four within–between models:

- Model 1a was fitted based on the full sample and using a linear year-of-birth variable; and
- Model 1b was fitted based on the full sample using a linear and a non-linear year-of-birth variable; and
- Model 2 was fitted based on the wealth sample using the same set of variables as Model 1a; and
- Model 3 was fitted based on the wealth sample using the same set of variables as Models 1a and 2, with the addition of wealth variables.

In all four models, the natural logarithm of household living space represents the dependent variable. Table 2 shows the coefficients of the models considering within-household as well as between-household variance. The table also lists standard deviations of the random parameters and the regression model accuracy metrics.

When interpreting the results below, it should be noted that Model 2 differs from Model 1a and 1b in the sample on which it is based (the wealth sample). The wealth sample consists of the 2002, 2007, 2012 and 2017 waves only, which may lead to changes in the estimates compared to Model 1a and 1b. At the same time, there is a gap of 5 years between waves in the wealth sample, which may affect the within effects: it is no longer just a 1-year period in which correlations between deviations of independent variables and deviations of size of living space are considered, but a 5-year period, which may cause larger estimates of within effects. The differences between Models 2 and 3, on the other hand, are entirely due to introducing net wealth.

First, we turn to the within-effects, i.e. changes in living space that occur within household alongside changes of the explanatory variables. As for most covariates the model findings conform to expectation. As an illustration of the interpretation of the coefficients, we will have a look at the household size variable: with each additional household member, households tend to increase their living space. Since the explained variable is the natural logarithm of living space, this means that the second person entering the household goes along, on average, with an 17% increase in living space.

The within effects of the household size variables indicate that changes in household size are one of the key trigger events for households to change their living space (i.e. to move), conforming to previous research (e.g. Clark *et al*., 1984; Karlen *et al*., 2022). The within effect of income is comparably small in all three models. Considering that income has no significant effect on a household's intentions to move – or the outcome of that move – in newer research (Clark & Lisowski, 2017), it seems plausible that an increase in income goes along with only small within effects in our models, as changes in income probably rarely act as a trigger for an immediate relocation, unless the change is quite large. The housing costs variables' show that housing costs effectively moderate living space consumption when households relocate. The within effects of educational attainment mark both transitions between life stages that are

Table 2. Estimates and standard deviations (in parentheses) of the four within–between models, *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

	Model 1a	Model 1b	Model 2	Model 3
		Within effects		
Second person in household (HH)	0.1755***	0.1763***	0.1658***	0.1625***
	(0.0015)	(0.0015)	(0.0046)	(0.0046)
Third person in HH	0.0865***	0.0867***	0.0800***	0.0792***
	(0.0016)	(0.0016)	(0.0049)	(0.0049)
Fourth person in HH	0.0575***	0.0575***	0.0632***	0.0619***
	(0.0019)	(0.0019)	(0.0060)	(0.0060)
No. of additional HH members	0.0459***	0.0458***	0.0424***	0.0429***
	(0.0021)	(0.0021)	(0.0072)	(0.0072)
Income	0.0057***	0.0057***	0.0106***	0.0098***
	(0.0002)	(0.0002)	(0.0009)	(0.0009)
Local housing cost level	−0.0052***	−0.0053***	−0.0224***	−0.0230***
	(0.0006)	(0.0006)	(0.0024)	(0.0024)
Actual-to-median rent ratio (log)	−0.2249***	−0.2248***	−0.2382***	−0.2397***
	(0.0017)	(0.0017)	(0.0064)	(0.0063)
Owner *(reference: tenant)*	0.2711***	0.2714***	0.2741***	0.2554***
	(0.0018)	(0.0018)	(0.0055)	(0.0058)
HH located in East Germany *(reference: West Germany)*	0.0082	0.0081	−0.0161	−0.0175
	(0.0052)	(0.0052)	(0.0151)	(0.0150)
Age (reference: 19–30 years old)				
31–40 years old	0.1458***	0.1450***	0.1653***	0.1636***
	(0.0019)	(0.0019)	(0.0069)	(0.0069)
41–50 years old	0.2242***	0.2231***	0.2369***	0.2329***
	(0.0024)	(0.0024)	(0.0083)	(0.0083)
51–60 years old	0.2620***	0.2610***	0.2704***	0.2644***
	(0.0027)	(0.0027)	(0.0093)	(0.0093)
61–70 years old	0.2841***	0.2836***	0.2882***	0.2838***
	(0.0031)	(0.0031)	(0.0103)	(0.0103)
71–80 years old	0.3001***	0.3004***	0.3038***	0.3008***
	(0.0034)	(0.0034)	(0.0112)	(0.0112)
81 years and older	0.3044***	0.3056***	0.3233***	0.3211***
	(0.0041)	(0.0041)	(0.0130)	(0.0129)
Educational level (reference: general elementary)				
Middle vocational	−0.0019	−0.0024	−0.0085	−0.0107
	(0.0030)	(0.0030)	(0.0134)	(0.0134)
Vocational and Abi	0.0213***	0.0213***	0.0119	0.0076
	(0.0050)	(0.0050)	(0.0197)	(0.0197)
Higher vocational	0.0315***	0.0313***	0.0363	0.0314
	(0.0045)	(0.0045)	(0.0191)	(0.0190)
Higher education	0.1167***	0.1165***	0.1393***	0.1343***
	(0.0044)	(0.0044)	(0.0169)	(0.0169)
Inadequately	−0.0390***	−0.0384***	−0.0140	−0.0110
	(0.0092)	(0.0092)	(0.0495)	(0.0493)
Wealth ***(reference: less than €50K)***				
€50K–€200K				0.0202***
				(0.0043)
€200K–€500K				0.0537***
				(0.0057)
€500K–€1,000K				0.0684***
				(0.0083)
More than €1,000K				0.0962***
				(0.0126)
		Between effects		
(Intercept)	3.8090***	3.8909***	3.9410***	3.9868***
	(0.0094)	(0.0134)	(0.0223)	(0.0219)
Second person in HH	0.2697***	0.2682***	0.1922***	0.1848***
	(0.0046)	(0.0046)	(0.0071)	(0.0069)
Third person in HH	0.1309***	0.1313***	0.1106***	0.1150***
	(0.0059)	(0.0059)	(0.0094)	(0.0091)

(*Continued*)

Table 2. Continued.

	Model 1a	Model 1b	Model 2	Model 3
Fourth person in HH	0.0741***	0.0743***	0.0762***	0.0739***
	(0.0065)	(0.0065)	(0.0106)	(0.0104)
No. of additional HH members	0.0698***	0.0703***	0.0604***	0.0629***
	(0.0041)	(0.0041)	(0.0077)	(0.0076)
Income	0.0131***	0.0131***	0.0456***	0.0339***
	(0.0005)	(0.0005)	(0.0013)	(0.0014)
Local housing cost level	−0.0174***	−0.0164***	−0.0284***	−0.0325***
	(0.0013)	(0.0013)	(0.0021)	(0.0021)
Actual-to-median rent ratio (log)	−0.2923***	−0.2934***	−0.2995***	−0.2988***
	(0.0067)	(0.0067)	(0.0126)	(0.0123)
Owner *(reference: tenant)*	0.3781***	0.3774***	0.3464***	0.2174***
	(0.0037)	(0.0037)	(0.0056)	(0.0085)
HH located in East Germany *(reference: West Germany)*	−0.1533***	−0.1522***	−0.1666***	−0.1417***
	(0.0042)	(0.0042)	(0.0064)	(0.0063)
Age (reference: 19–30 years old)				
31–40 years old	0.1295***	0.1141***	0.1268***	0.1386***
	(0.0068)	(0.0070)	(0.0163)	(0.0160)
41–50 years old	0.1998***	0.1745***	0.1807***	0.1819***
	(0.0068)	(0.0074)	(0.0159)	(0.0156)
51–60 years old	0.2701***	0.2405***	0.2340***	0.2244***
	(0.0077)	(0.0084)	(0.0189)	(0.0185)
61–70 years old	0.3620***	0.3343***	0.3331***	0.3151***
	(0.0090)	(0.0096)	(0.0226)	(0.0222)
71–80 years old	0.3879***	0.3707***	0.3663***	0.3542***
	(0.0106)	(0.0107)	(0.0261)	(0.0256)
81 years and older	0.4669***	0.4691***	0.3875***	0.3827***
	(0.0139)	(0.0138)	(0.0320)	(0.0315)
Educational level (reference: general elementary)				
Middle vocational	0.0649***	0.0629***	0.0388***	0.0286***
	(0.0052)	(0.0051)	(0.0087)	(0.0085)
Vocational and Abi	0.0954***	0.0950***	0.0724***	0.0607***
	(0.0075)	(0.0075)	(0.0127)	(0.0125)
Higher vocational	0.1214***	0.1182***	0.0676***	0.0476***
	(0.0076)	(0.0076)	(0.0116)	(0.0114)
Higher education	0.1859***	0.1840***	0.1147***	0.0834***
	(0.0058)	(0.0058)	(0.0098)	(0.0097)
Inadequately	−0.0591***	−0.0612***	−0.0282	−0.0385
	(0.0116)	(0.0115)	(0.0267)	(0.0261)
Migration background (*reference: no migration background*)	−0.0859***	−0.0850***	−0.0895***	−0.0747***
	(0.0034)	(0.0034)	(0.0069)	(0.0067)
Year of birth	0.0051***	0.0022***	0.0045***	0.0049***
	(0.0001)	(0.0004)	(0.0004)	(0.0004)
Years born before 1998 (squared)		−0.00003***		
		(0.00000)		
Wealth *(reference: less than €50K)*				
€50K–€200K				0.0857***
				(0.0094)
€200K–€500K				0.2072***
				(0.0110)
€500K–€1,000K				0.2933***
				(0.0145)
More than €1,000K				0.3394***
				(0.0194)
		Random effects		
SD (intercept)	0.2464	0.2460	0.2221	0.2155
SD (observations)	0.1702	0.1702	0.1638	0.1632
	Model fit			
n	299,393	299,393	35,744	35,744
R^2 marg.	0.551	0.552	0.597	0.614

(*Continued*)

Table 2. Continued.

	Model 1a	Model 1b	Model 2	Model 3
R^2 cond.	0.855	0.855	0.858	0.859
AIC (Akaike Information Criterion)	−1651.2	−1700.8	9525.8	8850.4
BIC (Bayesian Information Criterion)	−1173.8	−1212.7	9907.6	9300.0
RMSE	0.17	0.17	0.16	0.16

associated with an increase in the size of living space (e.g. entering the labour market after education) as well as an increase in the chances of good career prospects, e.g. after graduation. Model 3 indicates that increases in wealth are accompanied by increases in living space. However, these do not appear to be particularly large.

Examining the between-household effect, again, by and large the coefficients of our covariates conform to expectation. Households consisting of more and older members live on larger floor areas compared to smaller and younger households (under ceteribus paribus conditions). Again, our housing costs variables proof that prices moderate how much living space a household consumes. And the between effects of educational attainment confirm the correlations between education and wealth or expected wealth previously analysed by Woessman (2016), which in turn influence housing consumption, as also found by Green & Lee (2016).

Households which have, on average, more wealth during the observation period also consume more living space. In particular, the wealth groups with more than €200,000 net wealth have significantly more living space than those in the reference category (net wealth less than €50,000).

Regarding migration background, even in Model 3 with its control for wealth, households whose head has a migration background consume less living space. These results point to both divergent housing preferences and lower space expectations among ethnic minorities compared to the native majority (e.g. Skifter Andersen, 2019) as well as continuing inequalities (e.g. discrimination from landlords, banks and real estate agents) in the German housing market which have been shown by Drever & Clark (2002) before.

All models show variations between households of different birth cohorts, which are statistically significant (99% significance level). Households of earlier-born cohorts consume less living space compared to those of later-born cohorts. When modelled as time-invariant linear effect (Models 1a, 2 and 3), the difference in living space consumption increases by approx. 0.5% with each year difference in year of birth (mean of adult household members). This means that under otherwise equal conditions, a household whose year of birth is 1990 consumes 10% more living space than a same-aged household whose year of birth is 1970. Since this effect is modelled *via* a linear variable for year of birth, it should be interpreted as mean cohort difference per year-of-birth difference for German households surveyed between 1984 and 2018 (ceteribus paribus).

When adding a squared term (Model 1b), whose estimates are statistically significant at the 99% significance level, cohort differences change over time. According to Model 1b, a household born in 1950 consumes about 11% more living space than a household of the same age born 20 years earlier, while the difference in living space between households born in 1990 and 1970 would be only 6.5%. As Model 1b has a slightly better fit than model 1a, it indicates that cohort differences are declining.

In summary, while some of our results confirm existing research, our models also provide some unprecedented insights. Model 3 shows that changes in wealth do not lead to large short-term adjustments in a household's living space. A common scenario of increases in household wealth may be inter-generational family support, which often takes the form of transmitted or inherited home ownership (Lennartz & Helbrecht, 2018), after which households may consume more living space. We expect many of these cases to be depicted in the within effect of tenure status, not in the within effect of wealth. It is also possible that a 5-year interval between survey years in the wealth sample is insufficient to observe substantial changes in wealth and reactions to them. However, the fact that there is a connection between wealth and living space can be seen in the between effects. Here, households with high wealth have significantly larger estimated living space, even after controlling for tenure status and educational attainment, the between effect of which is smaller in Model 3. The model results thus also reflect the close correlations between wealth and property ownership (Bach *et al.* 2021) as well as between wealth and educational level (Woessmann, 2016). Since net wealth is controlled for in Model 3, the between effects of educational level should indicate its functioning as proxy for anticipated wealth. This might be one reason for the fact that net wealth adds only little explanatory power to Model 3 compared to Model 2 where wealth is not included. Hence, one could argue that educational level in combination with tenure status work as a sufficient proxy for wealth when analysing cohort effects, at least in the German housing context.

Controlling for income, tenure status, housing costs, age, household structure, educational level, migration background and (in Model 3) net wealth, there still remains a between effect contributing to the higher housing consumption of cohorts born later. This cohort effect is statistically significant in all four models with our test for a non-linear link in model 1b indicating that cohort differences are getting smaller.

Discussion

Showing a cohort effect beyond wealth and changing household structures, our model results leave room for interpretation.

The models do not cover the development of the German housing stock. As Weber (2020) analysed, average floor spaces of new-built dwellings increased with year of construction until the Great Financial Crisis although household sizes have at the same time been shrinking. This probably contributes to the cohort effect in our model while it may also indicate changing housing preferences. Accordingly, another possible explanation for the identified cohort effect would be that more recent cohorts have higher expectations regarding their size of living space.

To test the hypothesis of higher living space expectations further, we looked at the judgement of living space adequacy variable in the SOEP data. Figure 5 illustrates that the subjective evaluation of the adequacy of dwelling size has exhibited a notable shift over time. The per-capita living space of individuals who perceive their current dwelling size to be 'just right' has increased on average across all age groups. This trend also applies to individuals who feel their current living space is either too small or too large. Notably, the increases are particularly pronounced in

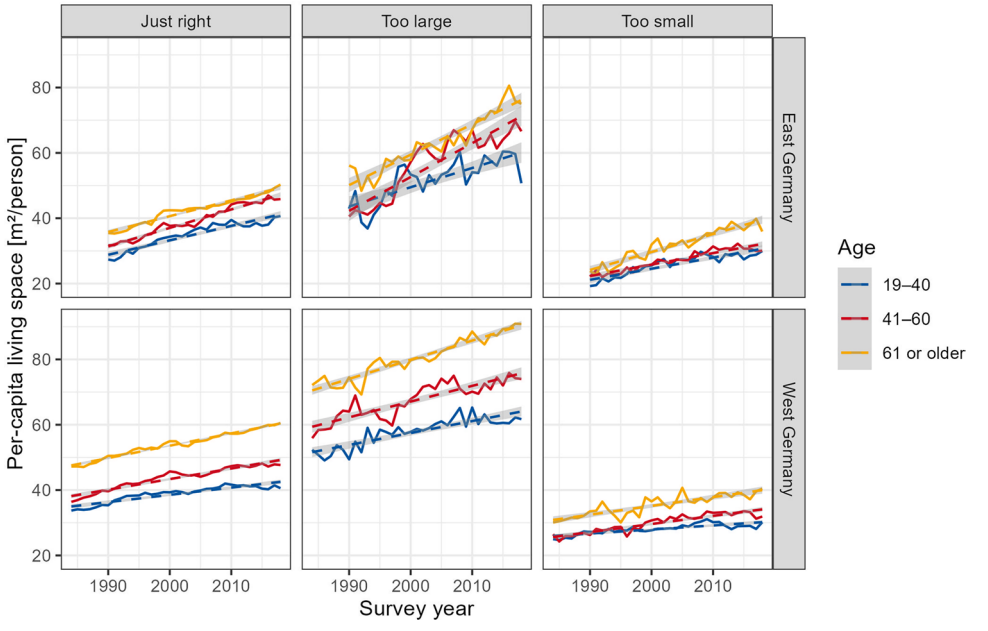


Figure 5. Mean per-capita living space across SOEP survey years by judgement of living space adequacy for different age groups in East and West Germany between 1984 and 2018 with linear trends (dashed) and 95% confidence intervals. Source: SOEP v35, authors' calculations.

cases where individuals perceive their current dwelling size to be either suitable or too large. We thus observe that in both East and West Germany, across all age groups, the rise in mean per-capita living space (see Figure 2) has also corresponded with an adjustment in space expectations. This finding is corroborated by the results of Foye (2021), who also identified a similar trend in Germany and the UK.

If these heightened space expectations are, at least in part, responsible for the cohort effect identified, this gives rise to the question of how these expectations can be met. As we have accounted for housing costs, income and net wealth in our modelling, meeting these demands should be associated with proportionately higher housing expenditures. The existing literature provides substantial empirical evidence to support this hypothesis. While expenditure on housing as a proportion of total household expenditures has increased significantly in Germany across almost all income groups, shares of non-housing expenditure have decreased accordingly, especially among low-income households (Dustmann *et al.*, 2022; Weber, 2020). With regards to changes between birth cohorts, the proportion of income allocated to housing expenditures has undergone shifts both overall and for the lowest and highest incomes, with the proportion of income allocated to housing expenditures increasing considerably across later-born cohorts for all age groups in the lowest income quintile but remaining constant or even declining for those in the highest income quintile (Dustmann *et al.*, 2022). Consequently, the increasing space expectations indeed go hand in hand with higher shares of income spent on housing on average, but especially for low-income households.

Changes in proportion of people evaluating their homes as too small indicate to which extent individuals may be able to fulfil their increased space expectations over

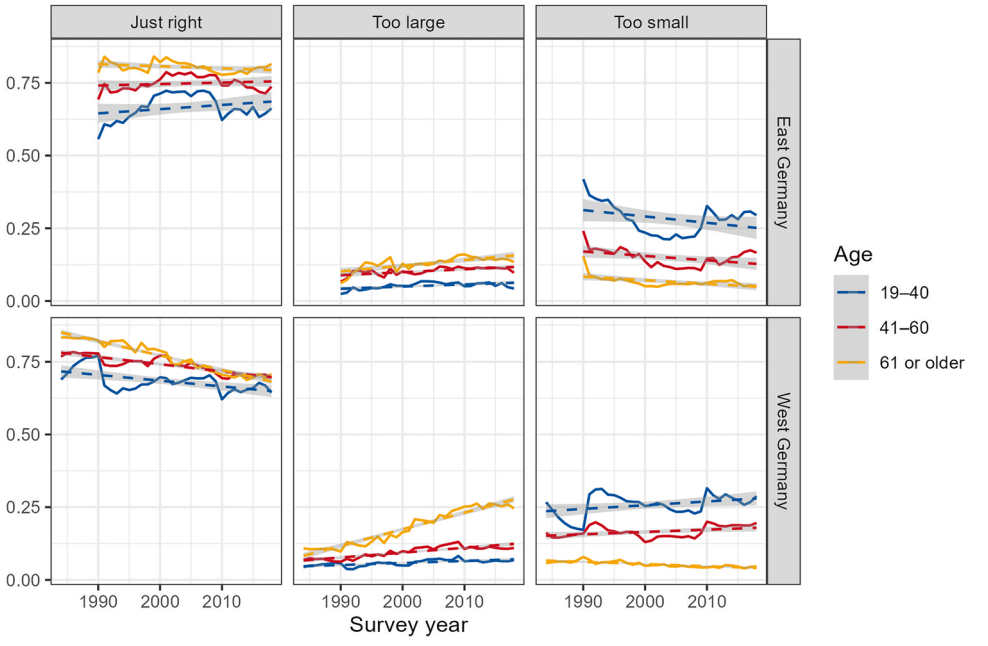


Figure 6. Share of people evaluating their living space as 'Just right', 'Too large' or 'Too small' across SOEP survey years within age groups in East and West Germany between 1984 and 2018 with linear trends (dashed) and 95% confidence intervals. Source: SOEP v35, authors' calculations.

time. Although the picture is not entirely definitive, it appears that the proportion of individuals in Germany considering their living space to be too small increases since the mid-2000s (see Figure 6). We interpret this as an indication that increased housing expenditure relative to income, in conjunction with elevated expectations regarding the living space, result in a greater proportion of individuals (aged between 19 and 60) being unable to meet these expectations. This could also be an explanation for the declining cohort effects that the results of model 1b suggest.

Concurrently, Figure 6 also provides information on intra-generational inequalities. The proportions of individuals across all age groups with living space perceived as too large is on the rise, with the most pronounced increase observed among West Germans aged 61 or above. The rise in both the proportion of individuals (aged between 19 and 60) with too small living spaces and those with excessive living spaces, observable since the mid-2000s, shows both inter-generational and intra-generational divergences in the fulfilment of space expectations. From the mid-2000s onwards, inequality within birth cohorts rises for those born later. Increasing intra-generational inequality thus affects per-capita living space consumption, housing expenditure relative to income (Dustmann *et al.*, 2022) and the fulfilment of space expectations.

Finding higher space expectations among more recent cohorts corresponding with a more concentrated distribution of living space within cohorts might also point to the prevalence of a phenomenon Frank *et al.* (2014) called 'expenditure cascades'. Changes in the expenditures of one group shift the frame of reference that defines consumption standards for others just below them on the income scale, giving rise to cascading preferences and expenditures (Frank *et al.*, 2014).

Prior to concluding, we reflect on the methodology employed, beginning with an examination of the limitations thereof. High-wealth households are underrepresented in the SOEP data (Schröder *et al.* 2020). Consequently, our analysis does not encompass the living space consumption of top-wealth households. A further limitation of our model approach is that it does not consider the actual housing costs of owner-occupiers. These are instead taken into account *via* median mortgage and interest payments which had the advantage of averaging out some of the factors that cause a high variance in the monthly mortgages of owner-occupiers. However, the utilization of median levels calculated for each municipal category was accompanied by an additional constraint: as there are still differences in housing costs within municipalities of the same category, these median levels are subject to a certain inaccuracy. To assess the robustness of the models, we fitted versions only based on households located in East Germany using the same independent variables (see Table A1 in the appendix). These models revealed deviations in the coefficients, indicating that the dummy 'household located in East Germany' is unable to fully control all confounding effects of reunification even after filtering out East German households until the 1997 SOEP wave (as we did fitting Models 1a and 1b). Nevertheless, these deviations in the coefficients are limited to specific covariates, such as household size and age. The absence of statistical significance in certain effects (e.g. within effects of net wealth, between effects of local housing cost level and migration background) we assume to be primarily attributed to the reduced number of observations. Despite its influence on some covariates, the stability of the year-of-birth variable's between effect across all models suggests, in our view, that the reunification or its aftermath does not affect the main findings of our analysis.

Conclusions and outlook

Our findings support the notion that housing can be considered an object of both inter- and intra-generational inequality. Nevertheless, with regard to the consumption of living space, it cannot generally be stated that more recently-born cohorts are worse off than earlier born cohorts.

Analysing data from the German SOEP applying descriptive and econometric analyses, we found that under ceteris paribus conditions more recently born cohorts consume more living space (mean across surveyed households: approx. 0.5% per year-of-birth difference) than previous cohorts. We interpret this effect as a cohort effect beyond wealth accumulation and changing household structures and attribute it to heightened space expectations. Our model results also indicate that these cohort differences are declining.

The identified inter-generational disparities are accompanied by growing intra-generational inequality concerning the fulfilment of space expectations, housing expenditure relative to income, and inequality of living space allocation per capita within cohorts, which is increasing in West Germany. Consequently, a more complex picture emerges: even though divergences between cohorts seem to decrease, later-born cohorts have significantly larger per-capita living spaces corresponding with an increasingly unequal allocation of living space and a growing proportion of the population unable to meet their space expectations since the mid-2000s.

This poses two challenges for housing policy. First, with regard to the environmental footprint of housing, our findings point to the importance of increasing the

energy efficiency of the housing system, as well as to the necessity of discussion on sufficiency and downsizing (Cohen, 2021; Karlen *et al.*, 2022; Lorek & Spangenberg, 2019; Pagani *et al.*, 2022). With the cohort of baby boomers approaching retirement, it seems all the more important to counteract the non-demographic part of the cohort effects that our research carved out. Second, policy should address the rising unequal distribution of living space so as not to further exacerbate existing overcrowding problems, which puts the focus on more efficient utilization of the housing stock.

The example of rent control demonstrates the complexity of integrating ecological and socio-economic considerations. As part of German housing policy, rent control mitigates increases of rental costs in existing contracts, which moderate the consumption of living space. While rent control may effectively address issues of gentrification in major cities, it unintendedly contributes to a misallocation of living space (Kholodilin, 2024b). However, in light of evidence that households in the lowest income quantile are particularly affected by high housing cost burdens (Dustmann *et al.*, 2022) and overcrowding (Federal Statistical Office, 2024), a withdrawal of these regulations also appears problematic unless affected households are supported in another way.

Even stricter measures, such as upper limits on living space proposed by Brokow-Loga & Neßler (2020), evoke the policy of housing rationing applied mostly in the planned economies, which had negative repercussions on the well-being of individuals (Kholodilin & Meerovich, 2018). Likewise, the political enforceability of such measures appears questionable. Yet, we argue that it is sensible to develop policy steps towards initiating a socio-ecological transformation of the housing market treating living space consumption as a *space justice* issue (Brokow-Loga & Neßler, 2020).

Less restrictive measures could form the starting point. In particular, housing – or, more precisely, living space as a status symbol – should be addressed raising awareness and problematising overconsumption of living space. An option to further disincentivise overconsumption would be taxing housing wealth. Findings of Rotberg (2022) indicate that taxing expensive properties heavily can reduce housing demand resulting in low-income households profiting from declining rents. In addition, the potential of home swapping as an instrument for more housing sufficiency should be further exploited (Kitzmann, 2024). This could also turn out to be a step towards reducing the consumption of living space of small households and thus the demand for new-built dwellings, an area which offers particularly high potential for both space and energy savings (Ivanova & Büchs, 2022).

Notes

1. Own calculations based on German Federal Statistical Office (2022): https://www-genesis.destatis.de/datenbank/ (Table 31231-0001 and table 31121-0001).
2. Dataset information on SOEP-Core v35 (data 1984–2018): DOI:10.5684/soep-core.v35.
3. Access: https://www.destatis.de/DE/Themen/Wirtschaft/Preise/Verbraucherpreisindex/Publikationen/Downloads-Verbraucherpreise/verbraucherpreisindex-lange-reihen-pdf-5611103.html
4. Examples of categories are 'large core city within a high-density urban agglomeration' or 'high- or middle-order centre within a lower density rural area'. Further information on the classification of municipalities: https://www.bbsr.bund.de/BBSR/DE/forschung/raumbeobachtung/Raumabgrenzungen/deutschland/kreisgebietsreformen/SiedlungsstrukturelleGebietstypen_alt/gebietstypen.html

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Appendix

Table A1. Estimates and standard deviations (in parentheses) of the four within–between models fitted on East German HH only, *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

(Fitted on East German HH only)	Model 1a	Model 1b	Model 2	Model 3
			Within effects	
Second person in household (HH)	0.0956***	0.0963***	0.1129***	0.1129***
	(0.0033)	(0.0033)	(0.0089)	(0.0089)
Third person in HH	0.0693***	0.0693***	0.0668***	0.0673***
	(0.0033)	(0.0033)	(0.0088)	(0.0088)
Fourth person in HH	0.0536***	0.0533***	0.0416***	0.0418***
	(0.0042)	(0.0042)	(0.0113)	(0.0113)
No. of additional HH members	0.0621***	0.0621***	0.0871***	0.0868***
	(0.0052)	(0.0052)	(0.0141)	(0.0141)
Income	0.0287***	0.0288***	0.0218***	0.0214***
	(0.0012)	(0.0012)	(0.0034)	(0.0034)
Local housing cost level	−0.0059***	−0.0060***	−0.0219***	−0.0220***
	(0.0017)	(0.0017)	(0.0051)	(0.0051)
Actual-to-median rent ratio (log)	−0.1585***	−0.1583***	−0.1546***	−0.1542***
	(0.0035)	(0.0035)	(0.0124)	(0.0124)
Owner *(reference: tenant)*	0.3410***	0.3413***	0.2947***	0.2936***
	(0.0045)	(0.0045)	(0.0134)	(0.0139)
HH located in East Germany *(reference: West Germany)*				
Age (reference: 19–30 years old)				
31–40 years old	0.0978***	0.0968***	0.1135***	0.1142***
	(0.0043)	(0.0043)	(0.0130)	(0.0130)
41–50 years old	0.1481***	0.1464***	0.1783***	0.1784***
	(0.0053)	(0.0054)	(0.0157)	(0.0157)
51–60 years old	0.1769***	0.1752***	0.2140***	0.2143***
	(0.0061)	(0.0061)	(0.0176)	(0.0176)
61–70 years old	0.1852***	0.1840***	0.2196***	0.2202***
	(0.0069)	(0.0069)	(0.0195)	(0.0196)
71–80 years old	0.2019***	0.2014***	0.2431***	0.2437***
	(0.0078)	(0.0078)	(0.0218)	(0.0218)
81 years and older	0.2239***	0.2241***	0.2781***	0.2785***
	(0.0091)	(0.0091)	(0.0253)	(0.0253)
Educational level (reference: general elementary)				
Middle vocational	0.0334***	0.0292**	0.0494	0.0494
	(0.0101)	(0.0101)	(0.0319)	(0.0319)
Vocational and Abi	0.0573***	0.0524***	−0.0452	−0.0461
	(0.0150)	(0.0150)	(0.0442)	(0.0441)
Higher vocational	0.0698***	0.0661***	0.0931*	0.0926*
	(0.0124)	(0.0125)	(0.0376)	(0.0376)
Higher education	0.0857***	0.0811***	0.0460	0.0450
	(0.0124)	(0.0124)	(0.0369)	(0.0369)
Inadequately	0.0405	0.0399	0.0282	0.0268
	(0.0362)	(0.0362)	(0.1461)	(0.1461)
Wealth *(reference: less than €50K)*				
€50K–€200K				0.0004
				(0.0078)
€200K–€500K				0.0059
				(0.0115)
€500K–€1,000K				0.0027
				(0.0262)
More than €1,000K				0.0749
				(0.0459)
			Between effects	
(Intercept)	3.6342***	3.7956***	3.6634***	3.6834***
	(0.0235)	(0.0375)	(0.0425)	(0.0424)
Second person in HH	0.1837***	0.1803***	0.1509***	0.1519***
	(0.0092)	(0.0092)	(0.0130)	(0.0130)
Third person in HH	0.0887***	0.0888***	0.0716***	0.0757***

(*Continued*)

(Fitted on East German HH only)	Model 1a	Model 1b	Model 2	Model 3
	(0.0119)	(0.0119)	(0.0178)	(0.0177)
Fourth person in HH	0.0662***	0.0666***	0.0868***	0.0893***
	(0.0139)	(0.0139)	(0.0211)	(0.0210)
No. of additional HH members	0.0816***	0.0831***	0.0647***	0.0639***
	(0.0105)	(0.0105)	(0.0157)	(0.0156)
Income	0.0813***	0.0815***	0.0788***	0.0685***
	(0.0031)	(0.0031)	(0.0043)	(0.0046)
Local rent level	−0.0032	−0.0028	−0.0010	−0.0017
	(0.0032)	(0.0032)	(0.0042)	(0.0042)
Actual-to-median rent ratio (log)	−0.2948***	−0.2940***	−0.2779***	−0.2715***
	(0.0143)	(0.0143)	(0.0254)	(0.0253)
Owner *(reference: tenant)*	0.3560***	0.3546***	0.3702***	0.3067***
	(0.0093)	(0.0093)	(0.0129)	(0.0173)
HH located in East Germany *(reference: West Germany)*				
Age (reference: 19–30 years old)				
31–40 years old	0.1365***	0.1086***	0.0970***	0.0993***
	(0.0139)	(0.0147)	(0.0291)	(0.0290)
41–50 years old	0.1425***	0.0999***	0.1412***	0.1417***
	(0.0149)	(0.0168)	(0.0304)	(0.0302)
51–60 years old	0.1800***	0.1357***	0.1607***	0.1573***
	(0.0178)	(0.0195)	(0.0369)	(0.0368)
61–70 years old	0.2384***	0.2080***	0.2298***	0.2218***
	(0.0215)	(0.0222)	(0.0459)	(0.0458)
71–80 years old	0.2302***	0.2294***	0.2470***	0.2500***
	(0.0261)	(0.0261)	(0.0543)	(0.0541)
81 years and older	0.2544***	0.3007***	0.2172***	0.2168***
	(0.0331)	(0.0341)	(0.0659)	(0.0656)
Educational level (reference: general elementary)				
Middle vocational	0.0351**	0.0314*	0.0316	0.0308
	(0.0129)	(0.0129)	(0.0205)	(0.0204)
Vocational and Abi	0.0506**	0.0494**	0.0407	0.0424
	(0.0189)	(0.0189)	(0.0312)	(0.0311)
Higher vocational	0.0633***	0.0575***	0.0651**	0.0601*
	(0.0169)	(0.0169)	(0.0246)	(0.0245)
Higher education	0.0852***	0.0808***	0.0834***	0.0733***
	(0.0141)	(0.0141)	(0.0219)	(0.0219)
Inadequately	−0.0439	−0.0432	0.0038	−0.0032
	(0.0431)	(0.0430)	(0.0725)	(0.0720)
Migration background (*reference: no migration background*)	−0.0205	−0.0138	−0.0153	−0.0137
	(0.0111)	(0.0111)	(0.0261)	(0.0260)
Year of birth	0.0032***	−0.0021*	0.0041***	0.0042***
	(0.0004)	(0.0010)	(0.0009)	(0.0009)
Years born before 1998 (squared)		−0.00007***		
		(0.00001)		
Wealth *(reference: less than €50K)*				
€50K–€200K				0.0552**
				(0.0171)
€200K–€500K				0.1479***
				(0.0238)
€500K–€1,000K				0.1662***
				(0.0479)
More than €1,000K				0.2548**
				(0.0824)
		Random effects		
SD (intercept)	0.2188	0.2184	0.1975	0.1958
SD (observations)	0.1442	0.1442	0.1442	0.1441
		Model fit		
n	53,506	53,506	8,185	8,185

(*Continued*)

Table A1. Continued.

(Fitted on East German HH only)	Model 1a	Model 1b	Model 2	Model 3
R^2 marg.	0.605	0.605	0.630	0.635
R^2 cond.	0.880	0.880	0.871	0.872
AIC (Akaike Information Criterion)	−17998.2	−18005.9	12.8	22.8
BIC (Bayesian Information Criterion)	−17616.1	−17614.8	314.2	380.3
RMSE	0.14	0.14	0.14	0.14