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# **Housing density and its consequences for couples in Germany: Staying, moving, or breaking up?**

Maike van Damme<sup>a\*</sup>, Sandra Krapf<sup>b</sup> and Michael Wagner<sup>c</sup>

*<sup>a</sup>Department of Political and Social Sciences, Pompeu Fabra University, Barcelona, Spain; Centre D'estudis Demogràfics (CED), Barcelona, Spain; <sup>b</sup>MZES, University of Mannheim, Mannheim, Germany; <sup>c</sup>Institute of Sociology and Social-Psychology, University of Cologne, Cologne, Germany;*

\* Pompeu Fabra University, c/ Ramon Trias Fargas 25-27, Jaume I building, office 20.117. tel: +34 935421972; email: maikevd2011@gmail.com; maike.vandamme@upf.edu; mvandamme@ced.uab.es; ORCID: 0000-0003-1080-9789

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## **Housing density and its consequences for couples in Germany: Staying, moving, or breaking up?**

High housing density has been considered a stressor that is detrimental to couples' relationships. However, empirical research on this topic has been mixed, which might be due to the fact that not all couples respond to density in the same way. We contribute to the literature by not only considering separation as a potential reaction to density but also moving to a new place. Moreover, we combine insights from different theoretical models to explain how couples react differently to an overcrowded home, depending upon their resources. For our analyses, we use the German Family Panel PAIRFAM (10 waves, 2008/09 to 2017/18) with a sample of N=4180 couples, of which 484 experience a move and 488 a separation. Applying competing risk models, we find that vulnerable groups such as the poor and the low-educated are significantly more likely than others to separate when in a dense home rather than to stay in the same dwelling.

**Keywords:** competing risks; housing density; relocation; resources; separation; vulnerability

## Introduction

The home is a key space for everyday life that affects well-being and also personal relationships. Especially in a tight housing market like that of Germany, some couples might be forced to live in housing conditions with relatively little space and thus risk living in a stressful environment. Such psychological distress might put pressure on the couple and eventually lead to union dissolution (Bodenmann et al., 2007). The empirical evidence on the positive association between housing density and separation is mixed, however. Some studies were in line with the theoretically expected relationship (Coulter & Thomas, 2019; Gerber & Zavisca, 2015) while others did not find a statistically significant effect (Krapf & Wagner, 2020; Van Damme, 2019; Jalovaara, 2001; O'Connor, Pickering, & Dunn, 1999). Prior research considered only separation as a reaction to housing density and had not attended to the possibility that couples can escape a crowded housing situation also by moving to a new place with more space. Without the analysis of the alternative outcome *relocation*, we might undervalue the effect of housing density on union dissolution as those who do not separate are a heterogeneous group that comprise those who remain in the same dwelling and those who relocate because of a crowded home. In our study, we estimate a competing risks model with separation, relocation, and remaining in the dwelling (either voluntarily or 'forced') as alternative outcomes. From a methodological perspective, this procedure reduces potential bias that might occur by a reduced view on only separation as outcome. Moreover, analysing separation and relocation histories at the same time responds to the call of life course researchers for an integrated perspective on partnership development, housing characteristics and relocation decisions as intertwined life domains (Coulter, Ham, & Findlay, 2015; Mulder, 2013; Wagner & Mulder, 2015). Empirical studies that acknowledge the interrelation of partnerships and relocation decisions often focus on residential mobility associated

with life course events such as the transition to coresidence (Krapf, 2018; Wagner, Mulder, Weiß, & Krapf, 2019; Krapf, Mulder, & Wagner, 2021), the transition to parenthood (Kulu & Steele, 2013; Vidal, Huinink, & Feldhaus, 2017), the transition to homeownership (Bayrakdar, Coulter, Lersch, & Vidal, 2019), the synchronization of marriage and residential mobility (Mulder & Wagner, 1993; Thomas & Mulder, 2016), or separation (Lersch & Vidal, 2014; Mikolai & Kulu, 2018; Thomas, Mulder, & Cooke, 2017). In these instances, residential moves are conceptualized as a means to adjust to a change in the household composition. In line with this, we consider a dense household as a situation that affects two processes: the development of the relationship and the housing history. Our central argument starts from the idea that living in a dense household leads to stress. Reduced opportunities to withdraw from social interactions and a lack of privacy can increase the psychological distress of each partner in a dense home. Such stress, in turn, deteriorates relationship quality. In order to escape from the stressful dense household situation couples might simply move to a new place with more space. In such a case, moving relaxes the situation and partnership quality should rise again. However, there might be reasons that keep couples from moving ; e.g. some couples might be unable to afford the rent of a more spacious place. These couples are at risk to experience a further deterioration in relationship quality because they are continuously exposed to the stressful dense household. This can eventually lead to union dissolution.

Apart from this competing risks perspective, we want to contribute to the literature by taking into account resources of couples that might enable them to take the decision to move or to separate. We expect to find group-specific effects depending upon a couples' resources. In other words, we expect that even though the choice set (staying/moving/separating) as a reaction to housing density is similar in principle for different sub-groups, certain groups might have more

limited choices than other groups. Previous research may have missed important sources of variation across certain sub-groups of the population and we will look into interactions of resources of couples with housing density. More specifically, it has been shown that the level of economic resources is positively associated to relocation (Cooke, 2011). For union stability, most prior research indicates a lower risk of separation for couples with a high level of economic resources (Lyngstad & Jalovaara, 2010), although this mainly points to the male partners' income and not to the income of the female partner – where economic independence may lower the separation threshold. We expect, however, that a higher general level of household income will be related to a lower union dissolution risk, just like a higher educational level (as a second measure for socio-economic status) will. In addition to the socio-economic position we are also interested in psychological resources and how they are associated with separation or relocation of a couple. To this end, we also analyse the interaction effect of neuroticism and density on relationship development.

To investigate the question on how couples react to a dense housing situation, we use the German dataset PAIRFAM for the years 2008/09 to 2017/18 (waves 1-10). In the analytical sample, we observe 484 moves and 488 separations. We use competing risk models to test for the main effect of housing density on three housing outcomes staying, moving and separating as well as for interaction effects of housing density and lack of resources.

### **Previous research on the consequences of housing density on union dissolution and moving**

The starting point of our theoretical consideration is that housing density might be problematic for couples because it produces stress (see Campagna, 2016, for a brief overview). For well-being in general, prior research shows that density negatively affects children's outcomes, such as psychological distress, academic performance, aggression (Evans, Saegert, & Harris, 2001; Maxwell, 2003; Solari & Mare, 2012), and educational attainment (Conley, 2001). But how does a dense home affect couple relationships? Taking a life course perspective, we suggest that couples in a crowded home can move to a new place, separate or remain in their dwelling. This perspective integrates the idea that partnership development and residential decisions are closely interrelated (Mulder, 2013). To our knowledge, no study has analysed these different outcomes in a competing risk setting. The few studies that have focused on housing density as a determinant of separation have mixed findings. Two studies that were published around 20 years ago (Jalovaara, 2001; O'Connor, Pickering, & Dunn, 1999) found a positive relationship between housing density and separation in a bivariate model. However, after taking into consideration other socioeconomic characteristics, the association became statistically insignificant. In line with this, Van Damme (2019) found that the relationship between crowding and separation was insignificant when taking housing tenure into account in Luxembourg. Krapf and Wagner (2020) also did not find a significant relationship between housing density and union dissolution in Germany, while the results of Coulter and Thomas (2019) and Gerber and Zavisca (2015) support the hypothesis of a positive association between dense housing and the probability of separation in the UK and Russia, respectively.

The studies discussed so far focused on the association of housing density and union dissolution. However, instead of breaking up, a couple may escape a dense housing situation by moving to a new place with more space. This is in line with the view that residential moves are a

means of adjusting a family's housing situation to meet its needs (Coulter et al., 2015; Rossi, 1955; Wagner & Mulder, 2015). For example, families may move before or after the birth of a child because of their (anticipated) increased space demands (Kulu, 2008) although the presence of (older) children may be related to immobility and stability. A study on housing conditions before and after a residential relocation in Great Britain found that 59 per cent of movers with young children moved to a larger home (Gambaro, Joshi, & Lupton, 2017). The analyses also showed that families in dense dwellings were twice as likely to move to a new home than families who lived in non-dense dwellings. This implies that the desire for increased space is one aspect associated with a residential move, regardless of whether the decision to have a child comes before or after the move (Coulter et al., 2015). However, the reason why some couples who live in a dense home move to a more spacious home while others separate has been neglected in previous research.

### **Theoretical framework**

The life course perspective stresses that different life domains affect each other. The interrelation of housing, residential mobility and partnership/family developments has been acknowledged in the literature in recent years (Clark, 2013; Coulter et al., 2015; Wagner & Mulder, 2015). However, the life course approach is not a theory that explains behaviour and therefore it has to be complemented by a decision or behavioral theory at the micro-level. The two outcomes we consider as a 'reaction' to housing density—relocating and breaking up—are usually discussed and analysed within different theoretical approaches. Therefore, we combine theoretical arguments from the environmental-psychological model (Bell, Greene, Fisher, & Baum, 1996) and the stress-divorce model (Bodenmann et al., 2007). We also rely on the vulnerability-stress-adaptation



model (Karney & Bradbury, 1995) concerning its integration of attachment, crisis, and behavioural theoretical models.

*Housing density, crowding and stress: the environmental–psychological model*

The idea that a couple must take action to resolve an overly dense housing situation is predicated on the assumption that such living conditions are inherently stressful (e.g. Campagna, 2016). But what might be in the black box that could explain the relationship between housing density and stress? Several environmental psychological approaches (e.g. Baum & Paulus, 1987; Bell et al., 1996) have distinguished between the concepts of housing density and crowding. Housing density is considered an objective measure, whereas crowding is the subjective perception or evaluation of housing density (Bell et al., 1996), although the term crowding is nevertheless used for objective measurements as well (e.g. Coulter & Thomas, 2019; OECD, 2018; U.S. Department of Housing and Urban Development Office of Policy Development and Research, 2007). Whether called housing density or crowding, many studies have pointed towards negative effects of living in a dense household: it seems to affect physiological arousal, illness, attraction, withdrawal, helping behaviour, aggression, and task performance (see next section). From an environmental psychological perspective, control over the housing situation mediates the relationship between housing density and crowding (Baum & Paulus, 1987). In other words, when housing density leads to a lack of control over the situation, feelings of crowding, i.e. the subjective, stress-inducing perception of too little space, may occur more frequently. For instance, social overload and unwanted interactions can be interpreted as a lack of control over the setting and withdrawal can then be the result, a way of coping with lack of control (Stokols, 1972). A person may also perceive a lack of control when she is unable to maintain desired privacy in a high-density setting (Baum & Paulus, 1987; Bell et al., 1996). In sum, objective housing density may lead to lack of control

and when stress is perceived it is referred to as crowding. Hence, crowding is housing density that goes together with short-term stress, and this in turn may lead to enduring stress if not well coped with. While crowding is a subjective measure that implies some form of stress, density refers to the objective number of persons and rooms in a place (which may or may not go together with stress). In our empirical analyses, we only have a measure of objective housing density. Only in the case of resulting stress will we refer to crowding.

The effect of density is especially relevant if it is involuntary, i.e. in the situation where the couple would like to have more space but cannot afford a non-dense dwelling. However, living in a dense home can be voluntary. Couples may choose to live in a smaller home in order to be close to certain facilities in a city centre, for instance, or couples may invite relatives to live in their home to help them with financial or health challenges.

When a couple copes successfully with a dense living environment, the couple *adapts* to the situation (see also Karney and Bradbury, 1995) and the partners do not experience chronic stress as an outcome of housing density. However, if the couple is not able to cope with housing density, stress increases/continues. Coping is thus important because it mitigates the effects of housing density; it is a continuous process, in which both partners should be motivated to help one another, hence reducing one's own individual stress and maintaining a high relationship quality (Bodenmann, 1995).

The decision to move is also a strategy to cope with a dense housing situation. If preferences for more space and the space available in the present location do not match, a couple decides to relocate (Li, 2004; Mulder, 1993).

### *The stress–divorce model*

Couples who do feel stress in their dense household but who do not move are at risk to experience a deterioration in relationship quality. According to the categorization of Randall and Bodenmann (2009) in their review of stressors, crowding has been considered as an external, chronic, minor stressor. This type of stressor can be particularly detrimental to couples' relationships because couples are less aware of the stress effect of housing density compared to that of major stressors such as unemployment or critical life course events (divorce, child birth). In their stress–divorce model, Bodenmann et al. (2007) point out that stressors of low intensity such as daily hassles slowly accumulate in a process of relationship dysfunction- which eventually can lead to separation. We view this part of the stress-divorce model as a (mal)adaptation process to cope with a stressful, dense housing situation.

There is a main caveat when examining the association between housing density and relationship outcomes of stress. Certain socioeconomic groups might be more used to a lack of housing space than others. For instance, children from lower socio-economic backgrounds might be more used to sharing a room as a child, whereas upper-class children might be more used to having a room for themselves. As such, crowding is a subjective relative experience: subjective, because it is about people's perceptions of housing density, and relative, because people may compare themselves to their surroundings when judging whether their housing space is adequate or not.<sup>1</sup>

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<sup>1</sup> We checked to what extent these surroundings are in a similar housing situation by looking at reference groups (groups constructed by similar age and education). We compared the level of housing density in three cohorts and detailed educational levels, and we found that housing density is more common the less educated the couple is. This association especially holds among the oldest cohort (born between 1971 and 1973).

*Coping with stress and the moderating effect of vulnerabilities: the vulnerability-stress-adaptation model*

Based on the considerations above, couples living in dense dwellings are more likely either to move or to break up in order to escape the emotional stress that comes with housing density compared to couples in spacious dwellings. However, what conditions increase the likelihood either of a move or of a separation? We expect that partners with certain vulnerabilities are less successful in coping with an external stressor like housing density. Karney and Bradbury (1995) suggested in their integrated model that stress effects are moderated by vulnerabilities. We consider persons with a high level of neuroticism and those with few socio-economic resources as vulnerable. We expect that vulnerable persons have fewer (financial or emotional) resources to escape a crowded situation by moving to a new place. Indeed, existing research shows that low income, low education and a higher level of neuroticism are associated with a lower likelihood of relocation (Coulter, van Ham, & Feijten, 2011; McCann, 2015). *Instead of relocating, we expect that vulnerable persons more likely separate as a reaction to high density.* Neuroticism negatively affects communication or coping strategies between partners. For instance, those who score high on neuroticism report lower levels of problem-solving skills and higher levels of confrontation, escape avoidance, and self-blame (DeLongis & Holtzman, 2005). Experiencing high levels of negative emotions limits one's ability to choose adequate coping strategies and might thus influence separation (Bodenmann, 1995; Bodenmann et al., 2007). It is less clear how neuroticism affects relocation; some US-studies indicate that higher neuroticism is associated with a smaller probability to move (McCann, 2015), while others do not find this association (Jokela, 2009).

Next to psychological resources, couples can have other sources of vulnerabilities that are associated with their socio-economic position, for example economic and educational resources. Having fewer economic resources limits a couple's coping abilities in situations of housing

density. Couples with lower income can less easily decide to move to a more spacious home because a larger place is usually more expensive. Therefore, they stay in the high density home which might lead to psychological distress and eventually to a deterioration in relationship quality. Furthermore, lack of educational resources is an indication of the extent of life strains couples may experience. Studies have shown negative associations between education and work stress (Lunau, Siegrist, Dragano, & Wahrendorf, 2015), education and poor health (Hoffmann, Kröger, & Pakpahan, 2018), and education and housing deprivation (Fusco, 2015). Low education might therefore have a detrimental impact on relationship quality, especially in stressful situations, and as a consequence might lead to separation (Boertien & Härkönen, 2018; Matysiak, Styrac, & Vignoli, 2014; van Damme, 2020). In addition, we expect that higher educated couples are more likely to migrate, especially since their labour market engagement and occupational attainment is higher (e.g. Machin, Salvanes, & Pelkonen, 2012).

In sum, if vulnerabilities (i.e. lack of financial resources, having a high score on neuroticism, or having low education) occur simultaneously with housing density, the stress mechanism is likely to induce conflict and relationship dissatisfaction. Thus, we expect that partners with certain vulnerabilities are less successful in coping with stress due to housing density. They will experience more difficulties with dyadic coping and therefore experience more (chronic) stress, which reduces relationship quality (expressed in conflict and relationship dissatisfaction). Couples that do not cope well will eventually be more likely to separate rather than to stay. In addition, we will add to the literature to what extent couples with a lower educational level might be more likely to separate rather than to move.

### *A theoretical model as a brief summary*

Clearly, both the decision to move and the decision to separate are the product of many *reciprocally influencing processes*, which is difficult to analyse. In any case, the focus on one outcome lumps together those who remain in the same dwelling with either those who separate (in case the binary outcome variable is “moving”) or those who move (in case the binary outcome variable is “union dissolution”). We have tried to illustrate this argumentation in the conceptual model below (see Figure 1). Note that this model is a simplified version of actually expected processes that are influencing moving and separation as outcomes of high housing density. The graph illustrates that moving and separation are not necessarily competing outcomes at the exact same time; couples might consider these options at different points in a process of relationship deterioration (and are thus paths in the same process).

[Figure 1 about here]

### ***Hypotheses***

We expect the following processes to take place: Living in a dense home leads to a higher level of psychological distress, e.g. because there is too little space for privacy and/or to withdraw from social interaction. If couples realize that their dwelling does not meet their space demands (anymore), they might decide to move to a new place that is more spacious. In case a couple does not relocate but experiences crowding, relationship satisfaction might decline and lead to separation. *We expect that the less space couples have in a dwelling, the more likely they are to*

*experience a residential move or a relationship break-up (rather than to stay in the same dwelling without a relationship break-up) (H1).*

Moreover, housing density may affect coping and conflict even more when the couple is more vulnerable. Thus, we formulate more specific variations of Hypothesis 1 based on the vulnerability of the couple: *We expect that couples who live in a more dense home are less likely to move (rather than staying) if the couple has less economic resources (H2a), if the partners have a higher score on neuroticism (H2b), or if the partners of the couple are less educated (H2c). In addition, we expect that couples who live in a more dense home are more likely to experience a relationship break-up (rather than to stay) if the couple has less economic resources (H3a), if the partners have a higher score on neuroticism (H3b), or if the partners of the couple are less educated (H3c). Finally, we expect that more vulnerable couples (with less economic resources(a), higher neuroticism scores (b), and less education (c) are more likely to experience a relationship break-up rather than a move (H4a, b, c).*

## **Data, operationalization, method**

### ***Data***

To test these hypotheses, we used the German Family Panel PAIRFAM (Release 10.0), waves 1-10 (period 2008/9–2017/18) (Brüderl et al., 2017; Huinink et al., 2011). These data include the partnership histories of three birth cohorts (born 1991–1993, 1981–1983, and 1971–1973). Housing information was collected at the time of interview. Therefore, we had to restrict our analytical sample to couples who reported being in a co-residential partnership at the time of the interview (note that we had information on union duration from self-reported partnership histories). Respondents were asked about which months they were living together with a partner

and if not, whether they broke up or the partner passed away. We excluded couples that were in a LAT relationship. Hence, we only analysed respondents who either stayed together or stopped living together *and* also ended their intimate relationship. We also coded couples as separated if they dissolved their union within three months after one partner had moved out of the joint household. Moreover, we excluded couples in which the respondent or the partner reported that his/her main activity status was ‘being a student’ (there were few such couples; see appendix for results of a sensitivity analysis).

Information about income was missing in about one third of the cases and there was no information about neuroticism for the partner in about one third of the cases. Ignoring missing values by exclusively analysing complete cases might lead to inefficient and/or biased estimates in multiple regression analyses (Van Buuren, 2018). Therefore, we used Multiple Imputation by Chained Equations (MICE) to impute the missing cases. In the imputation model, all variables of wave  $t$  that are included in the final model were used to impute residual income in all waves and partner’s neuroticism in wave  $t+1$  (see operationalization below). We refrained from using weights because we took into account sex, age, and city size in our regression analyses. In Table A2c, we present a sensitivity check using only complete cases. The results are fairly similar.<sup>2</sup>

## ***Method***

To assess the association between housing density and relationship and housing outcomes, we used a competing risk discrete-time hazard model for the transition to either (1) another dwelling (move)

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<sup>2</sup> The only differences are that, in the complete case analysis, for the ‘main effect’ the dense category differs significantly from the medium housing density category and that the interaction between housing density and education is insignificant. Therefore, it seems worth to do the multiple imputation.



or (2) union dissolution compared to remaining in the same dwelling. This is implemented by a multinomial logit model on a person-period file. Moreover, using a number of interactions in the model, we analysed to what extent the association of housing density on either moving, separating or staying is moderated by vulnerability.

The data were organized in a discrete-time event history format, with relationship-years as units of observation. Right-censoring occurs, but is not a problem in an event history approach (Yamaguchi, 1991), unless it is selective with those relocating being more likely to dropout. Below we briefly address dropout (missing values) analyses and reason that our results might be conservative because of the more disadvantaged dropping out more frequently, just like other studies have suggested (Stone, 2014). To adjust for multiple observations of individuals in the period under study, we specified panel robust standard errors. Note that we did not include multiple events per person, but censored at the first event (relocation or separation, whichever comes first) that occurred in the first coresidential union of a person in our data. If mobility and breaking-up were experienced at the same time, we classified this as separation. Out of the sample of first move and separation events of 5,113 coupled individuals, we analysed 4,180 co-residential couples (22,208 relationship-years) that had no missing values. Overall, we lost 18% of the couples due to missing values on at least one of the independent variables.<sup>3</sup> Missing values analyses revealed that we had a selective sample which was ‘advantaged’ in some aspects (e.g. with respect to separation and income). Therefore, we expect to find conservative estimations of the housing density effect

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<sup>3</sup> We imputed residual income, net household income, respondents’ neuroticism score in wave 1, and partner’s neuroticism score in wave 2 out of the following variables of wave 1: separation, age, partners’ age, labour force status, educational level, living in east or west Germany, being married or not, living in the city or not, household type, health, equivalized household size, being a migrant or not. Of all the missing cases, we imputed 65% out of all the cases of all the waves. The rest of the cases remained incomplete because of unit non-response or not having a partner in a certain wave. The percentage missing values of our initial sample was 29% in the first wave, which we reduced to 18% by multiple imputation.

on housing outcomes. Most of the relationships in our sample were stable over the observed period, but there were 488 cases in which the relationship ended (2.2% of the relationship-years, or 10% of the couples) and 484 residential moves (2.2% of the relationship years, or 12% of the couples).

### ***Operationalization***

First, we created our categorical outcome variable. To do so, we considered the following categories: (0) remaining in dwelling (immobility) without separation (including putting up with the crowded situation), (1) moving to another dwelling by both partners (relocation), (2) breaking up (separation). Relocation information is available from full residential histories of respondents about their main residence. We extracted the separation information from a respondent's partnership history based on the information whether a relationship had ended according to the respondent. Notice that this category consists of two cases: either separation can go together with relocation or the partners remain living together in the same home after separation. (This latter group might comprise couples who have difficulties to find affordable housing on their own immediately after separation but it were too few couples to be analysed as a separate category.) Note that one partner can also relocate without separation. These LAT relationships are excluded from our analyses as the decision to start an LAT relationship might have other reasons than housing density (such as a job change). In Table 1, we show the descriptives for the housing outcome variable, including the combination of the two categories that involve separation, and the number of observed LAT transitions during the panel period.

[Table 1 about here]

Housing density was measured by an objective indicator: the number of persons per room (e.g. Conley, 2001; Gove, Hughes, & Galle, 1983; Regoeczi, 2008). In PAIRFAM the following question was asked: *And how many rooms does this apartment (or this house) have?* If this question was unclear to the respondent, the interviewer gave the instruction to count only rooms that are larger than six square meters and that are not bathrooms or kitchens. Thus, in our analysis the number of rooms refers to the number of bedrooms, living rooms, and other rooms such as workrooms. Based on this, we calculated the ratio of individuals living in the household to the crude number of rooms (children under age 12 were counted as 0.5). A low score on our density indicator refers to spacious dwellings, while couples with less space in the home have a higher density score. Many studies use a dichotomized variable, indicating higher housing density in case of more than one person per room. Here, we used three categories: (0) less than one person per room, (1) one person per room, and (2) more than one person per room (see also Krapf & Wagner, 2020). Table A1 reveals that 6% of respondents in our sample were living in a dense home. We discuss sensitivity checks with a continuous measure (see Figure 2 for the distribution of housing density based on the number of persons per room) as well as a floor space measure in the appendix.

[Figure 2 about here]

Financial resources are first a measure of our concept of economic vulnerability and second they are a relevant covariate of housing density because larger dwellings are more expensive (at least compared to smaller dwellings in the same local housing market). We measured economic

resources based on the residual income approach (Haffner & Heylen, 2011; Stone, 2006). The residual income is the available amount of net household income per month in Euro after housing costs are deducted, divided by the number of household members (in line with the OECD equivalised scale, children below age 12 are counted as 0.5). This approach increases the comparability of income levels of couples in different life course stages and in varying local housing markets. Regional housing costs differ substantially in Germany and this is captured by subtracting housing cost from the household income. By weighting adults and children differently, we account for the household's size and composition. For housing costs of owner-occupiers, we used the information on mortgages or building loans and monthly expenditures on utilities (heat, electricity, water). For tenants, we used monthly expenditures, including rent and utilities. These items were asked in waves 1, 3, 5, and 7 only. For waves 2, 4, 6, and 8, we used the values reported in the previous wave. In waves 3, 5, and 7 the respondents were asked the question only if they had reported a residential move. This approach was based on the assumption that a couple's housing costs had changed relatively little in subsequent years unless they had moved to a new dwelling. The reported amount was then deducted from the monthly net household income. We took the household structure into account by dividing this amount by the number of (equivalized) household members (and thus create equivalised residualised income). We use this continuous measure in our analyses. We also did additional analyses where we replaced the residual income variable for the unstandardized net household income per month.

The personalities of the respondent and of the partner were measured with the most important Big Five dimension (Digman, 1990) for proneness to divorce: neuroticism (Karney & Bradbury, 1995). The items for measuring this dimension can be found in the appendix and were measured in waves 2, 6 and 10 for the respondent and in wave 2 for the partner. The missing

neuroticism information of the respondent in waves 3-5 and waves 7-9 were filled in on the basis of the average between the surrounding waves. The level of neuroticism of the partner was assumed to remain stable throughout all waves. We calculated the average neuroticism score of both partners and used that score as a continuous measure in our analyses.

The educational level of the respondent and of the partner were measured by ISCED. To measure the ‘educational level of the couple’ we take the average educational level of both partners.

Time-varying variables were residual income and education. The question battery on neuroticism, as part of the Big Five personality traits, was asked only in wave 2, 6 and 10 for the respondent and in wave 2 for the partner and is therefore (almost) time-invariant.

### ***Control variables***

In our models we controlled for gender, age, union duration (in years), marital status, location in a city centre, and migrant status.<sup>4</sup> We had to control the analyses for possible suppressor effects of the number and age of children in the household (Jalovaara, 2001; van Damme, 2019) and explanatory effects of housing tenure (van Damme, 2019). See the appendix for the detailed operationalization of all variables (including the control variables) and their descriptives. All control variables were time-varying except gender and migrant status.

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<sup>4</sup> We did not take the other Big Five personality traits (extraversion, agreeableness, conscientiousness, and openness to experience) into account, since that would have taken up too many degrees of freedom (preliminary analyses showed no effects of any of those variables on our outcome variable).

## Results

### *Housing density and housing outcomes*

In Table 2, we show the results of our competing risk analyses. The first part of the table shows the logit coefficients with respect to moving versus staying, and the second part of the table concerns separation versus staying in the dwelling. There are no significant differences between living in a dense dwelling or a medium spaced dwelling and moving or separation on the one hand versus staying on the other hand (Models 1 and 2). However, living in low-density (spacious) homes significantly reduces the likelihood of a move compared to living in a medium-sized home (the difference between medium-size and dense homes is insignificant). This result is not in line with our hypothesis H1 on significant differences between dense and non-dense homes, but in line with our further expectations (H1a-c), because we theorized that only the behaviour of vulnerable couples would be affected by highly dense housing conditions. Ignoring this interaction effect may indeed show insignificant differences between the dense and non-dense households, when different socio-economic groups are pooled.

[Table 2 about here]

### *Housing density moderated by vulnerability affecting housing outcomes*

A central argument we developed in the theory section was that housing density is especially likely to affect the partnership behaviour of vulnerable persons. In Models 3, 4 and 5 (Table 2), we assessed to what extent there is a moderation of the housing density effect by neuroticism, educational level, and economic resources. Because of the ongoing discussion in the literature about the advantages and disadvantages of presenting results of logistic regressions as logits/odds

ratios or as Average Marginal Effects (AMEs), we relate to both in our interpretation (Buis, 2010; Williams, 2016). Below, we first interpret the logits and then discuss the AMEs. In Figures 3 to 5, we present the AMEs of the interactions between housing density for residual income (Figure 3), neuroticism (Figure 4), and educational level, respectively (Figure 5). Because our outcome variable is nominal, each bar in the figures refers to a different outcome. Bar (a) refers to the outcome ‘staying in the same dwelling’, bar (b) refers to ‘moving to another dwelling’, while bar (c) refers to ‘separation’. In the graphs, we present the Average Marginal Effects, which are the change in predicted probabilities for each outcome in a housing density category when resources (economic, psychological, educational) are increased by one unit. This allows us to test our interaction hypotheses, which are specifications of our main housing density hypothesis.

With regard to the main effects of resources on housing outcomes, we would expect that more neurotic couples are more likely to break-up<sup>5</sup> and that higher educated couples are more likely to move and less likely to break-up.<sup>6</sup> This is indeed what we find (see Table 2). For income, one might expect theoretically a positive impact on moving (higher income couples have more resources to move) and a ‘competing’ (or null) effect on separation: I.e. a ‘positive’ influence of household income since couples with more income have less financial stress versus a ‘negative’ influence of higher income of the female partner. The null-finding for the effect of income on separation is indeed in line with this competing expectation (i.e. simultaneously a positive and a

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<sup>5</sup> Note that the effect of couples’ combined neuroticism score is mainly due to anchors’ neuroticism score. We ran models including both partners’ neuroticism scores separately and did not find an influence of partners’ score on neuroticism, once controlling for anchors’ neuroticism (both are very low correlated, hence multicollinearity is not an issue here).

<sup>6</sup> In addition, we ran a model collapsing the moving and separation category together in one ‘non-staying’ category. We find a non-significant result, which we believe can be explained by the positive influence of education on moving cancelling out the negative influence of education on separation.

negative impact of income on separation). For moving, however, we also find an insignificant income effect.

As shown in Table 2, Model 3, we find that the interaction of housing density with economic resources relates to the likelihood of separation (the interaction effect differs significantly from zero [ $\chi^2_{(df=10)} = 30.34$ ;  $p=0.001$ ]): Those in dense homes with few economic resources (i.e., having a smaller amount left after housing costs are deducted from their income) are more likely to separate than those in less dense homes; For couples without residual income, the odds of breaking up (rather than remaining in the dwelling) for couples living in dense dwellings are almost three times higher than for couples living in medium-sized homes [ $\exp(0.836 - 0.228) = 2.90$ ] – the interaction effect for dense versus medium-sized homes is statistically significant. However, for every 1000 Euros equivalised residual income a couple earns more, this difference between dense and medium-sized dwellings decreases. For instance, for a couple with 1000 Euro's residual income the odds of separation rather than staying are 29% lower for those living in a dense and not in a medium-sized home [ $\exp([0.836 - 0.228] + 1 * [-1.033 - 0.368]) = 0.71$ ] (see Table 1, Model 3, separate versus stay). We also comment on the difference between spacious homes and medium-sized homes for couples with different economic resources – the interaction-effect of income with the difference between spacious homes and dense homes is insignificant. The difference between living in a spacious home and living in a medium-sized home is positive for those couples without any residual income. However, the more income couples have, the less likely couples living in spacious homes separate compared to those living in medium-sized homes. More specifically, for couples without residual income, the odds of breaking up (rather than remaining in the dwelling) for couples living in spacious dwellings are 26% higher than for couples living in medium-sized homes [ $\exp(0.228) = 1.26$ ]. However, for couples who have 1000 Euros



equivalised residual income, this difference between spacious and medium-sized dwellings decreases to a negative difference of 13% [ $\exp(0.228 - 0.368)=0.87$ ]. In other words, the odds of separation for couples (with 1000 Euros of residual income) in spacious homes are 13% lower than for couples in medium-sized homes. Note that 65% of the couples in the sample have a residual income below 1000 and 95% below 2000 Euros. With respect to hypothesis 4a, we also compared the odds of separation to the odds of moving: For economic resources, we found that the interaction with housing density is borderline significant when comparing couples living in dense homes to those in medium-sized homes ( $b=-.938$ ,  $p<0.0601$ ) – the housing density impact is insignificant when comparing dense homes to spacious homes. This borderline significant differences between couples living in dense homes versus medium-sized ones implies that couples living in dense homes are more likely to break up rather than move when the couple has very little financial resources (0 Euro's), but the more income a couple has, the smaller the housing density effect on separation versus moving (base category) becomes (i.e. the less likely the couple separates rather than moves).

The interaction effects of housing density and neuroticism are presented in Model 4, Table 1. Here, the interaction between housing density and vulnerability is not significant. However, when we interpret the odds of separating vs. staying for the interaction effect of housing density and education (Model 5, Table 2), we again observe a significant difference. Couples without any secondary education are about 3,5 times more likely to separate when living in a dense home than living in a spacious home [ $\exp(1.570+(-0.308*1))=3.53$ ]. However for a one unit increase on the ISCED scale for couples average score this difference decreases with 27% [ $\exp(-0.308=0.73)$ ] (see Table 1, Model 5, separate versus stay). Maximally, education decreases the housing density difference in separation risk until a positive difference with – for those with at least doctoral

degrees – couples living in a dense home being half as likely to separate than couples living in a spacious home [ $\exp(1.570 + (-.308 * (8-1))) = 0.56$ ]. Note that the interaction effect of the couple's educational level and housing density on housing outcomes is significant ( $\chi^2_{(df=10)} = 71.66$ ;  $p < 0.000$ ). We also tested the impact of housing density on separation versus moving (as a base category) according to the couples' educational level to test hypothesis 4c (not in table). We indeed find that couples with less resources are more likely to break up rather than to move ( $b = -0.389$ ,  $p < 0.018$ ). The impact of housing density on separation (versus moving) decreases the more couples education increases. For instance, for couples where both partners do not have a degree, the odds of separation (versus moving) for those living in a dense home are [ $\exp(1.802 + 1 * -0.389) = 4.11$ ] about four times higher than for those living in a spacious home. In contrast, for couples where both partners have a doctoral degree, the odds of separation (versus moving) for those living in a dense home are much lower than for those living in a spacious home [ $\exp(1.802 + 8 * -0.389) = 0.27$ ]. This confirms our fourth specified hypothesis for education as indicator of vulnerability to impact the effect of housing density on separation versus moving.

Figures 3 to 5 illustrate the interaction effects graphically: Couples with zero equivalized residual income living in a dense home are 2.6 percentage points more likely to separate than those living in a spacious dwelling. Put differently, poor couples in high-density homes are the most likely to separate, although there is a lot of variation among those who are living in dense dwellings and their likelihood to separate (in any case, the Confidence Interval indicates a positive impact). However, for couples having 1000 Euro's more of income, living in a dense home compared to a spacious one does hardly increase the probability to separate, whereas for couples with a residual income of 1000 Euro's living in a dense home have a 0.4 percentage point lower probability to separate than couples living in a spacious dwelling. Furthermore, we find a significant interaction

effect of housing density and educational level. Couples living in a dense home are 7.3 percentage points more likely to break-up than those in a spacious home when they are very low educated (educational level ISCED 1b – no degree). Educational level decreases this negative housing density impact. More concretely, for very high educated couples (educational level ISCED 6 – doctoral degree), the probability to separate is 0.9 percentage points lower for those living in a dense home compared to a spacious dwelling.

[Figures 3 – 5 about here]

In order to check whether these results were robust after changing the operationalization of variables and including subgroups that were excluded in our main analyses, we specified six additional models (see appendix). For instance, we used a continuous measure of density instead of the number of persons/room measure in one model and included students instead of excluding them from the analyses in another model. These additional estimations did not substantially challenge the results presented above. Moreover, we estimated one model with net household income instead of our residual income measure. In this specification, we found a lower, but still significant, interaction effect of income and density on separation but not on moving (results will be provided upon request).

## **Conclusion and discussion**

In this paper, we tried to unravel the effect of housing density on partnership outcomes. While most research focused on the association between density and separation, we suggested to consider

moving to a new place as an alternative ‘reaction’ to dense housing. We translated this into a competing risks setting in our empirical analyses with three housing outcomes: (1) separation, (2) relocation and (3) remaining (or ‘putting up’) in the dwelling with the partner. First of all, we did not find a robust significant difference between dense housing and medium-sized housing for couples’ housing outcomes in our initial analyses. This insignificant difference on separation/moving/staying is in line with the recent findings of Krapf and Wagner (2020) – who used the same data as this paper – and van Damme (2019), who also did not find ‘main effects’ of housing density on union dissolution. As an extension to existing studies, we developed hypotheses with regard to vulnerable groups: We expected that the decision processes of couples with more resources versus couples with fewer resources would differ. Indeed, in our empirical analyses we found evidence of an interaction between socio-economic status and housing density. Put differently, we believe that our empirical findings show how household resources affect how people (can) deal with housing density. We found that the effect of housing density was moderated by vulnerability, such that (compared to couples with more resources) poorer couples and less educated couples were more likely to separate when the couple was living in a dense dwelling. The fact that density affects the behaviors of rich and poor persons in a different way provides evidence for our hypothesis that expected group-specific effects depend on a couple’s financial and educational resources. We did not find such an interaction between emotional resources, measured as neuroticism, and density, however.

Although not all the results are equally robust across different model specifications<sup>7</sup>, we seem to find a tendency to react to housing density which is partly determined by the amount of

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<sup>7</sup> Models using a continuous floor space measure did not show significant interaction-effects with vulnerabilities, apart from the neuroticism score of the couple. This is, however, not surprising, since floor space is expected to be a less severe indicator of housing density.

socio-economic resources couples have. Those with more resources are more likely to resolve living in a too dense household situation by moving to a new (larger) home, whereas those with little resources do not seem to have this option. These more vulnerable couples (compared to couples with more resources) are instead more likely to break-up when living in a dense dwelling compared to those living in more spacious homes,. These findings are in line with our expectations according to the environmental-psychological model that links housing density and stress, the stress-divorce model that links stress (from housing density) to union dissolution, and the vulnerability-stress-adaptation model that suggests moderation effects of (housing) stress by several forms of vulnerabilities. What is not compatible with the vulnerability-stress-adaptation model is that we did not find a moderating impact of neuroticism on the effect of housing density on union dissolution or moving. We would have expected to find this, as according to the vulnerability-stress-adaptation model, those with more vulnerable characteristics to experience stress (i.e. those with higher scores on neuroticism) would be more likely to dissolve their union than those who are less vulnerable. Perhaps other indicators of vulnerability are likely to stress individuals and couples. We focused on neuroticism because it is a well-know influential factor explaining union dissolution (at least among older women in Germany), driving difficulties in problem-solving for couples (Lundberg, 2012), but it appears not to be moderating the impact of housing density on separation. We are not aware of any findings of a relationship between neuroticism and moving, hence, our null finding is in line with previous literature on this aspect.

In any case, when it comes to socio-economic resources, our results support the idea that the effect of housing density is not the same for all groups: vulnerable groups may be more negatively affected when it comes to their ability to move, and more ‘positively’ affected when it comes to separation. Future research should investigate to what extent stress is the mechanism

explaining this, thereby testing the vulnerability-stress-adaptation model even more explicitly. In addition, it seems plausible that we did not always find strong differences between high density and medium density dwellings because we could not account for the extent to which these crowded conditions were voluntary and therefore could not consider to what extent couples experienced a lack of control while living in a dense household. Future research should therefore measure the effects of (subjective) crowding rather than (objective) housing density, because the former is more closely related to the experience of stress.

Despite these limitations, the fact that we did find interaction effects of couples with few resources and housing density on the decision to move or to separate (rather than to stay) in a relatively small sample<sup>8</sup> is telling and suggests that a situation with little resources leads to reduced coping abilities when in a highly dense household situation. As a consequence, those couples that do not have sufficient financial or educational resources to adjust their living conditions, when already living in a dense household, are faced with higher risks of separation. And in turn, separation is usually associated with downward shifts on the housing ladder. Hence, a combination of poor housing conditions and limited resources seems to trigger both partnership and residential instability.

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<sup>8</sup> The cell sizes for couples living in a highly dense home are small.

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## Tables

Table 1. Relationship outcomes. PAIRFAM 2008/09-2017/18. Data set including multiple imputation. Final analytical sample

	frequency	percentage
Start living apart together (LAT; excluded)	19	0.09
Stay in relationship and do not move	21236	96
Stay in relationship and move	484	2.18
Separated, including those who	488	2.20
(a) Separate and do not relocate	117	0.53
(b) Separate and relocate	371	1.67
Total person-years	22227	100

Table 2. Discrete-time event history analyses of reaction to household density. Logit coefficients; significance levels. (Standard errors in parentheses)

	(1)	(2)	(3)	(4)	(5)
MOVE vs STAY					
Union duration	-0.027 (0.031)	-0.025 (0.031)	-0.024 (0.031)	-0.025 (0.031)	-0.025 (0.031)
Union duration_2	-0.001 (0.002)	-0.001 (0.002)	-0.001 (0.002)	-0.001 (0.002)	-0.001 (0.002)
Spacious (< 1 pp room)	ref	ref	ref	ref	ref
Medium (1 pp room)	0.486*** (0.114)	0.499*** (0.115)	0.334 (0.204)	0.909* (0.483)	0.209 (0.432)
Dense (> 1 pp room)	0.153 (0.200)	0.185 (0.199)	0.348 (0.325)	0.663 (0.738)	-0.232 (0.670)
Male (anchor)	0.021 (0.089)	0.055 (0.090)	0.056 (0.090)	0.054 (0.090)	0.054 (0.090)
Age (anchor)	-0.041*** (0.010)	-0.051*** (0.010)	-0.051*** (0.010)	-0.050*** (0.010)	-0.051*** (0.010)
Married	0.302** (0.115)	0.278** (0.116)	0.282** (0.116)	0.278** (0.116)	0.277** (0.116)
City	-0.331** (0.116)	-0.419*** (0.117)	-0.421*** (0.117)	-0.423*** (0.117)	-0.420*** (0.118)
Native (anchor)	ref	ref	ref	ref	ref
1 <sup>st</sup> generation migrant (anchor)	-0.147	-0.109	-0.106	-0.114	-0.111

	(0.133)	(0.133)	(0.133)	(0.133)	(0.133)
2 <sup>nd</sup> generation migrant (anchor)	-0.071	-0.042	-0.040	-0.038	-0.038
	(0.163)	(0.161)	(0.160)	(0.160)	(0.161)
Child <= 12	-0.085	-0.049	-0.049	-0.047	-0.046
	(0.055)	(0.057)	(0.058)	(0.058)	(0.057)
Child > 12	0.074	0.169	0.162	0.170	0.177
	(0.130)	(0.133)	(0.135)	(0.134)	(0.133)
Tenant	ref	ref	ref	ref	ref
Home owner	-1.513*** (0.147)	-1.574*** (0.149)	-1.572*** (0.149)	-1.572*** (0.149)	-1.572*** (0.149)
Others' property	-0.573** (0.202)	-0.628*** (0.202)	-0.625** (0.203)	-0.628*** (0.202)	-0.631*** (0.202)
Equivalised residual income / 1000		-0.027 (0.069)	-0.052 (0.080)	-0.025 (0.069)	-0.022 (0.068)
Neuroticism		-0.020 (0.071)	-0.021 (0.071)	0.033 (0.086)	-0.020 (0.071)
Educational level		0.176*** (0.035)	0.175*** (0.035)	0.175*** (0.035)	0.154*** (0.043)
Spacious*residual income			ref		
Medium*residual income			0.191 (0.187)		
Dense*residual income			-0.272 (0.380)		
Spacious*neuroticism				ref	
Medium*neuroticism				-0.152 (0.173)	
Dense*neuroticism				-0.179 (0.275)	
Spacious*education					ref
Medium*education					0.055 (0.078)
Dense*education					0.082 (0.124)
_cons	-1.750*** (0.292)	-2.336*** (0.389)	-2.302*** (0.394)	-2.487*** (0.415)	-2.229*** (0.407)

SEPARATE vs STAY					
Union duration	-0.079** (0.033)	-0.081** (0.033)	-0.079** (0.033)	-0.081** (0.033)	-0.082** (0.033)
Union duration_2	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)
Spacious (< 1 pp room)	ref	ref	ref	ref	ref
Medium (1 pp room)	0.113 (0.141)	0.092 (0.142)	-0.228 (0.250)	-0.502 (0.626)	0.281 (0.502)
Dense (> 1 pp room)	0.340* (0.197)	0.286 (0.196)	0.836* (0.424)	0.724 (0.757)	1.570** (0.528)
Male (anchor)	-0.034 (0.109)	-0.034 (0.110)	-0.032 (0.110)	-0.030 (0.109)	-0.033 (0.110)
Age (anchor)	-0.001 (0.011)	0.004 (0.011)	0.004 (0.011)	0.004 (0.011)	0.004 (0.011)
Married	-0.566*** (0.139)	-0.534*** (0.139)	-0.524*** (0.139)	-0.534*** (0.138)	-0.523*** (0.139)
City	-0.175 (0.134)	-0.079 (0.141)	-0.088 (0.141)	-0.077 (0.141)	-0.082 (0.142)
Native (anchor)	ref	ref	ref	ref	ref
1 <sup>st</sup> generation migrant (anchor)	-0.453* (0.237)	-0.504* (0.242)	-0.501* (0.243)	-0.508* (0.243)	-0.518* (0.244)
2 <sup>nd</sup> generation migrant (anchor)	-0.141 (0.183)	-0.179 (0.185)	-0.174 (0.185)	-0.184 (0.184)	-0.190 (0.186)
Child <= 12	-0.129* (0.069)	-0.156* (0.071)	-0.164* (0.073)	-0.156* (0.071)	-0.163* (0.072)
Child > 12	0.123 (0.142)	0.058 (0.146)	0.034 (0.147)	0.057 (0.146)	0.038 (0.148)
Tenant	ref	ref	ref	ref	ref
Home owner	-0.650*** (0.134)	-0.575*** (0.133)	-0.567*** (0.133)	-0.577*** (0.133)	-0.575*** (0.134)
Others' property	-0.110 (0.183)	-0.046 (0.184)	-0.021 (0.184)	-0.046 (0.184)	-0.029 (0.184)
Equivalised residual income / 1000		0.003 (0.120)	-0.037 (0.164)	0.002 (0.121)	-0.006 (0.128)
Neuroticism		0.189* (0.086)	0.186* (0.086)	0.164* (0.099)	0.188* (0.086)

Educational level	-0.151*** (0.045)	-0.147*** (0.045)	-0.151*** (0.045)	-0.120** (0.050)	
Spacious*residual income		ref			
Medium*residual income		0.368* (0.214)			
Dense*residual income		-1.033 (0.733)			
Spacious*neuroticism			ref		
Medium*neuroticism			0.210 (0.219)		
Dense*neuroticism			-0.159 (0.269)		
Spacious*education				ref	
Medium*education				-0.038 (0.104)	
Dense*education				-0.308** (0.118)	
_cons	-2.508*** (0.330)	-2.436*** (0.432)	-2.397*** (0.431)	-2.363*** (0.458)	-2.580*** (0.444)
N	22208	22208	22208	22208	22208

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , one-tailed tested

## Figures

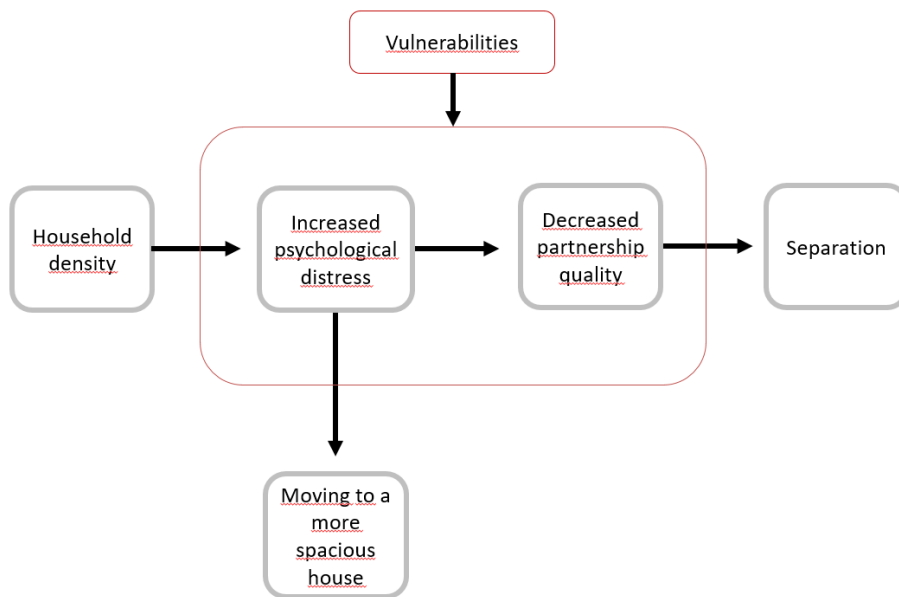


Figure 1. Household density effect on housing/partnership outcomes. Source: combination and simplification of environmental-psychological model (Bell et al., 1996), stress-divorce model (Bodenmann, et al., 2007), and vulnerability-stress-adaptation model (Karney and Bradbury, 1995).

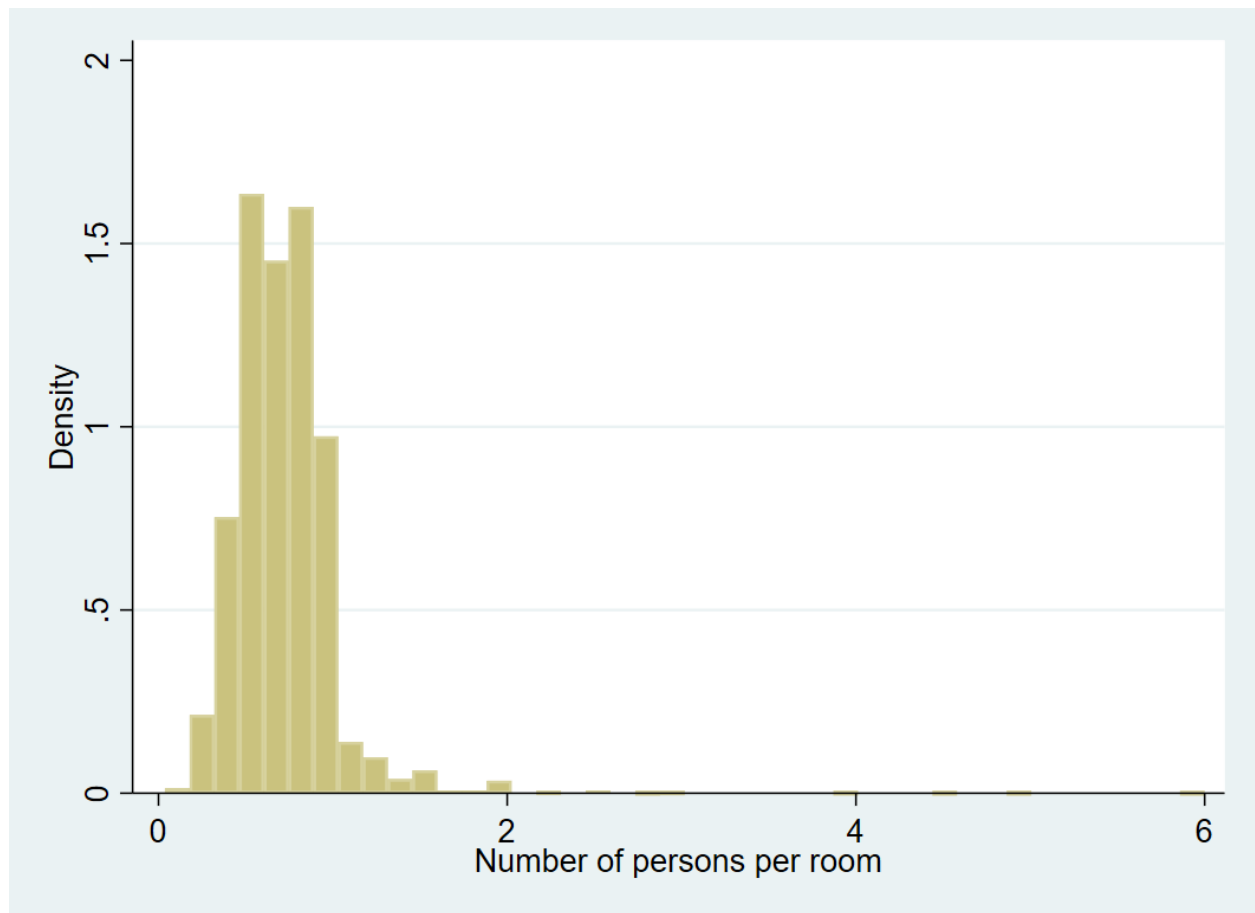


Figure 2. Distribution of household density measure. Average = 0.71, median = 0.67.



Figure 3a and b. Average Marginal Effects of moving or separating: interaction of household density (compared to spacious homes as reference category) \* residual income.

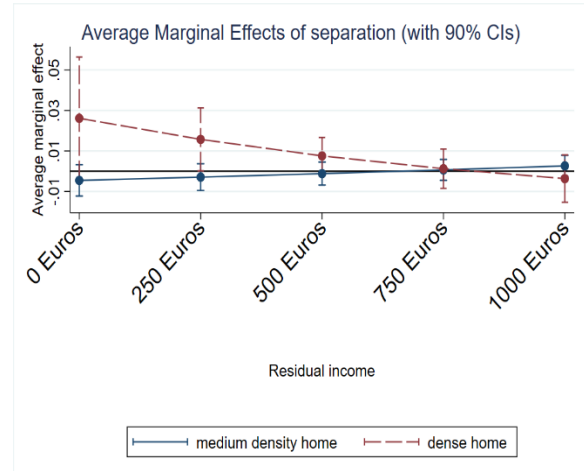
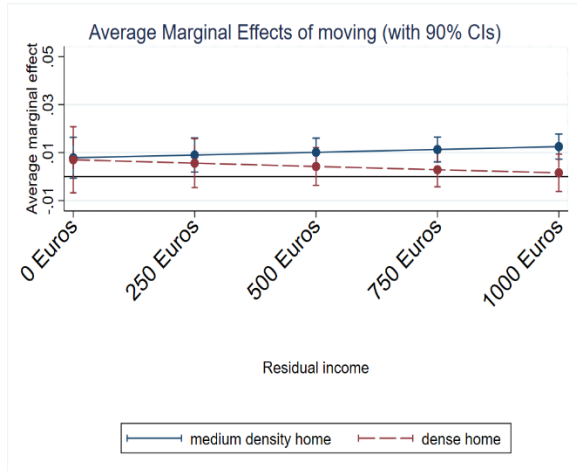


Figure 4a and b. Average Marginal Effects of moving, or separating: interaction of household density (compared to spacious homes as reference category) \* neuroticism.

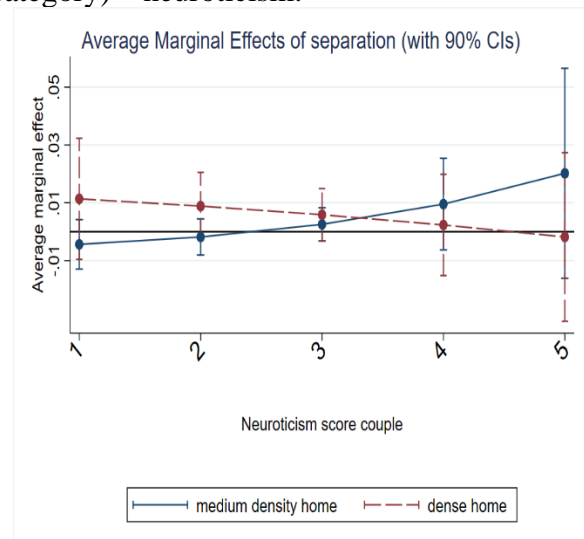
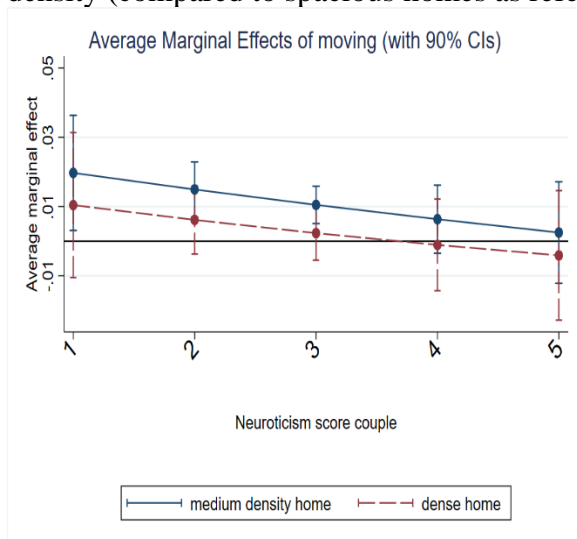
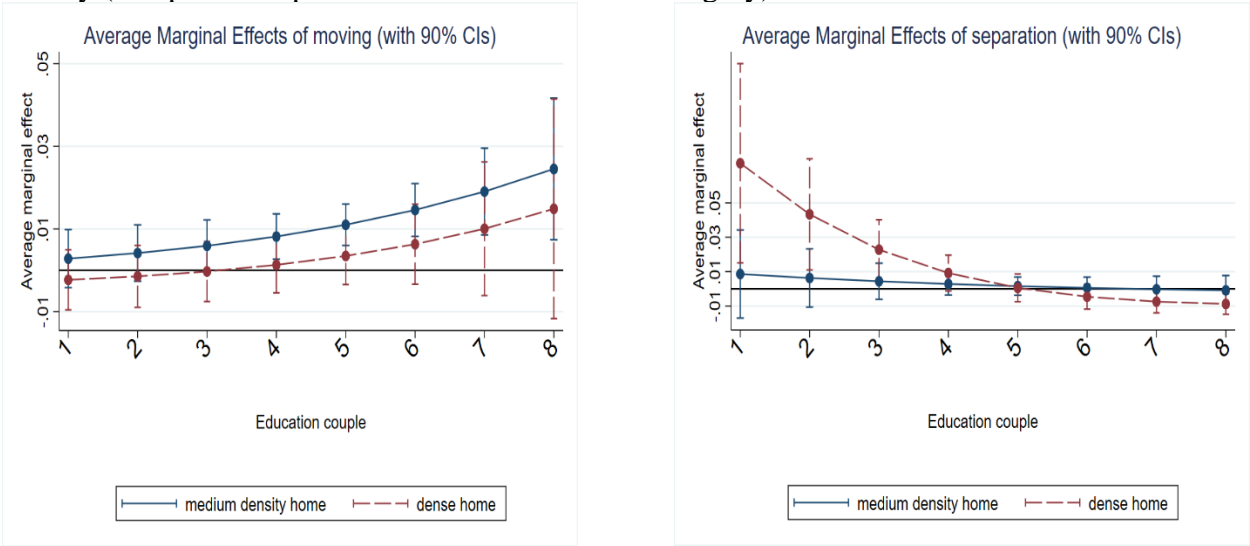


Figure 5 a and b. Average Marginal Effects of moving or separating: interaction of household density (compared to spacious homes as reference category) \* education.



## Appendix

Table A1. Description and descriptives of variables.

	Description	Mean percentages /	Standard Deviation
Housing/relationship outcome	(0) Stay in the same dwelling; (1) move to another dwelling; (2) separate	96; 2.2; 2.2	
Housing density	Number of persons per room (children under age 12 count for 0.5), Categorized into: (0) less than one person per room (spacious), (1) one person per room (medium), and (2) more than one person per room on average (dense)	81; 13; 5.7	
Residual income <sup>†</sup>	Available amount of income after housing costs divided by the number of household members (children below age 12 count for 0.5)/1000 Euro's.	0.94	0.71
Average neurotic personality <sup>†</sup>	(1) I easily become depressed or discouraged; (2) I am relaxed and don't let myself be worried by stress; (3) I worry a lot; (4) I easily become nervous and insecure [alpha: 0.70;0.71] Answering categories: 1. Absolutely incorrect; 2. Mostly incorrect; 3. Neither correct nor incorrect; 4. Mostly correct; 5. Absolutely correct; -1 Don't know; -2 I don't want to answer that. Higher scores imply more neuroticism. The extent of neuroticism is defined by the average score of both partners of the couple.	2.7	0.62
Average educational level	Average ISCED score (varying from no schooling (ISCED 1) to (ISCED 6) doctoral or equivalent level) of both partners (coded 1-8 per partner)	5.2	1.4
Gender anchor	(0) Female; (1) Male	58; 42	
Age anchor	20-46	35	5.8
Union duration	Duration of cohabiting relationship	10	6.3
Union duration squared	Duration of cohabiting relationship* Duration of cohabiting relationship	146	147
Married	(0) Cohabiting; (1) Married	26; 74	
City	Place of residence of main home: (0) Non city centre; (1) city centre 500,000+ inhabitants	81; 19	
Migrant status anchor	Native (no migration background); 1 <sup>st</sup> generation migrant; 2 <sup>nd</sup> generation migrant	78; 13; 8.6	
Number of children below age 12	Number of children age 0-12	1.1	1.0
Number of children above age 12	Number of children age 13-17	0.27	0.60
Housing tenure	(0) tenant; (1) homeowner (single or joint) (2) others' property	47; 48; 5.8	

<sup>†</sup> Note that missing values of residual income and neurotic personality are imputed by multiple imputation.

Table A2a. Associations of independent variables with housing density. Row percentages.

	Spacious	Medium	Dense
<i>Gender</i>			
Female	81	13	5.8
Male	82	13	5.6
Union duration (mean)	10	9.1	11
Age (mean)	36	33	35
<i>Marital status</i>			
Unmarried	75	20	5.7
Married	84	10	5.7
<i>Urbanization degree</i>			
Non city center	84	11	5.2
City center	73	19	7.8
<i>Migrant status</i>			
Native	85	11	3.9
1 <sup>st</sup> generation	64	21	15
2 <sup>nd</sup> generation	79	13	8.6
<i>Having young/old children</i>			
No Child	77	20	2.4
Child <= 12	87	8.2	4.8
At least one child > 12	72	15	13
<i>Housing tenure</i>			
Tenant	70	21	9.0
Home owner	93	4.4	2.3
Others' property	79	13	7.9
<i>Resources</i>			
Residual income (mean)	1.0	0.8	0.6
Average neuroticism (mean)	2.6	2.7	2.7
Average education (mean)	5.3	5.0	4.5

Table A2b. Cell sizes of independent variables with housing density. Absolute numbers.

	Spacious	Medium	Dense
<i>Gender</i>			
Female	10,521	1,663	751
Male	7,560	1,190	523
Union duration	18,081	2,853	1,274
Age	18,081	2,853	1,274
<i>Marital status</i>			
Unmarried	4,353	1,140	333
Married	13,728	1,713	941
<i>Urbanization degree</i>			
Non city center	14,955	2,014	936
City center	3,126	839	338
<i>Migrant status</i>			
Native	14,683	1,995	688
1 <sup>st</sup> generation	1,882	614	421
2 <sup>nd</sup> generation	1,516	244	165
<i>Having young/old children</i>			
No Child	4,648	1,223	148
Child <= 12	10,298	981	571
At least one child > 12	3,135	649	555
<i>Housing tenure</i>			
Tenant	7,207	2,228	932
Home owner	9,851	462	239
Others' property	1,023	163	103
<i>Resources</i>			
Residual income	18,081	2,853	1,274
Average neuroticism	18,081	2,853	1,274
Average education	18,081	2,853	1,274

Table A2c. Discrete-time event history analyses of housing/relationship outcomes. Logit coefficients; significance levels. Complete case analyses.

	(1)	(2)	(3)	(4)	(5)
MOVE vs STAY					
Union duration	-0.033	-0.031	-0.031	-0.031	-0.031
Union duration_2	-0.001	-0.001	-0.001	-0.001	-0.001
Male (anchor)	0.034	0.064	0.064	0.065	0.064
Age (anchor)	-0.036***	-0.044***	-0.044***	-0.043***	-0.044***
Married	0.410***	0.384**	0.383**	0.383**	0.382**
City	-0.274*	-0.360**	-0.361**	-0.367**	-0.360**
Native (anchor)	ref	ref	ref	ref	ref
1 <sup>st</sup> generation migrant (anchor)	-0.293*	-0.255*	-0.249	-0.261*	-0.254*
2 <sup>nd</sup> generation migrant (anchor)	-0.241	-0.210	-0.208	-0.207	-0.207
Child <= 12	-0.077	-0.046	-0.046	-0.043	-0.045
Child > 12	0.154	0.236*	0.239*	0.240*	0.240*
Tenant	ref	ref	ref	ref	ref
Home owner	-1.595***	-1.650***	-1.650***	-1.648***	-1.650***
Others' property	-0.821***	-0.849***	-0.851***	-0.850***	-0.851***
Spacious (< 1 pp room)	ref	ref	ref	ref	ref
Medium (1 pp room)	0.448***	0.460***	0.356	0.959*	0.478
Dense (> 1 pp room)	0.107	0.142	0.080	1.131	-0.135
Residual income poor / 1000		-0.044	-0.068	-0.041	-0.042
Neuroticism		0.020	0.020	0.094	0.021
Educational level		0.170***	0.169***	0.169***	0.166***
Spacious*residual income			ref		
Medium*residual income			0.119		
Dense*residual income			0.080		
Spacious*neuroticism				ref	
Medium*neuroticism				-0.184	
Dense*neuroticism				-0.373	
Spacious*education					ref
Medium*education					-0.004
Dense*education					0.056
_cons	-1.915***	-2.594***	-2.567***	-2.805***	-2.575***
SEPARATE vs STAY					
Union duration	-0.091**	-0.093**	-0.091**	-0.093**	-0.094**
Union duration_2	0.002	0.002	0.002	0.002	0.003
Male (anchor)	-0.020	-0.014	-0.013	-0.009	-0.014
Age (anchor)	-0.002	0.004	0.004	0.004	0.004
Married	-0.547***	-0.511***	-0.498***	-0.510***	-0.503***
City	-0.155	-0.043	-0.053	-0.042	-0.043
Native (anchor)	ref	ref	ref	ref	ref
1 <sup>st</sup> generation migrant (anchor)	-0.602**	-0.667***	-0.666***	-0.676***	-0.684***
2 <sup>nd</sup> generation migrant (anchor)	-0.123	-0.166	-0.168	-0.174	-0.187
Child <= 12	-0.085	-0.116	-0.129	-0.115	-0.126
Child > 12	0.156	0.084	0.049	0.083	0.065
Tenant	ref	ref	ref	ref	ref
Home owner	-0.568***	-0.476***	-0.466***	-0.478***	-0.478***
Others' property	0.033	0.107	0.156	0.107	0.119
Spacious (< 1 pp room)	ref	ref	ref	ref	ref
Medium (1 pp room)	0.120	0.090	-0.245	-0.452	0.733
Dense (> 1 pp room)	0.303	0.242	1.072*	1.082	1.418*
Residual income poor / 1000		-0.008	-0.055	-0.008	-0.021
Neuroticism		0.245**	0.239**	0.234*	0.243**
Educational level		-0.163***	-0.157***	-0.164***	-0.118*
Spacious*residual income			ref		

Medium*residual income			0.388*		
Dense*residual income			-1.706*		
Spacious*neuroticism				ref	
Medium*neuroticism				0.190	
Dense*neuroticism				-0.307	
Spacious*education					ref
Medium*education					-0.137
Dense*education					-0.278*
_cons	-2.539***	-2.577***	-2.543***	-2.541***	-2.771***
<i>N</i>	18285	18285	18285	18285	18285

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , one-tailed tested

### *Additional analyses*

We made the following adjustments to the analyses to check the robustness of the results: (1) using a continuous measure of density instead of the number of persons/room measure; (2) using a dichotomous measure indicating whether housing density was higher or lower than the average (the norm); (3) using a continuous floor space measure instead of the persons/room measure; (4) adding one category to the reaction to housing density outcome: the transition to a living-apart-together (LAT) relationships (as a reaction to housing density, one partner can move out of the shared dwelling in order to escape the dense environment); (5) including the small sample of students instead of excluding them from the analyses; (6) controlling for whether the household included other relatives or non-relatives rather than children.

The results of these sensitivity checks are as follows: (1) We find a significant effect of housing density for the relative odds of moving compared to staying when using a continuous measure: The more densely people live in a dwelling, the more likely the couple is to move. In addition, there is an interaction effect for the relative odds of separation versus staying in the dwelling without breaking-up: The ones with the least resources are the most likely to break up; less educated couples are significantly more likely to break up when they are living in a dense home compared to couples where both partners are highly educated. These results are more or less in line with what we found with our categorical measure.

(2) Those in a dense home (when using 0.71 as the normative persons/room measure) are more likely to move rather than stay in the dwelling. Moreover, vulnerable couples (with respect to education) are significantly less likely to move and more likely to separate.

(3) The more square meters per person living in the household, the less likely the couple moves



rather than stays in the dwelling. We did not find any significant interaction effects with resources/vulnerabilities, apart from a significant interaction of neuroticism with floor space: The higher the average neuroticism score of couples, the more likely they separate. Yet, the larger the floor space of the couple, the less strong this effect is.

(4) Those living in a dense home are more likely to start an LAT relationship rather than stay in the same dwelling together compared to those in a non-dense home (but the difference is insignificant). Especially couples with higher incomes are more likely to start to live apart together when they live in a dense home. Moreover, the higher the couple is educated, the more likely the couple starts an LAT relationship when living in a dense dwelling. In these analyses, we still find the interaction effects between resources and housing density on the separation outcome: For couples living in a dense home it is less likely that they separate the more financial and educational resources a couple has.

(5) Including 37 couples in which one of them is a full-time student does not significantly affect the results.

(6) Controlling for the presence of other household members other than children or the couple itself in the household does not make much of a difference. Note that only 2 per cent of households contain other members than children or the couple. Even though this percentage is higher for those living in a dense home (11%), correcting for living in a multigenerational or non-relative household did not alter the results substantially. The interaction effect of financial resources and housing density now turns insignificant due to lack of power (the effect size is similar as in the main analysis, but the number of cases is slightly lower because of missing values on the type of household members variable). Living with ‘others’ in the household does affect the risk of separation ‘positively’.