FACULTAD ECONOMÍA Y NEGOCIOS
UNIVERSIDAD DE CHILE
DEPARTAMENTO DE ECONOMÍA

SERIE DE DOCUMENTOS DE TRABAJO

SDT 494

Household Overcrowding and Mental Well-being: Better Safe than Sorry

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Santiago, Mayo de 2020

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Household overcrowding and mental well-being: better safe than sorry

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This version: March 2nd, 2020

Abstract

It has been widely documented that household overcrowding over time negatively affects mental health. However, scant evidence documents this dynamic relationship in the low- and middle- income countries of Latin America, where housing issues remain a relevant policy issue. Employing a nationally representative panel dataset of 10,024 Chilean households, we examine whether variation in household overcrowding levels between 2006 and 2009 is associated with the prevalence of depressive symptoms in 2009. We find that an increase in household overcrowding levels (due to a reduction in the number of bedrooms) is associated with an increase in depressive symptoms, while a constant or decreasing trajectory of household overcrowding over time is not associated with changes in depressive symptoms. These results suggest an asymmetric relationship between household density and mental health over a three-year window and support the implementation of preventive rather than corrective housing policies to address overcrowding.

Keywords: overcrowding, mental health, depressive symptoms, housing conditions
JEL: O18, I14, I31, R2

*We thank Daniel Hojman, Fabian Duarte, Graciela Rojas and Joaquín Mayorga for helpful comments. All remaining errors are our own. We acknowledge financial support from the Research Fund Faculty of Economics and Business and Dr. Ruiz-Tagle acknowledges the financial support provided by the Millennium Nucleus of Social Development, which is supported by the Millennium Scientific Initiative of the Ministry of Economy, Development and Tourism (Chile).

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1. Introduction

Housing conditions are an important dimension of human well-being. They determine households' daily activities and capacity to meet basic needs, as housing conditions are central part of a household's environment (OECD, 2011). The importance of housing conditions is demonstrated by its incorporation into indicators of poverty and well-being around the world, which have shifted from a traditional focus on income and consumption towards a multidimensional approach to welfare [1] (Foye, 2017; Hojman and Miranda, 2018).

Given the adverse effects of poor housing quality on health and mental health in particular, poor housing is likely to negatively affect subjective well-being (see Evans et al. (2003) and Clapham et al. (2018) for a review). Household overcrowding is one of the channels through which this relationship is observed. Indeed, insufficient personal space and lack of privacy hinder social interactions, expose daily private life activities and force social receptivity, potentially leading to stress, cognitive and physical fatigue, and frustration for many individuals (Altman, 1975; Desor, 1972; Evans et al., 2003; Gove et al., 1979).

Moreover, overcrowding is a pressing issue for housing policy in Latin American countries. The region has undergone rapid urbanization, leading to more than 80% of the population living in urban areas, among the highest levels in the world (United Nations, 2019). This phenomenon has generated urgency in the provision of quality housing: a third of urban Latin American families live in inadequate housing conditions (Bouillon et al., 2012). To confront this problem, most Latin American countries have adopted a strategy of financialization of the housing market with a focus on homeownership (Rolnik, 2019). The provision of subsidies to low-income beneficiaries and the production of affordable dwellings by private firms following an utility-cost model has contributed to the inflation of land prices and the clustering of low and middle-income families in peripheral ghettos, deepening social inequalities (Molina et al., 2019; Santoro, 2019). For instance, in Chile, the profit maximization criteria combined with poor regulation led to the construction of social condominiums[2] in an extremely population-dense setting, producing, among other housing and social problems, household overcrowding (Rodríguez and Sugranyes, 2004; Vergara et al., 2019).

Within this context, it is crucial to study the relationship between housing quality conditions, such as overcrowding, and well-being in a Latin American country like Chile. Moreover, to the best of our knowledge, the dynamic relationship of overcrowding has been quantified only in studies of high-income countries; not in Latin America and low- and middle-income countries. For instance, Pierse et al. (2016) use a fixed-effects model to identify the role of overcrowding, housing tenure and housing affordability on psychological distress in New Zealand, not finding a significative impact of overcrowding. Pevalin et al. (2008) study the increase or decrease of a self-reported shortage of space over time in the United Kingdom and do not find any significant effect on physical or mental health. More closely related to our study, Foye (2017) analyzes the magnitude, direction, and shape of the relationship between an objective measure of density (rooms-per-person) and subjective well-being in the UK. Using a subsample of individuals from the British Household Panel Survey who

[1] See the OECD "Better Life Index" or the US Census Bureau "Extended Measures of Well-Being".

[2] Social condominiums are medium-size apartment buildings built as public housing in Chile (Vergara et al., 2019).

decided to move to a larger dwelling to increase space, the author finds a weak positive relationship between an increase in the size of living space and mental health for men. However, the author only identifies decreasing trajectories of overcrowding and thus cannot compare the impact of positive versus negative changes in household density.

By studying the dynamic relationship between constant, decreasing and increasing household overcrowding trajectories and mental well-being in a Latin American country, this paper seeks to add to this body of literature. Using a nationally representative panel dataset from Chile, we test whether an increase of household overcrowding levels is associated with worsened mental health, whether a decrease is correlated with better mental well-being, and whether these two effects are *asymmetrical*.

Housing density depends on two dimensions: the quality of housing (number of bedrooms) and household size (number of people in the household). Both of these measures correlate simultaneously with mental health and unobserved factors that also influence mental health, such as the neighborhood environment or social networks. We can improve the precision of our estimates if we study the evolution of household overcrowding over time by controlling whether shifts in the household size or the number of bedrooms cause changes in household density. In addition, we can identify the relationship between household overcrowding and mental health separately for the housing quality dimension and the household composition dimension.

This paper contributes to the existing literature in three main ways. First, there are no studies on overcrowding and mental health from countries of Latin America using a nationally-representative longitudinal dataset with controls for environmental, genetic, economic, demographic, psychological and health factors simultaneously. Second, we can identify positive and negative shifts in household density and thus determine whether the psychological responses to these changes vary. Third, by using trajectories in overcrowding, we can distinguish between the effect of overcrowding due to changes in the number of bedrooms versus changes in the number of household members.

The rest of the paper is organized as follows. Section 2 examines the data used and describes how mental well-being and overcrowding are measured. Section 3 presents the empirical strategy used to estimate the relationship between overcrowding and mental health. Section 4 presents our main results and section 5 discusses the main policy implications of our findings.

2. Measuring depressive symptoms and overcrowding trajectories

We use the 2006 and 2009 waves of the Chilean Social Protection Survey (SPS: *Encuesta de Protección Social* in Spanish). The SPS is a nationally representative longitudinal household survey of the adult population in Chile. The 2009 wave includes a short set of questions that identify depressive symptoms. Combining this information with the 2006 wave, we construct the evolution of household overcrowding over time and control for psychological, health, employment, socioeconomic and genetic factors. A total of 13,371 individuals responded to both survey waves; we use a subsample composed of 10,024 individuals with complete information for all variables in panel

data[3]

Below we define how we measure mental well-being by creating a depressive symptoms index based on the individuals' responses to the Center for Epidemiologic Studies Depression (CESD) scale. We also define household overcrowding trajectories and how the evolution of household overcrowding is useful to identify the relationship between household overcrowding and mental health.

2.1. Depressive symptoms index: CES-D short form

The 2009 wave of the SPS includes a short version of the CESD scale (*CES-D* 8 question form) that measures the individual's self-reported depressive feelings and symptoms of the past week (Karim et al., 2015; Radloff, 1977).

Following Hojman et al. (2016), an index of depressive symptoms was constructed based on this questionnaire. Responses to questions are recorded as *Yes* or *No*. If the response indicates a depressive symptom, a value of 1 is assigned to the question and a value of 0 otherwise. The index value (D_i) is then the sum of the scores for the CES-D questions (For more details, see the Appendix).

Consequently, this variable ranges from 0 to 8, where 8 corresponds to the maximum value of depressive symptom prevalence. The average value for the sample is 3.54 with a standard deviation of 2.37. Additionally, the correlation between the depressive symptoms index score and a binary variable indicating whether the individual was diagnosed with depression in the last two years is 0.31.

We observe for our sample the same pattern as at the population level: a positive and then negative gradient for age, a higher prevalence of depressive symptoms in women, and a negative gradient for income, just as Hojman et al. (2016), who use the same index for Chile. In addition, we compare the depressive symptoms index of respondents experiencing and not experiencing overcrowding. Following the criteria of the Chilean Ministry of Housing and Urban Planning and the Ministry of Social Development and Family, we define "overcrowding" for individuals living in households with a density of 2.5 or more persons per bedroom. We observe that individuals experiencing overcrowding have higher depressive symptoms score relative to those that are not. In particular, overcrowded respondents report on average 0.6 (0.25 standard deviations of the index) more depressive symptoms than those not overcrowded (Appendix A).

2.2. Overcrowding trajectories

In order to identify a potential relationship between the evolution over time of household overcrowding and mental well-being, we need to determine the trajectories of the respondents' household overcrowding between 2006 and 2009. We first explain why we use a physical measure of overcrowding rather than a subjective one. Then we define how we measure these trajectories. Finally, we present descriptive statistics of the relationship between the depressive symptoms index score and these household overcrowding trajectories.

[3]We show in Appendix A that the samples are comparable in most of their characteristics.

We examine the objective and physical measure of persons per bedrooms to define household density rather than a subjective measure for four main reasons. First, it avoids the problem of double causality between the mood of the respondent and the lack of a perception of privacy (Booth et al., 1980). Second, the number of persons per bedroom is a quantifiable and easily observable measure, which is also less susceptible to measurement error. Third, physical housing density can indicate space and privacy within a home, as it is reasonable to assume that personal space decreases when household density increases (Gove et al., 1979). Finally, this type of measure is used widely by public institutions that plan and apply public policies associated with housing, poverty, and inequality.

Due to the panel nature of the SPS, we can observe the housing history of the respondents. Using household density in 2006 and 2009, we define four overcrowding trajectories: *Never overcrowded* individuals that are neither overcrowded in 2006 nor in 2009; *Always overcrowded* individuals who live in overcrowded households in 2006 and 2009, *Increasing overcrowding* respondents that were not overcrowded in 2006 but became overcrowded in 2009 and *Decreasing overcrowding* respondents in the opposite situation.

In addition, to remove the effect of a change in general housing characteristics, we consider only individuals who are observed in the same housing type in 2006 and 2009 in the construction of the trajectories. Thus, of the 10,024 respondents for whom complete information is available for both periods, our subsample is reduced to 9,046 for those with fixed housing type over time.

Moreover, we decompose the evolution of overcrowding into two components, as demonstrated in the tree in figure 1. One component is a change in overcrowding produced by a shift in household size (left side of the tree). The other is a change in overcrowding produced by a shift in the number of bedrooms (leaves A1 and B1). Controlling each one of these dimensions separately improves identification. Indeed, these two elements are determined by the conditions of vulnerability that most overcrowded households experience, which, in turn, directly influence the mental health of its members. Therefore, the shift in both dimensions is removed from the overcrowding trajectories analysis (Leaf A1).

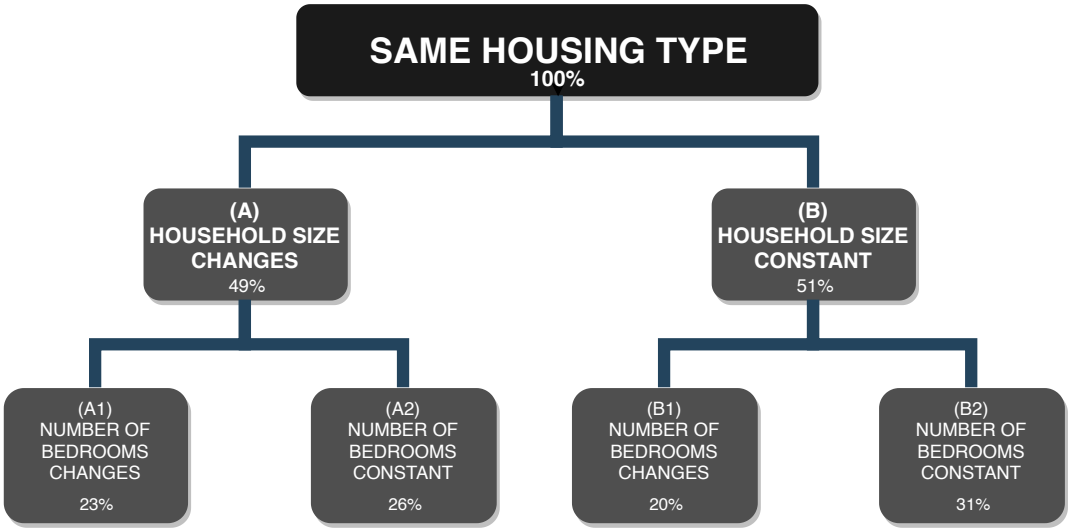
Two groups of overcrowding trajectories are used: *household infrastructure* trajectories and *household composition* trajectories. The first corresponds to the subsample of respondents whose household size and housing type are constant between 2006 and 2009 (Right side of the tree in figure 1). It is worth noting that, to rule out changes in household composition, we exclude from this group households for which there are member arrivals or departures. The second trajectory corresponds to the group of individuals for which the number of bedrooms and housing type remained constant between 2006 and 2009, so that the shift in overcrowding status is caused by household size and composition (Leaves A2 and B2 of the tree in figure 1)[4]

It is important to note that this strategy mitigates, but does not guarantee the elimination of, the potential endogeneity explained above. In the case of household infrastructure trajectories, the change in bedrooms can be caused by a transformation within the dwelling or because the respondent decided to move to a new home. The latter may be motivated by unobserved factors and is

[4]For more details about the size and composition of trajectories, see Appendix B.

surely associated with a change of neighbourhood and environment that also affects mental health. In the case of household composition trajectories, the reasons behind household member arrival or departure may positively or negatively impact the mental well-being of respondents and may also correlate in the same or opposite direction as the effect of the shift in the level of overcrowding. Thus, the results cannot be interpreted as causal effects, although they may allow useful insights about housing policies as we discuss below.

Figure 1: Sample size by cause of overcrowding trajectory



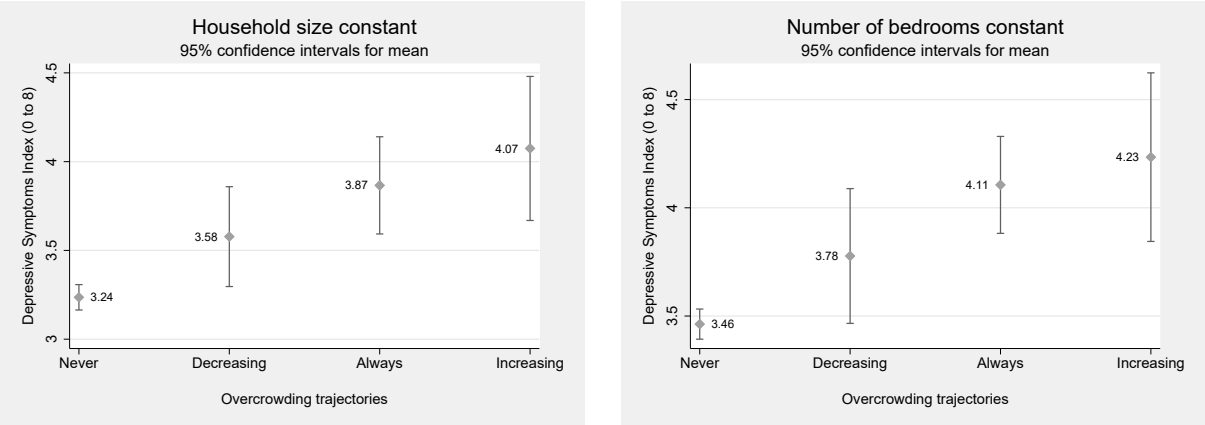
Note: Authors' calculations based on SPS 2006 and 2009.

We estimate the mean depressive symptoms index score by trajectories of overcrowding (Figure 2). The same increasing pattern is observed when the household size and the number of bedrooms is constant, respectively, even though the mean estimates for the latter have higher variance. The increasing overcrowding trajectory is associated with higher mean scores on the depressive symptoms index (4.07 and 4.23), while the mean scores of always overcrowded (3.87 and 4.11), decreasing overcrowding (3.58 and 3.78) and never overcrowded trajectories (3.24 and 3.46) are relatively lower, in that order. Moreover, the difference between those who were never overcrowded and those who are overcrowded in 2009, either because they are in the always overcrowded or increasing overcrowding trajectory, are the only ones that are statistically significant at least at the 90% level. These trajectories are as expected according to the hypothesis. However, since there are unobserved variables that may be positively correlated with depressive symptoms and a positive shock to household density, there is still the possibility that this gap is overestimated.

2.3. Controlling for confounding effects

The literature identifies multiple characteristics that may determine depressive symptoms. The SPS survey includes a wide range of variables that may be used as controls as we examine over-

Figure 2: Increasing relationship between the mean of depressive symptoms index score and household overcrowding trajectories



(a) Household Infrastructure Trajectories

(b) Household Composition Trajectories

Note: Authors' calculations based on SPS 2006 and 2009. *Never overcrowded* corresponds to individuals who did not live in overcrowded households in 2006 and in 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009.

crowding. We control for a standard set of socio-demographic variables, including age, education, income, income variation between 2006 and 2009, number of children, household size (in 2006 and 2009), employment, and marital status. To control for genetic factors, we include whether a family member or the respondent has been diagnosed with depression. For health controls, we include whether the respondent has been diagnosed with cancer or other chronic illness, cigarette and alcohol consumption, and body mass index (BMI). We also include dummies for essential life events, such as the death of a relative. Since social status can be a source of stress and depression, we consider whether the respondent owns a car, machinery, or a business (Foye, 2017; Popham et al., 2015). Additionally, we include the amount of household debt, as high debt levels can be harmful to mental health (Hojman et al., 2016).

In addition, we include measures of personality traits obtained from the ten-item personal inventory test (TIPI) Gosling et al. (2003)) as controls. There is evidence that personality traits correlate with mental health, and studies have shown that these personality traits moderate the effect of socio-economic status on depressive symptoms (Jokela and Keltikangas-Järvinen, 2011; Koorevaar et al., 2013).

There is extensive evidence that housing conditions correlate with mental health. Poor material housing conditions increase the likelihood of contracting various diseases as well as suffering from depression and other psychological disorders (Evans et al., 2003; Pevalin et al., 2008). As housing tenure (whether an individual owns, rents, etc. the dwelling) potentially affects mental health as well, we control for housing type and tenure (Baker et al., 2013; Pevalin et al., 2017).

In countries where overcrowding is a public health concern, it is essential to consider issues related to whether and with whom housing is shared, as the number of persons with whom an individual shares housing and overcrowding are closely linked. We use the term "shared residence" for a household in which there are more than one family groups. This concept is also close to what has been called as "doubled-up" households (households where there are more adults than the head of household and spouse or partner).

When a household becomes a shared residence, the unplanned arrival of new members generates a direct increase in the number of persons per bedroom. On a psychological level, living with additional people may reduce personal and intimate space and generate more situations of forced interaction. However, potential negative effects on mental health may be mitigated or reversed, depending on how close the individual feels to this person. For instance, the arrival of a new member can generate happiness if that family member or acquaintance is welcome and wanted (e.g., a situation where the respondent's son arrives with his partner and their new-born child). In this sense, the addition of family members to the household may have a different effect than non-family members, as family members may form cooperation dynamics more easily (Epstein, 1981). Thus, we identify whether there is the arrival of a person or family group from outside the nuclear family between 2006 and 2009. We also identify whether that person or family group includes relatives, and whether the respondent is part of the arriving family group.

This identification concern is closely linked to the one associated with household composition trajectories, which may also correspond to the arrival of new household members. Is not clear whether the arrival of new members is associated with higher or lower prevalence of depressive symptoms. We can take the example of the return of the respondent's son to the household with his partner and their new-born child. The arrival of a grandchild may be positive for mental health, but the interactions of two family groups in the same household may have negative effects. We can apply the same logic to the departure of household members. The reduction in household density may be caused by the death of a relative or a son/daughter leaving home at early adulthood (independence). The conflicting correlations with mental health generate noisier estimates for the household composition trajectories[5].

3. Identifying the relationship between overcrowding trajectories and mental well-being

Our main objective is to identify whether the evolution of household overcrowding affects subjective well-being, measured by a depressive symptoms index (D_i). Consequently, we estimate the following equation:

$$D_i = \alpha_0 + \alpha_1 Always_i + \alpha_2 Increasing_i + \alpha_3 Decreasing_i + \beta X_i + \epsilon_i \quad (1)$$

where $Always_i$ is a dummy equal to 1 if individual i lives in an overcrowded household both in 2006 and 2009, $Increasing_i$ is a dummy equal to 1 if individual i lives in an overcrowded household in 2009 but not in 2006, and $Decreasing_i$ is a dummy equal to 1 if the individual i lives in an overcrowded household in 2006 but not in 2009. The reference group is the $Never$ trajectory.

[5]To see the situations that produce a change in the household composition, see Appendix D

X_i is the vector of controls with all the variables presented in the previous section. It is worth mentioning that we include marital status of the respondent and an indicator for being diagnosed with depression in either period (indicators for 2006 and 2009).

In addition to the full sample of 10,024 respondents, we use three different subsamples to estimate this equation. The first one includes the 9,046 individuals who report the same housing type in 2006 and 2009[6]. This way, the trajectories' coefficients do not include the effect of a change in the general material conditions of the dwelling. The second and third subsamples include only the 4,638 observations from the household infrastructure group, and the 5,224 observations of the household composition trajectories group, respectively. Drawing on the estimates of these two subsamples, we decompose the relationship between overcrowding and subjective well-being, assessing whether a change in the number of bedrooms or the number of persons in the household is associated with varying changes in depressive symptoms, in terms of the direction, magnitude and significance of α_k (k=1,2,3).

For simplicity of interpretation, we present the estimations of model 1 using ordinary least squares (OLS). Considering the ordered and discrete nature of the depressive symptoms index, we also estimate the model using an ordered probit specification and present the results (which provide the same conclusions as the OLS estimation) in the appendix (Appendix F).

4. Results: the asymmmetrical relationship between overcrowding trajectories and mental well-being

First, we present the results of the OLS estimation of model (1) for the four samples: whole sample, housing type constant, *household infrastructure* trajectories and *household composition* trajectories. Then, we perform various robustness exercises.

4.1. Overcrowding trajectories and depressive symptoms

We present the main findings of the whole sample estimation in column (1) of table 1. First, considering the controls, our estimates are in line with what previous literature has found. Women report, on average, 0.7 more depressive symptoms than men, and unemployed individuals have higher depressive index scores than do employed individuals on average. Having a chronic illness such as diabetes, AIDS, heart problems or high pressure is associated with higher levels of depressive symptoms (0.5 points of the index). Sharing housing with those outside the nuclear family is also a relevant factor, in particular when the person/group sharing housing is a family member[7].

We also identify the existence of a relevant dynamic relationship between overcrowding and depressive symptoms, observed only when individuals report an increasing overcrowding trajectory of over time. Belonging to the increasing overcrowding trajectory group implies an increase of 0.327 points (0.14 standard deviations) in the depressive symptoms index score relative to *Never overcrowded* trajectory membership. This effect is relatively significant, as it is the same estimated

[6]Again, we show in Appendix A that this sub sample is comparable in most of their characteristics.
[7]For a full report of the estimation results, see Appendix C.

magnitude of the association with being unemployed.

Interestingly, we observe an asymmetrical relationship between mental health and overcrowding, as the coefficient associated with the *Increasing overcrowding* trajectory is significant, but that of the *Decreasing overcrowding* trajectory is not. Similarly, we do not observe a significant relationship between the *Always overcrowded* trajectory and mental health. This evidence suggests that depressive symptoms may increase only when individuals experience a negative shock to housing conditions, and that they may adapt to overcrowding over time.

To improve the accuracy of our estimates, we control for a possible housing type change between 2006 and 2009. In column (2) of table 1, we present results considering only individuals who report the same housing type in both waves of the SPS. Previous findings are confirmed, as the increasing overcrowding trajectory is the only one with a statistically significant association with mental well-being. However, compared to column (1), the magnitude of the coefficient is 25% higher (0.373 index points or 0.16 standard deviations).

When we estimate our model using the household infrastructure trajectories, we once again confirm our main result: there is an asymmetrical and dynamic relationship between household overcrowding and mental health. In column (3) of table 1, we observe that only the *Increasing overcrowding* trajectory has a significant association with mental health: an increase in the level of overcrowding between 2006 and 2009 is associated with an increase of 0.512 points (0.22 standard deviations) in the depressive symptom index relative to individuals of the *Never overcrowded* trajectory. This association is higher than that observed in columns (1) and (2) and is higher than the association with unemployment (0.410) or having a chronic illness (0.425).

However, we do not observe this asymmetrical and dynamic relationship when we estimate the model using the household composition trajectories. This difference suggests that it is important to differentiate between a change in the household infrastructure or the household composition when we estimate the relationship between overcrowding and mental health. As presented in column (4), none of the trajectories displays a significant coefficient for the relationship between household overcrowding and depressive symptoms. Although the value of the coefficient associated with the *Increasing overcrowding* trajectory (0.448) is similar to the one observed in column (3), the accuracy of the estimate is lower. This result may be driven by the multiple factors that produce a change in household composition. Finally, it is worth noting that the arrival of a non-family member is associated with an increase of 1.016 points in the depressive symptoms index (0.43 standard deviations), suggesting the importance of the arrival of new household members on mental health separate from the association with overcrowding.

4.2. Beyond a discrete definition of overcrowding

It is reasonable to assume that there is a psychological response to changes in housing density, regardless of whether the threshold of 2.5 persons per bedroom is exceeded. Indeed, some individuals experience changes in the housing density over time but are not considered in the overcrowding binary trajectories since this variation occurs below or above the threshold of 2.5 people per bedroom. This aspect of variable construction generates a loss of relevant information about individuals' psychological behaviour and limits the power of our sample. Therefore, we estimate the model replacing

Table 1: Depressive symptoms index and household overcrowding trajectories: OLS estimates

Dependent variable: Depressive Symptoms Index				
	(1)	(2)	(3)	(4)
	Full Sample	Same House Type	Changes in bedrooms	Changes in household size
Always overcrowded (=1)	0.148	0.220	0.246	0.200
	(0.133)	(0.145)	(0.190)	(0.169)
Increasing overcrowding (=1)	0.327**	0.414***	0.512**	0.448
	(0.141)	(0.154)	(0.228)	(0.326)
Decreasing overcrowding (=1)	-0.001	-0.039	0.173	-0.064
	(0.123)	(0.135)	(0.187)	(0.251)
Shared residence: family (=1)	0.291**	0.370***	0.000	0.309*
	(0.116)	(0.121)	(.)	(0.165)
Shared residence: non-family (=1)	0.069	0.039	0.000	1.016**
	(0.300)	(0.320)	(.)	(0.414)
Shared residence: respondent (=1)	-0.181	-0.171	-0.258	-0.054
	(0.197)	(0.209)	(0.265)	(0.257)
Female (=1)	0.720***	0.702***	0.747***	0.783***
	(0.080)	(0.083)	(0.104)	(0.107)
Unemployed, searching (=1)	0.329***	0.318**	0.410**	0.286*
	(0.120)	(0.125)	(0.164)	(0.161)
Unemployed, not searching (=1)	0.205*	0.180	0.058	0.218
	(0.107)	(0.114)	(0.127)	(0.145)
Chronic illness (=1)	0.503***	0.452***	0.425***	0.393***
	(0.074)	(0.076)	(0.106)	(0.099)
Controls:				
Housing and household composition	✓	✓	✓	✓
Socio-demographics	✓	✓	✓	✓
Personal and family health	✓	✓	✓	✓
Personality traits	✓	✓	✓	✓
Debts and assets	✓	✓	✓	✓
N	10024	9046	4638	5224
R^2	0.244	0.242	0.243	0.243

Note: Authors' calculations based on SPS 2006 and 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009.*Housing and household composition controls*: shared residence, size of household, housing type, housing tenure, marital status in 2006 and 2009, number of children (by age groups). *Socio-demographic controls*: gender, age, education, monthly household income per capita, the variation of monthly household income per capita between 2006 and 2009, and employment status. *Personal and family health controls*: indicators for individual diagnosed with depression in 2006 or 2009, family member diagnosed with depression, individual diagnosed with cancer, individual smokes or drinks alcohol, individual has any disability, BMI, and whether a family member died recently. *Personality traits*: extraversion, agreeableness, conscientiousness, openness to experience and emotional stability. *Debt and assets controls*: log of total debt amount, individual owner of a car, company or machinery (capital). The variables for shared residence: family and non-family are omitted when using the subsample of individuals for whom only the number of bedrooms changes because, by construction, there is no arrival of new members. The same applies to the death of a close relative.

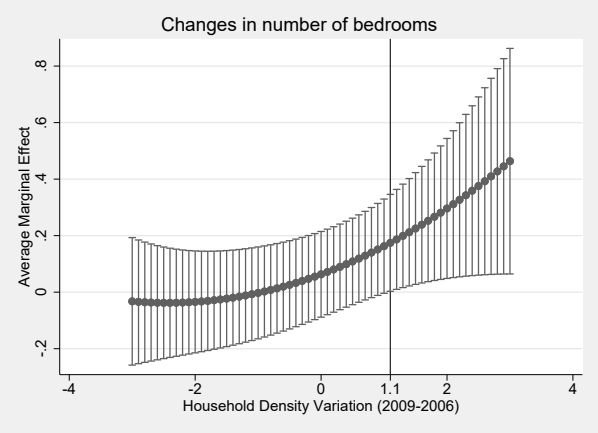
the household overcrowding trajectories with the difference between household density in 2009 and household density in 2006. This continuous variable measuring change in household density is also added as a quadratic term to allow for the asymmetrical nonlinear relationship observed in our previous estimates (for further details, see Appendix E).

We estimate the average marginal effects of the change in household density. For each level of the change in household density, we plot the point estimates with their corresponding confidence intervals in figure 3 (the coefficients are presented in table A11 of the appendix). When the change in household density is caused by a change in the number of bedrooms, our estimates become significant with an increase above 1.1 persons per bedroom in the household (left panel of figure 3, figure 3a). More precisely, a positive change of 1.1 persons per bedroom between 2006 and 2009 is associated with an increase of 0.17 points (0.07 standard deviations) in the depressive symptoms index. However, when the change in household density is caused by a change in the household size, we do not observe a statiscally significant effect at any level (right panel of figure 3, figure 3b). Our main finding is then confirmed: only when the number of bedrooms changes, an increase in household density is associated with more depressive symptoms, while a decrease in household density has no significant relationship with depressive symptoms. When we consider only changes in the household size, no significant effect is observed.

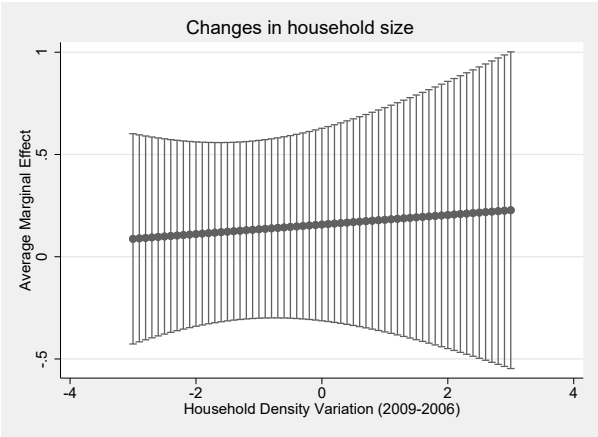
Finally, to test whether our results are sensitive to the reference trajectory we choose, we estimate equation 1 by OLS, replacing the *Never overcrowded* trajectory with the *Always overcrowded* trajectory as the reference trajectory. Indeed, the non-significance of the decreasing overcrowding trajectory coefficient may be explained by the fact that we are comparing the depressive symptoms in 2009 between two groups that both do not live in an overcrowded household that year. The same reasoning applies to the significance of the increasing overcrowding trajectory. If this explanation is true, we would expect a statistically significant coefficient associated with the decreasing overcrowding trajectory and a non-significant coefficient for the increasing overcrowding trajectory.

We note that, regardless of sample, neither the decreasing nor the increasing overcrowding trajectories display a statistically significant relationship with mental health (Appendix F). In other words, the non-significance of the decreasing overcrowding trajectory coefficient does not depend on the overcrowding level of the comparison group. However, the correlation of the increasing overcrowding trajectory must be interpreted relative to individuals who did not live in an overcrowded household.

Figure 3: Average marginal effect of change in household density on the depressive symptoms index.



(a) Significant effect of an increase of 1.1 persons per bedroom or higher



(b) No significant effect

Note: Authors' calculations based on SPS 2006 and 2009.

5. Conclusions

Household overcrowding is a relevant issue for Latin America where a significant number of families live in inadequate housing conditions. While housing conditions affect multiple dimensions of human well-being, including mental health, scant literature has explored the relationship between household overcrowding and mental health over time in this region.

Using a nationally representative panel data set of 10,024 Chilean households, we study the dynamic relationship between household overcrowding and depressive symptoms through the analysis of varying trajectories of household overcrowding between 2006 and 2009. We also differentiate between whether the evolution of household overcrowding levels was caused by changes in the number of bedrooms or in household size.

Three main lessons emerge from this research. First, we show that there is a dynamic relationship between household overcrowding and mental health observed in the short to medium term within a three-year window. In particular, an increase in the level of overcrowding is associated with more depressive symptoms. Moreover, the correlation is found to be relatively substantial, as its magnitude is similar to that of being unemployed or having a chronic illness.

Secondly, this relationship is asymmetrical. While an increase in the level of household overcrowding is relevant, the trajectories of constant overcrowding and decreasing overcrowding are not associated with a psychological response of depressive symptoms. This result is consistent with Pevalin et al. (2008), who find an asymmetrical response of health conditions to housing problems in the UK. On the one hand, asymmetry between the increasing and decreasing overcrowding trajectories suggests a subjective loss aversion to housing conditions or a difference in the duration of the psychological response to negative and positive shocks to housing quality. On the other hand, the non-significance of the constant overcrowding trajectory suggests a degree of subjective adaptation

to household overcrowding from individuals who live in overcrowded households over a long period of time (Foye, 2017).

Finally, we show that it is important to distinguish whether the change in the household density was caused by a shift in the number of bedrooms (the household infrastructure) or in household size (household composition). Indeed, this dynamic and asymmetrical relationship is observed when a change in the number of bedrooms occurs between 2006 and 2009 and not when a change in the household size occurs.

It is necessary to take into account the following considerations to interpret our findings accurately. The use of household overcrowding trajectories allows better accuracy in the estimates but does not eliminate the identification problem of the endogenous nature of overcrowding. A change in the number of bedrooms may be observed after an individual moves to a new home. In this case, the neighbourhood and environmental factors are confounding effects. Similarly, the reasons behind the departure or arrival of a household member may bias our estimates.

In any case, these findings provide evidence and information for housing policy planners in Latin American and similar regions where overcrowding is a public policy issue. The asymmetrical nature of our results supports preventive rather than corrective housing policies to confront overcrowding. Accordingly, it is necessary to solve overcrowding and the housing deficit from a multidimensional perspective, not only because of its multi-causal nature, but also because of its multiple effects, such as on mental health. Furthermore, since housing affordability is one of the leading causes of overcrowding, it must be included in the housing policy agenda, while recognizing the diversity and complexity of housing needs and the vulnerability context of the families affected by overcrowding (Molina et al., 2019).

It remains a challenge for future research to disentangle the mechanisms behind our findings. In particular, a task for future work is to explain the impact of the increasing household infrastructure trajectory, accounting for neighbourhood effects. Also, given the context of a rapid increase in migration flows within the region, the precarious housing conditions of the migrant population, and cultural preferences of migrant populations, it is also important to study the psychological response to household overcrowding within the context of substantial migration.

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Appendices

Appendix A: Descriptive Statistics

Table A1: Center for Epidemiological Studies Depression Scale (CES-D) Short Form (8 questions)

	Yes	No
Have you felt depressed?	1	0
Have you felt that everything you do is an effort?	1	0
Have you felt that your sleep is restless?	1	0
Have you felt alone?	0	1
Have you felt happy?	1	0
Have you felt that you enjoy your life?	0	1
Have you felt sad?	1	0
Have you felt you could not get going?	1	0

Source: Hojman et al. (2016)

The index is the sum of the answers to these 8 questions:

$$D_i = \sum_{i=1}^{8} d_{ij}$$

where d_{ij} is 1 if the answer of respondent i to question j indicates a depressive symptom.

Table A2: Descriptive statistics of depressive symptoms index score by observed characteristics (2009)

Variable	%	D_i	Variable	%	D_i
Overcrowding (=0)	86.5	3.5	Chronic illness (=0)	69.4	3.3
Overcrowding (=1)	11.8	4.1	Chronic illness (=1)	28.9	4.3
Shared residence: family (=0)	86.7	3.5	Smokes (=0)	69.5	3.5
Shared residence: family (=1)	11.6	4.0	Smokes (=1)	28.9	3.6
Shared residence: non-family (=0)	96.0	3.5	Cancer (=0)	96.3	3.5
Shared residence: non-family (=1)	2.3	3.6	Cancer (=1)	2.0	4.5
Shared residence: respondent (=0)	94.9	3.6	Diagnosed with depression (=0)	89.1	3.3
Shared residence: respondent (=1)	3.4	3.4	Diagnosed with depression (=1)	9.2	5.8
Age: $\leq$ 24 years old	1.1	3.2	Relative diagnosed with depression (=0)	91.8	3.5
Age: 25 to 44 years old	38.3	3.3	Relative diagnosed with depression (=1)	6.6	4.5
Age: 45 to 65 years old	40.8	3.8	Close relative passed away (=0)	91.6	3.5
Age: $\geq$ 65 years old	18.1	3.7	Close relative passed away (=1)	6.7	4.0
Male	48.1	3.0	Owner: machinery (=0)	96.6	3.6
Female	50.2	4.1	Owner: machinery (=1)	1.7	3.4
Working	56.0	3.2	Owner: car (=0)	73.5	3.7
Unemployed, searching	9.8	3.9	Owner: car (=1)	24.8	3.0
Unemployed, not searching	32.5	4.1	Housing tenure: Owner	61.3	3.6
Single	19.6	3.3	Housing tenure: Still paying	11.3	3.3
Married	63.5	3.5	Housing tenure: Sharing Ownership	1.5	3.6
Divorced	8.6	4.4	Housing tenure: Rent	8.1	3.6
Widower	6.6	4.3	Housing tenure: Employer is owner	1.7	3.4
Has children under 1 year of age (=1)	3.7	3.3	Housing tenure: Family or friend is owner	14.4	3.7
Has children between 2 and 4 years old (=1)	7.5	3.5	Housing type: House	88.6	3.5
Has children between 5 and 13 years old (=1)	28.0	3.6	Housing type: Alley tenement	0.4	3.9
Has children between 14 and 18 years old (=1)	23.9	3.8	Housing type: Condominium	0.3	3.5
Has children over 18 years old (=1)	47.1	3.9	Housing type: Appartment	5.2	3.6
No formal education	2.9	4.1	Housing type: Room in house or appartment	0.9	4.2
Education: Primary	35.5	4.1	Housing type: Room in old house	0.5	5.5
Education: Secondary	43.8	3.5	Housing type: Slum	2.4	4.1
Education: Tertiary	16.1	2.8	Household size above median (=0)	41.8	3.5
Total household income: quintile I	18.6	4.0	Household size below median (=1)	56.5	3.6
Total household income: quintile II	20.1	4.0	Extraversion index $\leq$ 4	33.3	4.0
Total household income: quintile III	18.7	3.5	Extraversion index $\geq$ 4	65.0	3.3
Total household income: quintile IV	18.4	3.3	Conscientiousness index $\leq$ 4	9.9	3.9
Total household income: quintile V	17.6	2.9	Conscientiousness index $\geq$ 4	88.4	3.5
Debt amount below median	77.8	3.5	Openness to Experience index $\leq$ 4	24.9	4.0
Debt amount over median	20.5	3.7	Openness to Experience index $\geq$ 4	73.4	3.4
BMI $\leq$ 30	78.2	3.4	Emotional Stability index $\leq$ 4	20.0	4.4
BMI $\geq$ 30	20.1	3.9	Emotional Stability index $\geq$ 4	78.3	3.3
Drinks Alcohol (=0)	61.1	3.8	Agreeableness index $\leq$ 4	14.2	3.7
Drinks Alcohol (=1)	37.2	3.3	Agreeableness index $\geq$ 4	84.1	3.5
N= 10,024					

Note: Authors' calculations based on SPS 2009.The median debt amount (716 US$) was calculated using only debt holders. The median household size is 4 persons. The personality traits indices range from 0 to 7.

Table A3: Descriptive statistics of samples (2006-2009)

Wave	2006		2009		2006-2009		2006-2009 Fixed housing type	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Overcrowding (=1)	0.14	0.35	0.12	0.33	0.13	0.34	0.12	0.33
Annual household per capita income (US$)	3166.38	4452.27	3274.73	4678.53	3198.99	4560.44	3152.48	4411.59
Female (=1)	0.51	0.50	0.51	0.50	0.52	0.50	0.53	0.50
Education: None (=1)	0.02	0.14	0.02	0.15	0.02	0.15	0.02	0.15
Education: Primary (=1)	0.28	0.45	0.30	0.46	0.32	0.46	0.31	0.46
Education: Secondary (=1)	0.44	0.50	0.46	0.50	0.45	0.50	0.45	0.50
Education: Tertiary (=1)	0.26	0.44	0.22	0.41	0.21	0.41	0.21	0.41
Employed (=1)	0.57	0.50	0.57	0.50	0.56	0.50	0.55	0.50
Unemployed, searching (=1)	0.13	0.33	0.11	0.31	0.11	0.31	0.11	0.31
Unemployed, not searching (=1)	0.30	0.46	0.32	0.47	0.33	0.47	0.34	0.47
Diagnosed with depression (=1)	0.09	0.28	0.09	0.29	0.09	0.29	0.09	0.29
N	16,432		13,707		10,024		9,046	

Note: Authors' calculations based on SPS 2006 and 2009.

Appendix B: Descriptive Statistics for Household Overcrowding Trajectories

Table A4: Sample size of possible overcrowding trayectories

Trajectories	**Panel A** Household size changes		**Panel B** Household size constant		Total
	(i) Bedrooms changes	(ii) Bedrooms constant	(i) Bedrooms changes	(ii) Bedrooms constant	
Never overcrowded	1519	1798	1409	2611	7337
Always overcrowded	84	109	33	247	543
Increasing overcrowding	176	154	115	0	445
Decreasing overcrowding	263	32	223	0	721
Total	2042	2366	1780	2858	**9046**
	4408		**4638**		

Note: Authors' calculations based on SPS 2006 and 2009. *Never overcrowded* corresponds to individuals who did not live in overcrowded households in 2006 and in 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009.

Table A5: Descriptive statistics of household density variation by overcrowding trajectories

Variable: Household density 2009 - Household density 2006						
	Panel A: Changes in bedrooms					
	N	Median	Mean	S.D.	Min	Max
Never overcrowded	4020	0.0	-0.0	0.3	-1.7	1.5
Always overcrowded	280	0.0	-0.1	1.0	-7.5	5.5
Increasing overcrowding	115	1.0	1.3	0.8	0.7	5.3
Decreasing overcrowding	223	-1.3	-1.5	0.8	-4.7	-0.7
	Panel B: Changes in household size					
	N	Median	Mean	S.D.	Min	Max
Never overcrowded	4409	0.0	-0.1	0.4	-1.7	2.2
Always overcrowded	426	0.0	0.0	0.7	-4.0	4.0
Increasing overcrowding	154	1.0	1.0	0.6	0.3	4.0
Decreasing overcrowding	235	-1.0	-1.2	0.9	-5.5	-0.2

Note: Authors' calculations based on SPS 2006 and 2009. *Never overcrowded* corresponds to individuals who did not live in overcrowded households in 2006 and in 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009.

Appendix C: Results

Table A6: Depressive symptoms index and household overcrowding trajectories: complete OLS estimates for the whole sample

Dependent variable: Depressive Symptoms Index					
Always overcrowded (=1)	0.148	Divorced (2006)	0.256	Smokes (=1)	0.303***
	(0.133)		(0.177)		(0.073)
Increasing overcrowding (=1)	0.327**	Widow (2006)	-0.410*	Drinks Alcohol (=1)	0.014
	(0.141)		(0.233)		(0.072)
Decreasing overcrowding (=1)	-0.001	Has children under 1 year of age (=1)	-0.189	Disability (=1)	0.601***
	(0.123)		(0.165)		(0.103)
Housing and household composition		Has children between 2 and 4 years old (=1)	-0.038	BMI	0.000
Shared residence: family (=1)	0.291**		(0.149)		(0.001)
	(0.116)	Has children between 5 and 13 years old (=1)	0.187**	Close relative passed away (=1)	0.352***
Shared residence: non-family (=1)	0.069		(0.082)		(0.134)
	(0.300)	Has children between 14 and 18 years old (=1)	0.174**	*Personality traits*	
Shared residence: respondent (=1)	-0.181		(0.068)	Extraversion	-0.173***
	(0.197)	Has children over 18 years old (=1)	0.156**		(0.024)
Household size (2009)	-0.025		(0.072)	Conscientiousness	-0.014
	(0.033)	*Socio-demographics*			(0.030)
Household size (2006)	-0.013	Female (=1)	0.720***	Openness to Experience	0.012
	(0.029)		(0.080)		(0.023)
Housing type: Tenement	0.050	Age	-0.006*	Emotional Stability	-0.239***
	(0.440)		(0.004)		(0.030)
Housing type: Condominium	0.357	Education: Primary	0.033	Agreeableness	-0.000
	(0.474)		(0.198)		(0.030)
Housing type: Appartment	0.272*	Education: Secondary	-0.291	Extraversion not reported	-1.028***
	(0.158)		(0.205)		(0.308)
Housing type: Room in house or appartment	0.642*	Education: Tertiary	-0.681***	Conscientiousness not reported	-0.416
	(0.346)		(0.225)		(0.422)
Housing type: Room in tenement	0.780**	Household per capita income (log)	-0.099*	Openness to Experience not reported	0.355
	(0.386)		(0.051)		(0.340)
Housing type: Slum	0.361	Δ Household total per capita income (Log)	0.041	Emotional Stability not reported	-1.381***
	(0.250)		(0.044)		(0.359)
Tenure: Still paying	0.172*	Δ of income not reported	-1.254**	Agreeableness not reported	0.246
	(0.102)		(0.576)		(0.426)
Tenure: Sharing owner	0.023	Unemployed, searching (=1)	0.329	*Debt and assets*	
	(0.288)		(0.120)	Total debt amount (Log)	0.026***
Tenure: Rent	0.202*	Unemployed, not searching (=1)	0.205*		(0.005)
	(0.121)		(0.107)	Owner: car (=1)	-0.311***
Tenure: Employer tenant	-0.052				(0.076)
	(0.371)	*Personal and family health*		Owner: machinery (=1)	0.077
Tenure: Friend or family tenant	0.064	Diagnosed with depression (2009) (=1)	1.431***		(0.204)
	(0.112)		(0.098)	Owner: business (=1)	-0.033
Married	-0.321**	Diagnosed with depression (2006) (=1)	0.492***		(0.150)
	(0.156)		(0.133)		
Divorced	0.184	Relative diagnosed with depression (=1)	0.450***	Constant	5.915***
	(0.177)		(0.125)		(0.661)
Widow	0.362	Cancer (=1)	0.268		
	(0.222)		(0.279)		
Married (2006)	0.229	Chronic illness (=1)	0.503***	Observations	10,024
	(0.149)		(0.074)	R^2	0.244

Note: Authors' calculations based on SPS 2006 and 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009. Δ *Household total per capita income (Log)* corresponds to the difference between the individual's household total per capita income (log) in 2009 and the individual's household total per capita income (log) in 2006. Δ *of income not reported* is a dummy variable equal to 1 if the respondent does not report the variation of her household's income. The reference category of *housing type* is a house. The reference category of *housing tenure* is homeowner. The reference category of *marital status* is single. The reference category of *employment status* is employed.

Table A7: Depressive symptoms index and household overcrowding trajectories: complete OLS estimates for the constant housing type subsample

Dependent variable: Depressive Symptoms Index					
Always overcrowded (=1)	0.220	Divorced (2006)	0.182	Smokes (=1)	0.258***
	(0.145)		(0.188)		(0.076)
Increasing overcrowding (=1)	0.414***	Widow (2006)	-0.321	Drinks Alcohol (=1)	0.023
	(0.154)		(0.244)		(0.075)
Decreasing overcrowding (=1)	-0.039	Has children under 1 year of age (=1)	-0.357*	Disability (=1)	0.595***
	(0.135)		(0.186)		(0.109)
Housing and household composition		Has children between 2 and 4 years old (=1)	-0.048	BMI	0.000
Shared residence: family (=1)	0.370***		(0.165)		(0.001)
	(0.121)	Has children between 5 and 13 years old (=1)	0.135	Close relative passed away (=1)	0.401***
Shared residence: non-family (=1)	0.039		(0.086)		(0.133)
	(0.320)	Has children between 14 and 18 years old (=1)	0.185**	Personality traits	
Shared residence: respondent (=1)	-0.171		(0.072)	Extraversion	-0.159***
	(0.209)	Has children over 18 years old (=1)	0.127*		(0.025)
Household size (2009)	-0.040		(0.076)	Conscientiousness	-0.013
	(0.034)	Socio-demographics			(0.033)
Household size (2006)	-0.004	Female (=1)	0.702***	Openness to Experience	0.014
	(0.031)		(0.083)		(0.024)
Housing type: Tenement	-0.575	Age	-0.005	Emotional Stability	-0.254***
	(0.936)		(0.004)		(0.031)
Housing type: Condominium	-0.254	Education: Primary	0.155	Agreeableness	0.009
	(0.596)		(0.206)		(0.031)
Housing type: Appartment	0.281	Education: Secondary	-0.161	Extraversion not reported	-1.093***
	(0.192)		(0.213)		(0.315)
Housing type: Room in house or appartment	1.353	Education: Tertiary	-0.485**	Conscientiousness not reported	-0.327
	(1.171)		(0.233)		(0.458)
Housing type: Room in tenement	2.229***	Household per capita income (log)	-0.169***	Openness to Experience not reported	0.080
	(0.504)		(0.054)		(0.361)
Housing type: Slum	0.394	Δ Household total per capita income (Log)	0.089*	Emotional Stability not reported	-1.236***
	(0.302)		(0.047)		(0.378)
Tenure: Still paying	0.144	Δ of income not reported	-2.146***	Agreeableness not reported	0.258
	(0.105)		(0.613)		(0.465)
Tenure: Sharing owner	-0.134	Unemployed, searching (=1)	0.318**	Debt and assets	
	(0.260)		(0.125)	Total debt amount (Log)	0.029***
Tenure: Rent	0.229	Unemployed, not searching (=1)	0.180		(0.006)
	(0.141)		(0.114)	Owner: car (=1)	-0.298***
Tenure: Employer tenant	-0.644**				(0.080)
	(0.287)	Personal and family health		Owner: machinery (=1)	0.072
Tenure: Friend or family tenant	0.089	Diagnosed with depression (2009) (=1)	1.459***		(0.211)
	(0.121)		(0.101)	Owner: business (=1)	0.004
Married	-0.161	Diagnosed with depression (2006) (=1)	0.394***		(0.156)
	(0.167)		(0.135)		
Divorced	0.319*	Relative diagnosed with depression (=1)	0.471***	Constant	6.484***
	(0.189)		(0.131)		(0.709)
Widow	0.324	Cancer (=1)	0.281		
	(0.235)		(0.298)		
Married (2006)	0.144	Chronic illness (=1)	0.452***	Observations	9,046
	(0.158)		(0.076)	R^2	0.242

Note: Authors' calculations based on SPS 2006 and 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009. Δ *Household total per capita income (Log)* corresponds to the difference between the individual's household total per capita income (log) in 2009 and the individual's household total per capita income (log) in 2006. Δ *of income not reported* is a dummy variable equal to 1 if the respondent does not report the variation of her household's income. The reference category of *housing type* is a house. The reference category of *housing tenure* is homeowner. The reference category of *marital status* is single. The reference category of *employment status* is employed.

Table A8: Depressive symptoms index and household overcrowding trajectories: complete OLS estimates for the household infrastructure trajectories subsample

Dependent variable: Depressive Symptoms Index					
Always overcrowded (=1)	0.246	Divorced (2006)	-0.078	Smokes (=1)	0.404***
	(0.190)		(0.311)		(0.101)
Increasing overcrowding (=1)	0.512**	Widow (2006)	-0.205	Drinks Alcohol (=1)	-0.039
	(0.228)		(0.399)		(0.096)
Decreasing overcrowding (=1)	0.173	Has children under 1 year of age (=1)	3.185***	Disability (=1)	0.631***
	(0.187)		(0.224)		(0.148)
Housing and household composition		Has children between 2 and 4 years old (=1)	0.082	BMI	0.001
Shared residence: family (=1)	0.000		(0.176)		(0.001)
	(.)	Has children between 5 and 13 years old (=1)	0.167	Close relative passed away (=1)	0.000
Shared residence: non-family (=1)	0.000		(0.111)		(.)
	(.)	Has children between 14 and 18 years old (=1)	0.327***	Personality traits	
Shared residence: respondent (=1)	-0.258		(0.096)	Extraversion	-0.143***
	(0.265)	Has children over 18 years old (=1)	0.037		(0.029)
Household size (2009)	-0.051		(0.103)	Conscientiousness	0.005
	(0.037)	Socio-demographics			(0.034)
Household size (2006)	0.000	Female (=1)	0.747***	Openness to Experience	0.019
	(.)		(0.104)		(0.030)
Housing type: House in tenement	-1.248***	Age	0.004	Emotional Stability	-0.266***
	(0.467)		(0.004)		(0.034)
Housing type: Condominium	0.398	Education: Primary	0.278	Agreeableness	0.033
	(0.488)		(0.295)		(0.038)
Housing type: Appartment	0.219	Education: Secondary	-0.034	Extraversion not reported	-1.244***
	(0.193)		(0.300)		(0.390)
Housing type: Room in house or appartment	1.910	Education: Tertiary	-0.174	Conscientiousness not reported	-0.230
	(1.285)		(0.317)		(0.547)
Housing type: Room in tenement	1.502***	Household per capita income (log)	-0.131*	Openness to Experience not reported	-0.348
	(0.515)		(0.069)		(0.482)
Housing type: Slum	0.855**	Δ Household total per capita income (Log)	0.095	Emotional Stability not reported	-1.557***
	(0.389)		(0.063)		(0.471)
Tenure: Still paying	0.114	Δ of income not reported	-1.745**	Agreeableness not reported	0.587
	(0.129)		(0.798)		(0.528)
Tenure: Sharing owner	-0.114	Unemployed, searching (=1)	0.410**	Debt and assets	
	(0.376)		(0.164)	Total debt amount (Log)	0.036***
Tenure: Rent	0.354**	Unemployed, not searching (=1)	0.058		(0.007)
	(0.165)		(0.127)	Owner: car (=1)	-0.467***
Tenure: Employer tenant	-0.518				(0.100)
	(0.322)	Personal and family health		Owner: machinery (=1)	0.003
Tenure: Friend or family tenant	0.080	Diagnosed with depression (2009) (=1)	1.359***		(0.278)
	(0.137)		(0.144)	Owner: business (=1)	0.123
Married	0.085	Diagnosed with depression (2006) (=1)	0.387**		(0.165)
	(0.252)		(0.165)		
Divorced	0.367	Relative diagnosed with depression (=1)	0.700***	Constant	5.156***
	(0.307)		(0.189)		(0.929)
Widow	0.361	Cancer (=1)	0.741***		
	(0.394)		(0.233)		
Married (2006)	-0.136	Chronic illness (=1)	0.425***	Observations	4,638
	(0.258)		(0.106)	R^2	0.243

Note: Authors' calculations based on SPS 2006 and 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009. Δ *Household total per capita income (Log)* corresponds to the difference between the individual's household total per capita income (log) in 2009 and the individual's household total per capita income (log) in 2006. Δ *of income not reported* is a dummy variable equal to 1 if the respondent does not report the variation of her household's income. The reference category of *housing type* is a house. The reference category of *housing tenure* is homeowner. The reference category of *marital status* is single. The reference category of *employment status* is employed.The variables for shared residence: family and non-family are omitted when using the subsample of individuals for whom only the number of bedrooms changes because, by construction, there is no arrival of new members. The same applies to the death of a close relative.

Table A9: Depressive symptoms index and household overcrowding trajectories: complete OLS estimates for the household composition trajectories subsample

Dependent variable: Depressive Symptoms Index					
Always overcrowded (=1)	0.200	Divorced (2006)	-0.036	Smokes (=1)	0.257***
	(0.169)		(0.242)		(0.099)
Increasing overcrowding (=1)	0.448	Widow (2006)	-0.319	Drinks Alcohol (=1)	0.197**
	(0.326)		(0.327)		(0.094)
Decreasing overcrowding (=1)	-0.064	Has children under 1 year of age (=1)	-0.546*	Disability (=1)	0.669***
	(0.251)		(0.298)		(0.151)
Housing and household composition		Has children between 2 and 4 years old (=1)	-0.138	BMI	-0.000
Shared residence: family (=1)	0.309*		(0.219)		(0.001)
	(0.165)	Has children between 5 and 13 years old (=1)	0.073	Close relative passed away (=1)	0.376**
Shared residence: non-family (=1)	1.016**		(0.115)		(0.176)
	(0.414)	Has children between 14 and 18 years old (=1)	0.073	Personality traits	
Shared residence: respondent (=1)	-0.054		(0.093)	Extraversion	-0.187***
	(0.257)	Has children over 18 years old (=1)	0.009		(0.032)
Household size (2009)	-0.025		(0.100)	Conscientiousness	-0.070
	(0.056)	Socio-demographics			(0.043)
Household size (2006)	0.013	Female (=1)	0.783***	Openness to Experience	0.031
	(0.052)		(0.107)		(0.030)
Housing type: Tenement	-1.747**	Age	-0.004	Emotional Stability	-0.255***
	(0.857)		(0.005)		(0.041)
Housing type: Condominium	-0.425	Education: Primary	0.124	Agreeableness	-0.021
	(0.597)		(0.286)		(0.040)
Housing type: Appartment	0.283	Education: Secondary	-0.216	Extraversion not reported	-1.580***
	(0.191)		(0.292)		(0.427)
Housing type: Room in house or appartment	1.538	Education: Tertiary	-0.581*	Conscientiousness not reported	-1.050
	(1.238)		(0.317)		(0.720)
Housing type: Room in tenement	2.105***	Household per capita income (log)	-0.114	Openness to Experience not reported	0.673
	(0.628)		(0.071)		(0.465)
Housing type: Slum	0.635**	Δ Household total per capita income (Log)	0.024	Emotional Stability not reported	-0.903*
	(0.310)		(0.064)		(0.515)
Tenure: Still paying	0.136	Δ of income not reported	-1.797**	Agreeableness not reported	-0.004
	(0.126)		(0.804)		(0.693)
Tenure: Sharing owner	0.058	Unemployed, searching (=1)	0.286*	Debt and assets	
	(0.419)		(0.161)	Total debt amount (Log)	0.032***
Tenure: Rent	0.231	Unemployed, not searching (=1)	0.218		(0.007)
	(0.191)		(0.145)	Owner: car (=1)	-0.238**
Tenure: Employer tenant	-0.677***				(0.102)
	(0.252)	Personal and family health		Owner: machinery (=1)	0.286
Tenure: Friend or family tenant	0.117	Diagnosed with depression (2009) (=1)	1.462***		(0.228)
	(0.157)		(0.132)	Owner: business (=1)	0.150
Married	0.034	Diagnosed with depression (2006) (=1)	0.382**		(0.162)
	(0.203)		(0.149)		
Divorced	0.486**	Relative diagnosed with depression (=1)	0.316*	Constant	6.250***
	(0.234)		(0.163)		(0.919)
Widow	0.368	Cancer (=1)	0.298		
	(0.310)		(0.215)		
Married (2006)	-0.004	Chronic illness (=1)	0.393***	Observations	5,224
	(0.197)		(0.099)	R^2	0.243

Note: Authors' calculations based on SPS 2006 and 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009. Δ *Household total per capita income (Log)* corresponds to the difference between the individual's household total per capita income (log) in 2009 and the individual's household total per capita income (log) in 2006. Δ *of income not reported* is a dummy variable equal to 1 if the respondent does not report the variation of her household's income. The reference category of *housing type* is a house. The reference category of *housing tenure* is homeowner. The reference category of *marital status* is single. The reference category of *employment status* is employed.

Appendix D: Descriptive Statistics of changes of household composition

Table A10: Number of observations by situations that lead to household composition changes for each household composition trajectory (as a % of the total of the trajectory).

	Always Overcrowded	Increasing overcrowding	Decreasing Overcrowding
Arrival (%)			
Newborn	74	73	35
Partner	4	7	21
Partner of son/daughter	10	13	9
Family member	97	93	73
Son/Daughter	37	49	30
Parents	2	0	10
Father/mother in law	1	2	0
Grandson/daughter	38	29	18
Brother/Sister	4	5	2
Brother/Sister in law	7	12	4
Grandparents	0	0	6
Other family member	26	27	23
Non-family member	5	5	8
Departure (%)			
Marriage	11	12	44
Work	4	2	10
Study	0	1	3
Independence	5	8	20
Family problems	2	6	13
Passed away	4	5	6
Other reasons	10	10	46
N	426	154	235

Note: Authors' calculations based on SPS 2006 and 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009.We consider a newborn any new child living in the household between 0 and 3 years old. Each column does not add up to 100 because these are not mutually exclusive categories (e.g a newborn may be the grandson of the respondent). We use the sample of individuals who report a change in the household size and for whom the number of bedrooms does not change (household composition trajectories).

Appendix E: Continuous variation of household density and depressive symptoms

To identify a potential non-linear relationship between household density variation and mental health, we estimate the following equation:

$$D_i = \gamma_0 + \gamma_1 \Delta\text{Household density}_i + \gamma_2 \Delta^2\text{Household density}_i + \beta X_i + \epsilon_i \quad (.1)$$

where D_i is the depressive symptoms index of individual i, ΔHousehold density$_i$ is the difference between the individual's household density in 2009 and the individual's household density in 2006, Δ^2Household density$_i$ is the squared term of the variation of the household density and X_i is the vector of controls. Results are presented in table A11.

Table A11: Depressive symptoms index and household density variation: OLS estimates

	Dependent variable: Depressive Symptoms Index							
	(1) Full Sample	(2) Full Sample	(3) Same House Type	(4) Same House Type	(5) Changes in bedrooms	(6) Changes in bedrooms	(7) Changes in household size	(8) Changes in household size
Δ Household Density	0.047	0.049	0.086**	0.086**	0.086	0.063	0.140	0.157
	(0.035)	(0.035)	(0.038)	(0.039)	(0.063)	(0.077)	(0.221)	(0.240)
Δ^2 Household Density		0.002		0.000		0.041*		0.012
		(0.006)		(0.006)		(0.023)		(0.039)
Controls:								
Housing and household composition	✓	✓	✓	✓	✓	✓	✓	✓
Socio-demographics	✓	✓	✓	✓	✓	✓	✓	✓
Personal and family health	✓	✓	✓	✓	✓	✓	✓	✓
Personality traits	✓	✓	✓	✓	✓	✓	✓	✓
Debts and assets	✓	✓	✓	✓	✓	✓	✓	✓
N	10024	10024	9046	9046	4638	4638	5224	5224
R^2	0.243	0.243	0.241	0.241	0.242	0.243	0.242	0.242

Note: Authors' calculations based on SPS 2006 and 2009. Δ *Household density* corresponds to the difference between the individual's household density in 2009 and the individual's household density in 2006.*Housing and household composition controls*: shared residence, size of household, housing type, housing tenure, marital status in 2006 and 2009, number of children (by age groups). *Socio-demographic controls*: gender, age, education, monthly household income per capita, the variation of monthly household income per capita between 2006 and 2009, and employment status. *Personal and family health controls*: indicators for individual diagnosed with depression in 2006 or 2009, family member diagnosed with depression, individual diagnosed with cancer, individual smokes or drinks alcohol, individual has any disability, BMI, and whether a family member died recently. *Personality traits*: extraversion, agreeableness, conscientiousness, openness to experience and emotional stability. *Debt and assets controls*: log of total debt amount, individual owner of a car, company or machinery (capital).

Appendix F: Robustness checks

Table A12: Depression symptoms index and household overcrowding trajectories: ordered probit estimates

	Variable of interest					
	Changes in bedrooms:			Changes in Household Size:		
Depressive Symptoms Index Value	Always	Increasing	Decreasing	Always	Increasing	Decreasing
0	-0.019	-0.044**	-0.011	-0.015	-0.034	0.007
	(0.016)	(0.020)	(0.016)	(0.012)	(0.029)	(0.018)
1	-0.012	-0.028**	-0.007	-0.010	-0.024	0.005
	(0.010)	(0.013)	(0.010)	(0.009)	(0.020)	(0.013)
2	-0.005	-0.013**	-0.003	-0.006	-0.013	0.003
	(0.005)	(0.006)	(0.005)	(0.005)	(0.011)	(0.007)
3	0.000	0.000	0.000	-0.001	-0.002	0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)
4	0.003	0.008**	0.002	0.002	0.004	-0.001
	(0.003)	(0.004)	(0.003)	(0.002)	(0.004)	(0.002)
5	0.006	0.015**	0.004	0.005	0.011	-0.002
	(0.005)	(0.007)	(0.005)	(0.004)	(0.009)	(0.006)
6	0.012	0.028**	0.007	0.010	0.022	-0.005
	(0.010)	(0.013)	(0.010)	(0.008)	(0.019)	(0.012)
7	0.007	0.017**	0.004	0.006	0.015	-0.003
	(0.006)	(0.007)	(0.006)	(0.005)	(0.012)	(0.008)
8	0.007	0.017**	0.004	0.009	0.020	-0.004
	(0.006)	(0.008)	(0.006)	(0.007)	(0.018)	(0.011)
Controls:						
Housing and household composition	✓	✓	✓	✓	✓	✓
Socio-demographics	✓	✓	✓	✓	✓	✓
Personal and family health	✓	✓	✓	✓	✓	✓
Personality traits	✓	✓	✓	✓	✓	✓
Debts and assets	✓	✓	✓	✓	✓	✓
N		4,638			5,224	

Note: Authors' calculations based on SPS 2006 and 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009.*Housing and household composition controls*: shared residence, size of household, housing type, housing tenure, marital status in 2006 and 2009, number of children (by age groups). *Socio-demographic controls*: gender, age, education, monthly household income per capita, the variation of monthly household income per capita between 2006 and 2009, and employment status. *Personal and family health controls*: indicators for individual diagnosed with depression in 2006 or 2009, family member diagnosed with depression, individual diagnosed with cancer, individual smokes or drinks alcohol, individual has any disability, BMI, and whether a family member died recently. *Personality traits*: extraversion, agreeableness, conscientiousness, openness to experience and emotional stability. *Debt and assets controls*: log of total debt amount, individual owner of a car, company or machinery (capital).

Table A13: OLS estimates of overcrowding trajectories and depressive symptoms with *Always* trajectory as base level

Dependent variable: Depressive Symptoms Index				
	(1)	(2)	(3)	(4)
	Full Sample	Same House Type	Changes in bedrooms	Changes in household size
Never overcrowded (=1)	-0.148	-0.220	-0.246	-0.200
	(0.133)	(0.145)	(0.190)	(0.169)
Increasing overcrowding (=1)	0.179	0.194	0.266	0.248
	(0.180)	(0.202)	(0.276)	(0.376)
Decreasing overcrowding (=1)	-0.149	-0.259	-0.073	-0.264
	(0.158)	(0.175)	(0.234)	(0.284)
Shared residence: family (=1)	0.291**	0.370***	0.000	0.309*
	(0.116)	(0.121)	(.)	(0.165)
Shared residence: non-family (=1)	0.069	0.039	0.000	1.016**
	(0.300)	(0.320)	(.)	(0.414)
Shared residence: respondent (=1)	-0.181	-0.171	-0.258	-0.054
	(0.197)	(0.209)	(0.265)	(0.257)
Female (=1)	0.720***	0.702***	0.747***	0.783***
	(0.080)	(0.083)	(0.104)	(0.107)
Unemployed, searching (=1)	0.329***	0.318**	0.410**	0.286*
	(0.120)	(0.125)	(0.164)	(0.161)
Unemployed, not searching (=1)	0.205*	0.180	0.058	0.218
	(0.107)	(0.114)	(0.127)	(0.145)
Chronic illness (=1)	0.503***	0.452***	0.425***	0.393***
	(0.074)	(0.076)	(0.106)	(0.099)
Controls:				
Housing and household composition	✓	✓	✓	✓
Socio-demographics	✓	✓	✓	✓
Personal and family health	✓	✓	✓	✓
Personality traits	✓	✓	✓	✓
Debts and assets	✓	✓	✓	✓
N	10024	9046	4638	5224
R^2	0.244	0.242	0.243	0.243

Note: Authors' calculations based on SPS 2006 and 2009. *Always overcrowded* corresponds to individuals who live in overcrowded households in 2006 and 2009. *Increasing overcrowding* corresponds to individuals who live in an overcrowded household in 2009 but not in 2006. *Decreasing overcrowding* corresponds to individuals who live in an overcrowded household in 2006 but not in 2009.*Housing and household composition controls*: shared residence, size of household, housing type, housing tenure, marital status in 2006 and 2009, number of children (by age groups). *Socio-demographic controls*: gender, age, education, monthly household income per capita, the variation of monthly household income per capita between 2006 and 2009, and employment status. *Personal and family health controls*: indicators for individual diagnosed with depression in 2006 or 2009, family member diagnosed with depression, individual diagnosed with cancer, individual smokes or drinks alcohol, individual has any disability, BMI, and whether a family member died recently. *Personality traits*: extraversion, agreeableness, conscientiousness, openness to experience and emotional stability. *Debt and assets controls*: log of total debt amount, individual owner of a car, company or machinery (capital).