Maastricht University

Health in homes

An investigation of the Dutch rental housing market

Author:
Maaike Vranckaerts
I6045584

Supervisors:
Prof. Dr. Piet Eichholtz
Juan Palacios, PHD candidate

Master Thesis

For the degree of

MSc International Business – Sustainable Finance

School of Business and Economics

Maastricht University

January 22nd, 2018

THANK YOU – to all who have accompanied me during this rollercoaster experience. Whether it be with helpful feedback, comments, lively discussion, arguments, proofreading, testing my patience (unintended..?), mental support or distraction – it is highly appreciated. I especially thank my supervisors, Piet Eichholtz and Juan Palacios, for their knowledge, input and enthusiasm throughout the entire process. A praise to my colleagues, buddy, and mentor at Finance Ideas for their positivity and curiosity. For a listening ear, always, Lynn. But most of all: my dear mother, not for one sole reason, but for everything.

Executive summary

The effect of hazards in the outdoor environment on health and human capital formation is well established. Though, individuals spent approximately 90 percent of their time indoors, of which most in the home environment. Nevertheless, little is known about the health outcomes of housing conditions. The majority of existing literature is limited to the adverse health effects of extremely poor indoor housing quality. Most research comprises of policy interventions and small-scale experiments in developing countries, investigating the effects of specific indoor hazards (e.g. air pollution) on health. However, insights from most existing studies are not generalizable to developed economies as a result of different underlying fundamentals. The conducted research explores the pathways between housing conditions and health for occupants of rental housing in the Netherlands. The analysis is based on longitudinal data of 2,332 tenants and 803 social tenants from 2007 through 2016.

The results of this study show causal adverse health effects of experiencing hazards in the home environment. The effects are even stronger for social tenants, the most vulnerable individuals of society. Occupants of dwellings in poor condition report lower health status and experience loss of productivity. Specifically, tenants exposed to indoor hazards report adverse health effects up to 14 percent; for social tenants the magnitude increases to 21 percent. Similar conclusions are drawn with respect to demand for health care services. The detrimental effect on demand for healthcare is strongest for individuals experiencing rot in the home; as a result, up to 5.6 additional yearly visits are paid to medical specialists. The negative impact of indoor hazards on health is most pronounced for females; in particular those inhabiting social housing. Even limited exposure to poor housing conditions is related to increased demand for healthcare. As a result, individuals pay more visits to general practitioners and make more use of mental healthcare services. Furthermore, exposure to indoor hazards is found to play a role in the decision of individuals to change residency. The results confirm the robustness of the analysis and the dwelling-specific effects of hazards in the home on health. The analysis controls for neighbourhood effects, socio-economic status, demographics and health behaviour. Moreover, the conclusions confirm the adverse health effects of poor housing condition.

The results have implications for tenant health and housing quality investment decisions. The findings of this research implicate that poor housing conditions are a source of health deprivation. In the Netherlands, social housing institutions are responsible for providing adequate housing. Housing policy should therefore increase transparency of the quality of the existing housing stock and incorporate minimum requirements for healthy rental housing.

Table of content

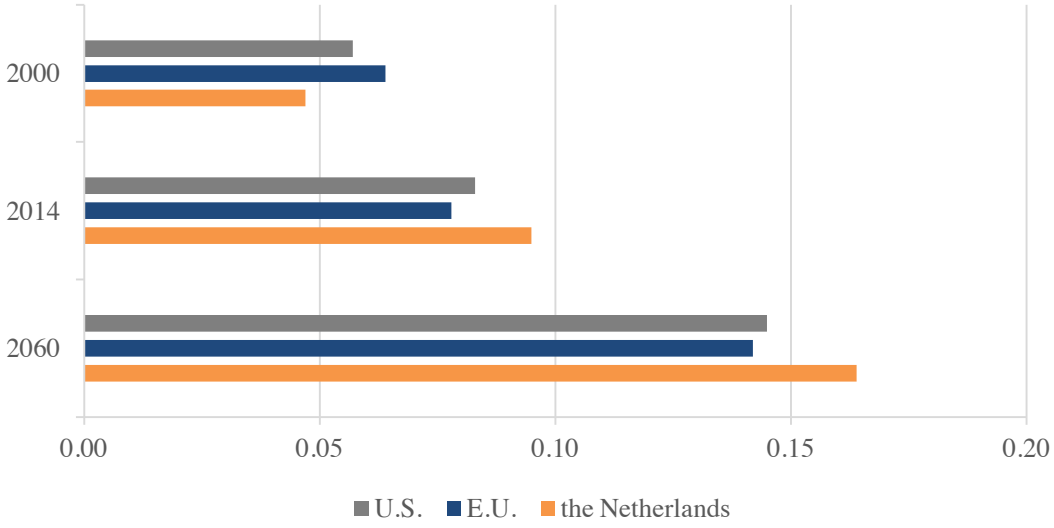
List of tables

List of figures

1 Introduction

Affordability is currently the most evident healthcare concern. Providing and funding health care has increasingly become a challenge. The costs of healthcare services continue to rise in the face of increasing demand. Welfare growth, willingness to invest financial assets in personal health, and longevity increases the demand for health services. In addition, depleting resources in healthcare systems and technological advances, accompanied by a rise in demand, result in increased healthcare costs. Policymakers are pressured to maintain the quality of and access to health care, while simultaneously reduce costs. Public finances are projected to be significantly burdened by healthcare expenditures over the next decades if no stepped-up policy action materializes. Projections issued by the OECD estimate that, by 2060, public expenditures reach 14.5 and 14.2 percent of GDP in the U.S. and the E.U., and even 16.4 percent in the Netherlands (Maisonneuve & Martins, 2013; 2015).

Figure 1: Public healthcare expenditure as a percentage of GDP



Source: the World Bank, (n.d.) and Maisonneuve & Martins, (2013; 2015)

The Dutch health care system has been regarded the best in Europe according to the Euro Health Consumer Index (Björnberg, 2017). However, unless demand for healthcare services can be reduced to manageable levels, the financial burden of healthcare on society will, most likely, become economically unacceptable. Therefore, it is important to explore sources of variations in health and contribute to the discussion on the prevention of health deprivation. As such, potential measures to reduce public healthcare costs are identified.

The World Health Organization (WHO, 2017b) categorizes the determinants of health into: person-specific characteristics and behaviours, and the social, economic, and physical environment. Individuals can influence their health by means of health investments, such as regular exercise and nutrition. Health deprivation is to a certain extent within personal control and, thus, self-inflicted. The development of preventable diseases and the minimization of risks of obesity, cardiovascular disease, diabetes, stroke, and some cancers have long been related to individual behaviour (Klepeis, et al., 2001). Deleterious lifestyle behaviour poses a formidable threat to health, however, is inseparable from the social and economic environment in which an individual is situated. Variation of income and education is also a well-known source of health deprivation. The role of socioeconomic status has been explored extensively and it is shown to have a large impact on health through means as income, education, and occupational status (Adams, Hurd, McFadden, Merrill, & Ribeiro, 2003).

The physical environment has long been associated to indicators of health and well-being. The impact of the environment on welfare-relevant factors, such as human capital formation, productivity and health, has been well established in literature. For example, there is growing evidence on the adverse effects of environmental hazards such as temperature, air and water quality on individual health (e.g. Currie, Neidell, & Schmieder, 2009; Deschenes, 2014; Deschenes, Greenstone, & Guryan, 2009). The vast majority of existing research has focused on outdoor measures of the environment. However, people spent approximately 90 percent of their time inside the built environment, of which most in their homes (Klepeis et al., 2001). Nevertheless, there is surprisingly little empirical research in the field of indoor environmental housing and health economics. The majority of the existing strand of research comprises of small-scale experiments and intervention studies exploring the adverse health effects of specific indoor environmental hazards in developing countries. Examples include negative health outcomes of indoor air pollution from cooking on open fire (Duflo, Greenstone, & Hanna, 2008), extreme temperatures (Gibson et al., 2011), and indoor lead painting (Pega & Wilson, 2016). Policy interventions such as the replacement of dirt for cement floors (Cattaneo, Galiani, Gertler, Martinez, & Titiunik, 2009) and the improvement of cooking stoves (Hanna, Duflo, & Greenstone, 2016) show positive health effects as a reduction in respiratory diseases and mortality rates.

The insights into the causal relation between housing and health based on research in developing countries are, however, hardly generalizable to the housing stock of developed countries. In addition to fundamentally different underlying socio-demographic and housing

characteristics, the baseline quality of dwellings in developed countries is considerable higher. Furthermore, while an effect of the indoor environment of housing on health is intuitively perspicuous, it is academically challenging to disentangle the effect of the quality of the indoor environment on health from confounding factors. This research attempts to bridge the gap in current academic literature related to health economics and the role of housing. The research question of this study is therefore

"What is the effect of poor housing condition on health?"

This research complements recent academic literature. To date, the strand of literature exploring the relation between housing and health in developed countries is limited to work published by Aydin, Eichholtz, Kok, & Palacios (2017) and Weinhold (2015). Based on longitudinal panel data of West-Germany from 1992 through 2014, Ayden et al. (2017) document a causal relationship between indoor housing conditions and occupant self-reported health and demand for healthcare services. Based on panel data from 2008 through 2013, Weinhold (2015) finds a strong and robust effect of residential noise annoyance on overall health level for people in the Netherlands. This study extends the latter, exploring pathways between dwelling quality and self-reported health and demand for healthcare services. The analysis is based on data from 2007 through 2016 of the Dutch LISS longitudinal panel. The research focuses on occupants of dwellings in the rental and social housing market. Tenants are more financially constrained (Dutch Ministry of Foreign Affairs, 2016), report poorer health and are more likely to be exposed to health damaging hazards of the indoor environment (Macintyre et al., 2003; Pollack, von dem Knesebeck, & Siegrist, 2004). Social tenants are positioned in the lowest income class and demand more healthcare, representing the most vulnerable segment of society.

The analysis estimates the effects of dwelling condition in the previous period on current health status. Measures of self-reported health perception and utilization of health care services serve as indicators of individual health. Poor dwelling condition is expressed by the prevalence of problems (such as mould, rot, and noise) in the home environment. The empirical strategy is based on pooled multiple linear (OLS) regression analysis and includes an extensive set of controls to account for dwelling and household characteristics, socioeconomics, demographics (i.e. age, gender), and health behaviour. Furthermore, the estimation of dwelling specific effects is ensured by controlling for extended exposure to the same dwelling.

The main findings are in line with previous research and shed insight into which indoor environmental hazards are responsible for specific health outcomes. Indoor environmental

hazards lead to lower self-reported health and well-being, increases overall hindrance and results in productivity loss. The same holds for demand for various types of healthcare services. The prevalence of rot, specifically, has strong and persistent economic health consequences. As expected, the adverse health effects of indoor hazards are stronger for tenants of social housing. Furthermore, females are more prone to the negative health effects of indoor hazards than males. The results are robust to dwelling-specific effects and conditional on extended exposure to the indoor environmental hazards. Moreover, the conclusions of this research confirm the adverse health effects of poor housing condition.

The main contribution of this research lies in the extension of the strand of literature in the field of health economics and housing. Health can be viewed from the perspective of economic theory, by considering the level of health a representation of the resources invested in health. Identifying sources of demand for units of health is thus a valuable strand of research. This research is unique in estimating the causal effect of poor dwelling quality on health status in the rental housing market in a developed country. At the time, it is one of the first to attempt to distinguish a causal link between the quality of the indoor environment and demand for healthcare. Contribution to this area of study strengthens the generalizability of the conclusions. Estimating the impact of indoor environmental hazards therefore prioritizes which dwelling conditions need to be explored in further research.

The conclusions of this research are relevant from three hierarchical perspectives of society. *First*, dependent on indoor dwelling conditions and personal needs, this research supports tenants in the financial decision-making of investing in health capital. *Second*, housing institutions, responsible for providing qualitative rental housing, should incorporate the insights in the prioritization of the investment process in maintenance and refurbishments as to enhance tenant health. *Third*, the insights should be considered in the discussion on policy interventions as to enhance the affordability of health care.

This paper is structured as follows. Section 2 describes the theoretical foundation of housing and health on which this research is based. Section 3 provides insights into the Dutch rental housing market. The expected relationships are described in section 4. In section 5, the data sources and descriptive statistics are presented. Section 6 describes the methodology and empirical design. In section 7, the results of the regression analysis are provided. Section 8 interprets these results, discusses the implications, and describes limitations and future research suggestions. The research concludes in section 9.

2 Theoretical foundation

This research paper analyses the potential causal relationship between the quality of rental housing and occupant health. As to provide a solid theoretical foundation for the underlying rationale of this research, the conceptual framework builds and reflects on the current state of research. This paper incorporates the most relevant concepts from the fields of the human and health capital theory, and relates these to in- and outdoor environmental economics.

2.1 Classical Human Capital theory

The theory of human capital stems from the field of development economics (Lewis, 1954) where it is applied to the analysis of the economic development of nations. However, the notion was first introduced by Smith (1776) in his definition of types of fixed capital. Capital requires an upfront investment and results in the form of capital accumulation for the same individual. Production growth over time, both on an individual and aggregate level, is explained by economists as the accumulation of capital resulting in a distribution of wealth across the population. Besides machinery, real estate property and land, Smith (1776) defines the "acquired and useful abilities of all the inhabitants or members of society" as one of the four types of fixed capital. Human resources can thus be viewed as a form of capital and a produced means of production (Fisher, 1906; Thunen von, 1875; Schultz, 1961).

Under the classical assumption of unlimited supply of labour, wealth is a direct function of human economic productivity. Scholars have since built upon this theoretical foundation. The distribution of income has been related to the distribution of individual abilities (Mincer, 1958; Nelson & Phelps, 1966; Roy, 1950; Schultz, 1961) and the accumulation of human capital has been attributed to produce economic income growth (Mincer, 1984). From a financial perspective, the accumulated amount of human resources is in part a product of investment. Individuals both possess innate and acquire resources throughout their lifecycle. Acquired useful skills and knowledge are a product of deliberate human investment (Schultz, 1961). These deliberate investments in human capital are defined by Becker (1962) as "activities that influence future real income through the imbedding of resources in people". While viewed by society as the consumption of time and monetary resources (Schultz, 1961), the expenditure assigned to the investment in knowledge and skills adheres to traditional capital theory since it yields a future capital gain (Becker, 1975).

Classical human capital theory describes that individuals have a limited amount of capital to their disposal which can be spend on producing goods and services (Becker, 1975;

Ben-Porath, 1967). Whereas in theory an accumulation of human capital results in additional wealth, there are practical limitations to this argument (e.g. in the form of cost conditions). Ben-Porath (1967) links the time profile of human capital investments to the life cycle of earnings. To a large extend individuals make investments by foregoing current earnings, as the time period over which the return on investment materializes is longer. The production function of human capital is conditional both on the investment and the costs and constraints facing the investor (Becker, 1966; Ben-Porath, 1967). The production function defines earning capacity as the maximum services of human capital an individual can offer in the market and thus his maximum attainable wealth. Therefore, the marginal cost of accumulating additional human capital equals the rate of production and thus the learning curve. In the Ben-Porath model (1967), the supply and cost conditions facing the individual are determined by opportunity costs alongside direct investment expenditures. These materialize in the form of education, schooling and training.

Albeit largely accepted and embedded in the field of economics and educational research, classical human capital theory has been criticized for various reasons. Most relevant for this research is the argument that the production of human capital, and therefore economic growth, has mostly been ascribed to the accumulation of education and training. However, the scope of human capital may encompass more forms thereof, such as 'health'.

2.2 The health capital investment decision

Academics have long attempted to identify causes for variations in public health. The notion of investment decisions in individual personal knowledge and skills in order to realize a potential future yield has been widely accepted. Whereas various scholars have suggested that "health" is a form of human capital itself (Barro, 1996; Becker, 1964; Fuchs, 1966; Mushkin, 1962), models that determine the optimal quantity of investment in human capital throughout the lifecycle (Becker, 1966; Ben-Porath, 1967) do not account for the health status dimension.

Grossman (1972; 1999) extends the stream of literature on the human capital theory by proposing a model of the production of health capital itself, to explain the decision to invest in health. The most commonly used definition of the commodity health by economists is that health is a durable capital stock that produces an output of healthy time. It is regarded as a variable of choice since market goods and services are combined with personal resources, such as time and monetary value, to produce the commodity health. Health capital, as opposed to other types of human capital affecting market- and nonmarket productivity, "determines the

total amount of time one can spend producing earnings and commodities" (Grossman, 1972). Health is both demanded and produced, as it is a source of utility as well as a determinant of wealth. That is, individuals are motivated to demand health both for consumption purposes in their preference functions and for investment purposes as to determine total time available for production. Similarly, illness imposes a source of disutility on individuals (Cropper, 1977). Health capital, thus, positively affects economic growth (Bloom, Canning, & Sevilla, 2004; Holland, 2017). Therefore, it can be regarded as an inseparable component of human capital alongside knowledge capital in the classical theoretical framework.

The human capital model introduced by Grossman (1972) assumes that individuals inherit an initial stock of health, which decreases over time due to ageing and which can be increased by health investments. The health production function depends upon health input choice variables such as medical care utilization and the health of living conditions (e.g. time spend on exercise) (Grossman, 1999). Furthermore, it is affected by the efficiency with which the individual is able to obtain an amount of health output from a given amount of health inputs (Grossman, 1999). Investments in health status are, therefore, defined as activities in which "medical care is combined with other inputs in order to produce new health so as to partly counteract the gradual 'natural' deterioration of health" (Muurinen, 1982). Following economic law of downward sloping demand curves, the demand for health should be negatively correlated with its shadow price. The shadow price of health depends upon market variables such as the price of medical care on the one hand, and the depreciation rate of the stock of health and the amount of knowledge capital accumulated by the individual on the other hand. Variations in these variables, which are inseparably linked to the course of the lifecycle, influence the optimal investment in health and corresponding allocation of resources.

While recognizing the significance of the health dimension in human capital theory (Barro, 1996), various scholars have unsuccessfully attempted to argue against the health capital model. Nevertheless, the original health capital model proposed by Grossman (1999) has been augmented to overcome methodological limitations. These include proposed extensions which account for diminishing returns of scale in the health production function (Ehrlich & Chuma, 1990) and the retirement decision of individuals (Galama, 2011). The model has been applied to health-related phenomena such as investments in health, health inequalities and preventions, demand for medical care, occupational choice and development economics.

2.3 Living conditions and health status

Health inequality is defined by the World Health Organization (2017a; WHO, 2009) as "differences in health status or in the distribution of health determinants" among populations and socially, economically, demographically or geographically defined groups (European Observatory on the Social Situation, 2005). Variations in health among individuals are attributed to various factors such as innate personal characteristics, human decisions, the external environment and conditions outside the individual's control. Demographic factors such as age, gender and race causally affect health services utilization (Anderson, 1973; Bertakis, Azari, Helms, Callahan, & Robbins, 2000) and thus both influence the demand and production of health. The household and family situation significantly impact health; marital status is shown to have a positive influence while being a parent not does not (Ross, Mirowsky, & Goldsteen, 1990). Similarly, an individual's personal control determines lifestyle behaviour (Mirowsky & Ross, 1998) and directly influences health. Living conditions and economic development, whether or not outside the scope of individual control, play a role in the deviation of health status among groups. Moreover, health is regarded as a "cornerstone of development" as both access to health services and knowledge of health investments varies significantly between developing and developed nations (Lennock & Ehrenpreis, 2003).

Variations in living conditions have been attributed to personal characteristics and behaviour, the social and economic, and the physical environment. In the socioeconomic domain, studies relying on self-reported health indicators from a variety of countries such as Germany, the United Kingdom and the United States document a direct relation between education, income and individual health status (e.g. Adams et al., 2003; Contoyannis, Jones, & Rice, 2004; Frijters, Haisken-DeNew, & Shields, 2005). In the environmental economics domain, the adverse effects of various environmental hazards in the home environment have been documented. A number of studies in particular document the relationship between air quality and respiratory health issues. The next sections review existing literature in the fields of social and environmental economics, which have explored the relationship between individual and aggregate living conditions and health status.

2.3.1 The role of the socioeconomic domain

The vast stream of literature investigating the relationship between living conditions and health status is located in the socioeconomic domain. Socioeconomic variations in a range of health outcomes are significant, persistent, and widespread across population groups (Hernandez &

Blazer, 2006). Socioeconomic status (hereafter: SES) is a parameter encompassing these variations and is comprised of indicators which capture distinctive aspects of an individual's social position. These indicators are educational attainment, income and occupational status.

The association between SES, economic outcomes and health status has been recognized and documented extensively by scholars (Antonovsky, 1967; Warner, Dennis, & Stephen, 2002). The general finding in previous literature is that a higher SES is causally associated with better health conditions (Adams et al., 2003). This finding holds for a variety of health variables (i.e. illnesses, self-rated health and psychological well-being) and is robust to alternative measures of SES such as wealth, education level, income and occupational status. SES has been documented to be a strong predictor of demand for health services and usage of medical care (Contoyannis et al., 2004). Furthermore, the dynamics of health outcomes are persistent and state dependant on socioeconomic characteristics (Contoyannis et al., 2004). Specifically, previous research finds strong evidence of the linkages between parental SES and child health status, and between child health and future economic status (Currie, 2009). This implies the significance of the effect throughout the lifecycle. Moreover, previous research identifies the revelevance of SES in the relationship between living conditions and health status.

Human capital theory proposes that education improves health, as it increases effective agency. Mirowsky and Ross (1998) argument that the positive effects of education extend beyond wealth to include self-rated health. The linkages between education and health outcomes include "mortality, morbidity, health behaviours and functional limitations" (Hernandez & Blazer, 2006) and this relationship is presence throughout the life course. However, a significant association between educational attainment and health does not prove causality, and reverse causality even might explain results in various studies. Quasi-experimental experiments based on policy interventions, such as the introduction of compulsory schooling in the United States (Lleras-Muney, 2005) suggest that a higher level of education is associated with improved health. Similarly, a natural cross-sectional experiment on the long-term effects of foetal health on adult economic outcomes finds that reduced educational attainment is associated with lower income, SES, and physical health (Almond, 2006). Furthermore, longitudinal studies find a causal relationship between the level of education (measured in years) and health (Cutler & Lleras-Muney, 2006).

The levels of education and income are positively related and both indicators of SES lead to similar conclusions. However, the measure of income is more complex due to increased data measurement errors (i.e. time horizon, sources of income, unit of measurement, and gross or disposable) and refusal rates in the data collection process. Furthermore, the relationship

between income and health status is both causal and dynamic and as with education, reverse causality may play a role. The foetal origins hypothesis, for instance, argues that health status in the beginning of the lifecycle has significant implications for economic labour market outcomes (Almond, 2006). Nevertheless, various longitudinal research on the income-health relationship suggest a causal association in both developed and developing economies. Based on a sample from the British Household Panel Survey from 1991 to 1997, Benzeval and Judge (2001) conclude that there is a causal relationship between low income (i.e. persistent poverty) and poor health. Similarly, a natural experiment based on the German Socio-Economic Panel from 1984 to 2002, capturing the reunification of Germany after the fall of the Berlin Wall, documents a significant positive effect of income changes on health satisfaction (Frijters et al., 2005). Likewise, labour market success, as an indicator of SES, is positively related to health status (Strauss & Thomas, 1998). Overall, the existing literature on the relationship between SES and health concludes that the former is an important determinant of economic growth, since it defines individual living conditions and is both an in- and output of health investments. Therefore, it contributes to the prior discussed health capital model.

2.3.2 The relationship between housing and health

While socioeconomic factors account for a significant extent for individual living conditions, other components of the latter play a role in the determination of health status. Another domain which to a greater extent has received attention in recent literature is the physical environment as a determinant of living conditions. Individuals spend eighty to ninety percent of their day in the built environment, of which most in their homes (WHO, 2010). Therefore, albeit limited, health economic research has explored the relationship between housing and health status.

Research on the association between housing and health falls more or less into two categories: the social, cultural and economic characteristics of housing, and specific characteristics and exposure of the home environment (Fuller-Thomson, Hulchanski, & Hwang, 2000). The majority of research is based upon cross-sectional analyses and self-assessed health as an indicator of health status. Despite concerns regarding reporting biases, it remains the measure of health used in most empirical analyses. In part, this is due to the ease of data collection through surveys or panel data on the one hand, and a significant and consistent correlation between self-assessed and objective measures of health such as hospitalization, medical care usage and prescription drugs on the other hand (Doiron, Fiebig, Johar, & Suziedelyte, 2014). Health status is determined by SES and housing conditions independently,

as well as the interaction amongst these. Specifically, environmental economic research explores the relationship between indoor and outdoor environmental characteristics and hazards of housing and health status.

2.3.2.2 The housing domain

Housing that is sited, designed, built, renovated and maintained in manners supporting the health status of its residents is labelled 'healthy housing'. The built environment has long been linked to health. In the early 20th century, Britten (1938) concluded that the population living under adverse housing conditions is subject to much chronic ill health. Various aspects of the home environment can have significant and directly measurable effects on both physical and mental health outcomes (Hood, 2005). The direct and material influence of housing on physical health is most apparent in a historical context and in developing countries (Shaw, 2004). Rapid industrialization and urbanization in Western economies in the previous century led to public health epidemics, stressing that "negative aspects of the built environment tend to interact with and magnify health disparities" (Jacobs, 2011). McGregor (1963) studied the relationship between housing standards and slums in England and Wales and found that low quality housing lead to higher mortality and disease rates. Similarly, individuals living in bad housing report poorer health, more recent as well as long-standing illness, suffer from more symptoms of respiratory disease and depression (Keithley, Byrne, Harrisson, & McCarthy, 1984).

Inadequate housing is related to health issues both in developing and developed economies (Turunen, Iso-Markku, Pekkonen, & Haverinen-Shaughnessy, 2017). The rapid economic growth and development is currently an issue for the housing and health relationship in developing countries. In more developed countries, where housing standards are embedded in regulation (e.g. requiring adequate ventilation, sanitation, and other habitability criteria) thus the baseline quality is already rather satisfactory (Jacobs, 2011), dwelling conditions may nevertheless affect health outcomes. The major recognized physical conditions which may form environmental hazards in the relationship between housing and health include variations in temperature (extreme cold or heat), humidity (damp or mould), the climate (e.g. air quality) and chemical and biological conditions.

The effect of the built environment on mental health and well-being reflects the direct and meaningful association between housing and health. Prior research documents mental health effects of deprived or inadequate housing conditions (WHO, 2007). A variety of housing characteristics influence mental health. Specifically, housing type (e.g. single-family detached

versus multiple dwelling), floor-level and quality (e.g. structural damage), crowding, noise, indoor air quality and light have a direct effect on mental health (Evans, Kantrowitz, & Eshelman, 2002). Furthermore, the sense of personal control in the home environment and social support facilities of the environment constitute the indirect mental health effects of housing. Combining both the direct and indirect effects of housing on mental health, a research performed in the United States documents the significant effect of moving from poor public housing to advantaged private housing on mental health status (Leventhal & Brooks-Gunn, 2003). Similarly, long-term changes in housing quality are found to predict psychological distress (Wells & Harris, 2007) and thus influence individual well-being. Moreover, housing is critical to household well-being in providing stability and security for its tenants (Bratt, 2002).

The impact of poor housing upon health throughout the life course has been explored relatively little in prior research. Whereas longitudinal research exists on the relationship between SES and health, less academic research examines the specific impact of adverse housing characteristics and conditions upon health. The existing literature linking housing and health can be categorized into cross-sectional and longitudinal research. Cross-sectional studies associate poor housing conditions with health status. Areas of study include extreme temperatures and respiratory disease, damp and mould, indoor air pollutants and overcrowding (Marsh, Gordon, Heslop, & Pantazis, 2000). The research on longitudinal effects of poor housing on health, however, is rather limited.

2.3.2.1 The interaction between housing and socioeconomics

The socioeconomic and environmental housing domains are related to variations in health. However, little research has investigated the pathways between housing, SES and health status. Housing could influence the social production of health inequalities via: the wealth inequality of housing type (homeownership versus rental housing), the influence of neighbourhood socioeconomic conditions, and the development of housing choice throughout the lifecycle (Dunn, 1999). The home environment is both a determinant of the production of SES (Dunn & Hayes, 2000) and a "crucial nexus for the operation of a range of socioeconomic factors" (Dunn, Hayes, Hulchanski, Hwang, & Potvin, 2006) that fundamentally shape living conditions.

It has become increasingly evident that the housing does not only directly impact health status. Housing also factors in less direct, material and meaningful ways into health status. Financial capacities and social determinants may lead to variations in housing conditions, and thus form a potential source of social inequality. Housing characteristics, therefore, can be

considered as a mechanism through which social inequality translates into health inequality (WHO, 2009). The general consensus in prior research is that housing is a concrete manifestation of SES (Dunn & Hayes, 2000). The most common used housing characteristic as an indicator for socioeconomic wealth position is housing tenure (owner occupied or rental housing). Housing tenure has been found to be related to health outcomes in multiple studies over an extended time span (Shaw, 2004). Pollack et al. (2004) find that, based on a cross-sectional panel study in Germany, the relationship between housing conditions, tenure and health are a result of individual wealth disparities. Specifically, housing tenure has been associated in literature with factors such as mortality, self-reported long-term illness and mental well-being (Macintyre, et al., 2003). Additionally, factors such as household amenities, condition and overcrowding have been used in prior research as indicators of SES. Dunn (1999) documents that lower educational attainment is associated with substandard dwelling conditions and psychological distress. A variety of studies explore disease outcomes by types of housing development. The consensus in prior research is that diseases such as tuberculosis and asthma are related to poor living environments and characteristics, which reflect socioeconomic standing (Low, et al., 2013; Rauh, Landrigan, & Claudio, 2008).

Traditional research has often aggregated multiple important components of housing into a single SES variable (Hood, 2005). This approach however makes it nearly impossible to segregate specific housing characteristics and conditions in exploring the relationship with health status. An increasing body of literature, therefore, examines housing factors individually of SES. The causal pathways interlinking housing, SES and health status have been explored very little in academic research. Various findings suggest that housing factors are independent of the influence of SES (Jacobs, 2011). Additionally, housing may have a significant interaction with rather than being an indication of SES in the relationship with health outcomes (Rauh et al., 2008). Therefore, housing can be regarded an interaction variable with SES as well as an independent variable in the relationship with health. Housing may both moderate and mediate the relationship between SES and health status.

2.3.2.2 Environmental economics

Prior research provides evidence to assume that a link between housing and health status exists. Environmental economic studies document that environmental factors have an influence on the level of health of individuals. Specifically, various environmental hazards have adverse effects on health outcomes. Environmental characteristics such as temperate, air quality, and water

pollution are identified to have a significant relationship with reported health level. Extreme temperatures (heat and cold) are related to respiratory and cardiovascular diseases, increased hospital admission, mortality rates and lower birth weight (e.g. Deschenes, 2014; Deschenes et al., 2009; Morabito et al., 2005). Similarly, various studies document that high levels of air pollutants such as carbon monoxide have an adverse effect on health outcomes (e.g. Currie et al., 2009; Schlenker & Walker, 2016). In particular, studies document the adverse affect on sickness leave and absenteeism (Hanna & Oliva, 2015), thereby reducing individual producitivity.

Outdoor environmental hazards influence the health status of individuals. Various studies document the significance of the location of the home. The vast majority of economic literature exploring the neighbourhood effect on health is related to the field experiment "Moving to Opportunity". This study shows that participants who moved from low income neighbourhoods to less distressed areas subsequently had a measurably improved health status (Ludwig et al., 2012). This field experiment, however, is far from generalizable as it is based on a United States sample comprised only of low-income households. Bilger and Carrieri (2013) extend the latter and explore the effect of a neighbourhood quality index based on pollution, crime and noise on self-assessed health and the presence of chronic conditions and limitations in daily activities. Based on an Italian cross-sectional dataset, their findings imply that low quality neighbourhoods are strongly health damaging and that this effect is even higher than the impact of poor economic circumstances (i.e. lower SES) on health. Another important source of environmental hazards for health is noise. Various studies document the adverse health impact of traffic, wind turbine and other environmental forms of noise in residential settings (Bluhm, Nordling, & Berglind, 2004; Shepherd, McBride, Welch, Dirks, & Hill, 2011).

Individuals can, in part, reduce their exposure to outdoor environmental conditions, thus avoiding the negative health externalities associated with environmental hazards. Individuals can mitigate the adverse health impacts via adaptation actions and avoidance behaviour. Specifically, adaptation actions directed at reducing the adverse health impact of extreme temperatures and air pollution include adequate air conditioning, change in outdoor/indoor time allocation, alteration of the built environment design and geographical mobility (Deschenes, 2014). Similarly, avoidance behaviour has been documented in the United States between 1968 and 2002, periods in which extreme outdoor temperatures preceded peaks in mortality rates and energy consumption (Deschenes, 2014). Avoidance behaviour, measured as a household response to information about pollution (smog alerts), is also documented for children in the United States suffering from asthma (Neidell, 2004).

Existing studies commonly rely on outdoor measures of environmental hazards and characteristics in exploring the relationship with health outcomes, whereas people spend most of their time and resources indoors. The field of study on the relationship between indoor environmental conditions and health is limited. Given the large proportion of time spent within the home, housing is both a key environmental influence upon health and a key health resource (Blackburn, 1990). While the quality of the indoor environment of housing is in part a function of outdoor conditions in the surrounding of the dwelling, they are not fully determined by outdoor conditions alone (Aydin et al., 2017). Thus, while individuals are perceived to be able to isolate themselves from outdoor environmental hazards or at least reduce their exposure dramatically, they may not be able to demonstrate this avoidance behaviour within the home environment.

The majority of existing research originates in the medical research domain and constitutes of small-scale experiments, cross-sectional research and several event studies (e.g. medical and policy interventions). Various studies based on natural experiments in the developing world suggest that indoor air pollution (e.g. cooking and heating with solid fuels on open fires and traditional stoves) negates high levels of health damaging pollutants (Duflo et al., 2008). Similarly, the 2007 WHO analysis and review of European housing and health status suggests that poor housing conditions (e.g. air quality, noise, lighting, etc.) is systematically related to individuals reporting more respiratory health problems. Additionally, cross-sectional panel studies in Germany and Scotland suggest that housing tenure is significantly associated with self-rated health. Specifically, tenants of rental dwellings are more likely to be exposed to health damaging features of the indoor environment and report poorer health (Macintyre et al., 2003; Pollack et al., 2004). Nevertheless, these studies are based on cross-sectional analyses and therefore do not contain causal explanatory power.

There are a number of high-quality small-scale studies providing evidence on the relevance of biological impact of specific hazards in the indoor environment (e.g. mould) and certain illness (e.g. respiratory diseases). For example, housing improvement interventions (e.g. removing indoor lead painting, retrofitting insulation, etc.) lead to significant improvement in health and decreases in chronic illness (Pega & Wilson, 2016). Additionally, warmth and energy efficiency are positively associated with health of low-income groups (e.g. Broderick, Byrne, Armstrong, Sheahan, & Coggins, 2017; Gibson, et al., 2011). However, generalization of small-scale interventions studies is limited due to small sample sizes and characteristics of the individuals. The other strand of intervention studies comprises of larger quasi-experimental policy intervention studies in developing countries. An example is the replacement of dirt for

cement floors in Mexican slums, which led to a significant reduction in respiratory diseases and allergies (Cattaneo et al., 2009). Another large-scale randomized trial in India documents the positive health effect of reduced indoor air pollution by means of improving cooking stoves (Hanna et al., 2016).

The results of such intervention studies are hardly generalizable to the housing stock in most developed countries, since socio-demographic and housing characteristics differ fundamentally from the average household in developed economies. Only a small strand of literature explores whether indoor dwelling conditions also have such a significant health effect when the baseline quality is already rather satisfactory. Based on a sample of the German Socio-Economic Panel of West-Germany post reunification, Ayden et al. (2017) document a significant causal relationship between indoor housing conditions and occupant health. Controlling for SES and health-affecting lifestyle behaviour, the research finds that individuals who inhabit poorly-maintained homes report a higher number of health issues and have a higher demand for healthcare services. Based on a sample of the Dutch LISS dataset from 2008 to 2013, Weinhold (2015) documents strong and robust effects of residential noise annoyances on self-reported overall level of health. Similarly, this research controls for a variety of socio-economic and demographic characteristics. Additionally, the study controls for whether tenants have moved from or to the dwelling, as moving rental homes is difficult and expensive in the Netherlands and may influence the results. While causality is indirectly observed, this study is based upon cross-sectional analyses and therefore causality cannot be assumed.

To summarize, the small strand of current literature concerning housing and health suggests that indoor environmental housing conditions may influence health status and demand for healthcare. It is meaningful to extend this strand of research to other wealthy countries, where the relationship may be less pronounced than in developing economies. The current association between housing tenure and health suggests the significance of investigating this specific area. However, no academic study yet has been identified to investigate the causal relationship between rental dwelling conditions and health status in Western economies.

3 The Dutch rental housing market

Thus far, relevant theory has been discussed. As to provide rationale for the research question and create a mutual understanding on the Dutch rental housing sector, this section presents information on the Dutch rental housing market. It includes specific characteristics of the rental market, the unique position of and the empirical perspective on social housing, as well as recent developments in the rental sector and healthy housing. In 2017, the Dutch population counts approximately 17.2 million individuals. The total housing stock equals 7.6 million dwellings, of which 42.5 percent (3.2 million) represents the rental housing sector (CBS, 2017). The rental market consists of both social (regulated) and private (non-regulated) housing. In the social housing sector rents are determined by legislation, whereas rents can be set freely in the non-regulated segment. Rents are regulated via the housing valuation system, which determines a maximum rent price. The system is based on points awarded for dwellings characteristics, such as floor size and sanitation (Rijksoverheid, n.d.b).

Housing associations, which are social enterprises, possess the largest share (2.4 million) of rental dwellings in the Netherlands. The majority of these are positioned in the social housing sector. The purpose of housing associations is to provide adequate and affordable public housing. The principal target group, therefore, consists of households with a lower to middle income. The income limit for access to social housing is determined by the liberalised tenancy agreement for the private rental housing sector, which marks the rent limit for social housing. The associations are obliged to let a minimum of eighty percent of their dwellings to low income, ten percent to middle income and are allowed to let the remainder to high income tenants. The fit housing allocation ensures that housing associations focus on their core task of public housing; minimizing expenses on housing allowances for those households with the lowest income.

3.1 The social segment

The social housing sector in the Netherlands is unique in Europe for its dominance in the housing market (Elsinga & Wassenberg, 2007). Representing 30 percent of the total housing stock, it is considerably larger than its counterparts in France (19%), the United Kingdom (15%) and Germany (5%) (BPD, 2016; Whitehead, et al., 2016). The sole requirement for admittance to social housing is a maximum annual disposable income. The social housing segment therefore discriminates towards low income households and may not be a representation of the

rental housing segment. Housing corporations are responsible for the allocation of individuals to social dwellings. These individuals are obliged to register and apply for social housing.

The social housing sector is highly rationed with waiting lists that approach up to 8 years in metropolitan areas (Rijksoverheid, 2016). Whenever tenants desire to move from one social dwelling to another social unit, they will again enter the application procedure. Tenants are therefore not likely to move regularly (Weinhold, 2015). The combination of blind allocation by housing corporations and the difficulty of moving results in the absence of self-segregation in the public housing sector. The level of diversity in housing areas is therefore endogenous. As such, self-sorting bias based on other grounds than income (e.g. ethnicity) is absent in the public housing sector (Algan, Hemet, & Laitin, 2016). Previous literature finds a significant negative causal effect of diversity on the quality of local public goods related to well-being, living conditions, and housing quality in the public housing sector (Algan et al., 2016). This relationship appears less pronounced in countries where public institutions are weak (Alesina & La Ferrara, 2000). The Netherlands, where public housing is well-established through the housing corporations, may be more prone to negative externalities of concentrations of social housing areas.

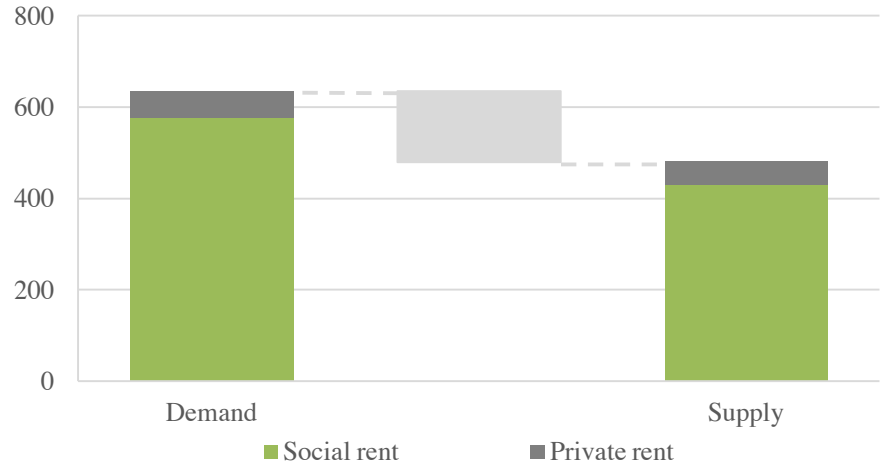
Moreover, the Dutch social segment differs substantially from other developed countries. Namely, the size of the social housing market, the relative high base dwelling quality and financial independent functioning without receiving substantial subsidies from the government (Hoekstra, 2013) makes it a unique case example to explore empirically.

3.2 Recent developments

The Netherlands has known the largest social housing sector within Europe. The housing corporations have become financially state independent in the 1990s. In 2015, the Dutch senate imposed new legislation for housing associations. The New Housing Act clarifies the role and status of these corporations, after the European Commissions expressed concern for a lack of clarity in the separation between social and other activities. The New Housing Act dictates an operational split between Services of General Economic Interests (SGEI) and non-SGEI activities. As such, housing associations are redirected to their core business: providing access to affordable housing for low income households and other attention groups (Lijzinga & Boertien, 2016).

Projections of the housing market, however, suggest a discrepancy between supply and demand of rental dwellings. This is shown in figure 2 on the next page.

Figure 2: Annual housing demand versus supply for 2016-2021 (thousands)

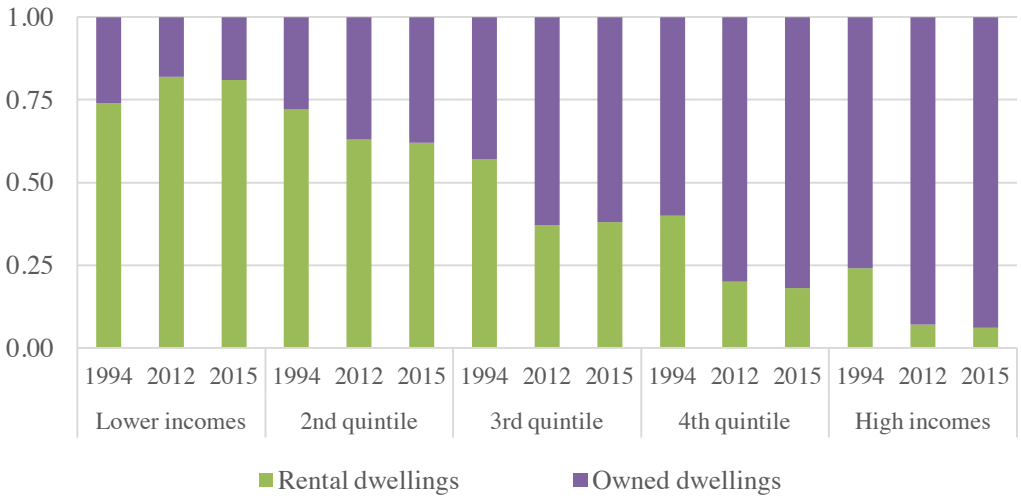


Source: Capital Value (2016)

The number of households is expected to increase more than the growth in available rental housing; yearly, approximately a hundred thousand households in the social and twelve thousand in the private rental sector are projected to be unable to find suitable rental dwellings (Capital Value, 2016). The shortage of affordable housing for the lower and middle-income segment is expected to persist (especially in tight urbanized markets) in upcoming years (Rijksoverheid, 2017). This further increases the applicants to vacant unit ratio.

In general, the majority of tenants are positioned in the lower income class. Homeowner have, on average, a higher disposable income. Over the past decade more individuals with a low income have rented, and those in the higher income class have purchased a dwelling.

Figure 3: Distribution of homeownership per income class



Source: WoOn 2015 (Dutch Ministry of Foreign Affairs, 2016)

Considerable demographic differences between homeowners (majority of family households with a higher average income) and tenants (majority of (elderly) single-member households) can be observed from figure 3 above (Dutch Ministry of Foreign Affairs, 2016). Additionally, in relation to homeownership and the private rental market, the main source of income for a large proportion of tenants of rental housing owned by housing associations are pensions and benefits (BZK, 2013; 2016).

Dwelling satisfaction is unabated high (more than 85%) and stable over the last decade (Dutch Ministry of Foreign Affairs, 2016). Tenants of rental dwellings are, in general, less satisfied with their housing conditions than homeowners. The majority of tenants who are (very) unsatisfied with their dwelling identify poor maintenance as their main concern.

3.3 Green housing

The built environment is responsible for 40 percent of energy consumption and 36 percent of CO_2 emissions in Europe (EU Parliament, 2003; 2010). Given the size of the rental dwelling sector in the Netherlands, this market has a considerable share in the production of environmental hazards. The decision to invest in housing improvements depends to a large extent on the economic return on the investment (Mayer, 1981). Correspondingly, the transaction values of high quality energy-label (e.g. A and B) affordable dwellings are found to be significantly higher than peer values (Chegut, Eichholtz, & Holtermans, 2016). Nevertheless, limited by the public housing purpose, housing associations are unlikely to frequently transact energy efficient dwellings.

A different means to stimulate housing enhancements in the rental housing market is legislation. The 2010 Energy Performance of Buildings Directive and the 2012 Energy Efficiency Directive are major European legislative measures directed at the reduction of energy consumption of buildings. The Dutch government agreed with the housing associations upon reaching an average energy label B for all dwellings by 2020. However, only 35 percent of all associations will meet this target (Finance Ideas, 2016). This research concludes that, at the current pace of development, this target can only be achieved by 2030.

The Dutch overarching organization of housing associations, Aedes, formulated the goal of achieving CO_2 neutrality in the social rental housing stock by 2050. Housing enhancements directed at energy reduction are likely to influence the overall quality of the dwelling. It is, however, questionable whether housing associations are financially capable of such investments. Indeed, Finance Ideas (2017) estimated that a maximum reduction of housing

emissions of 81 percent is achievable by 2050. Nevertheless, the 2017 government agreement includes the aforementioned target in the Dutch National Climate and Energy Act. Whereas this target is not a legal requirement, it does however reflect the positive national sentiment towards the transition to sustainable housing.

The research has hitherto provided an extensive overview of relevant prior literature as to create a theoretical background. Furthermore, it has elaborated on the characteristics and recent developments in the Dutch rental housing sector, with specific attention paid to the role of social housing. The next section develops the expectations for this study.

4 Hypotheses development

In light of inequalities in health status and increasing pressure on the financial affordability of societal health care services, an increasing body of literature examines the causes for variations in health. In particular, prior literature documents the adverse health impact of environmental hazards. Given the contribution of the built environment in the production of environmental hazards, more attention has been paid to examining the association between the former and individual health status. Generally, as people spend approximately 90% of their time indoors, of which the majority in the home environment, the question arises whether a causal relation exists between the quality of the indoor environment and health.

Housing tenure (living in a rental dwelling versus homeownership) has been positively related to increased exposure to adverse environmental hazards and health outcomes (e.g. Macintyre et al., 2003; Pollack et al., 2004). These authors find that the less wealthy are more likely to live in rental dwellings, which tend to be less well-maintained than owner-occupied dwellings. As occupants of rental dwellings in general are less wealthy than homeowners, and thus more financially burdened by health care affordability, it is of specific interest to examine the relationship between indoor rental dwelling quality and occupant health and well-being. The current literature leads to expect a negative relationship between indoor environmental hazards and occupant health status. Therefore, the main hypotheses are:

H1: Indoor dwelling problems negatively affect health status

H2: Indoor dwelling problems positively affect demand for health care services

Hypothesis 1 is expected to hold for all measures of self-assessed health status, including general health perception, poor health status, well-being, and hindrance as a result of health-related problems. Given that individual human economic productivity has been shown to depend on health capital, poor dwelling quality is expected to have an adverse effect on productivity. Specifically, this study therefore expects that dwelling quality negatively affects respondents' ability to perform work-related tasks, as well as increases total hindrance (including work, daily and social activities), as a result of self-assessed health-related problems. Hypothesis 2, likewise, is expected to hold for all measures of healthcare utilization, including total healthcare utilization, number of visits to a general practitioner, utilization of mental healthcare (including visits to a psychologist/psychiatrist), and medical specialist visits.

Next, based on existing literature, gender differences may materialize in the expected relationship as proposed in hypotheses 1 and 2 above. Demographic factors, such as gender, have been shown to causally affect utilization of health care services (Anderson, 1973). Specifically, women are shown to make more use of healthcare services (e.g. Bertakis et al., 2000) than men. It is therefore expected that women are more prone to the adverse health effects of poor dwelling quality. Therefore, the following hypothese is proposed:

H3: The positive effect of indoor dwelling problems on demand for health care is stronger for females than for males

The research is based on environmental economic theory that individuals who are exposed to certain environmental factors are expected to be affected by those factors. Therefore, it is expected that individuals who are exposed less to poor dwelling quality are less likely to experience an effect thereof. As a robustness test, therefore, the research examines the relationship proposed in hypothesis 2 solely for individuals who moved ever during the sample period. It is expected, since these tenants reside less in a specific dwelling, that tenants who moved at least once, experience less causal adverse health effects from poor dwelling quality.

H4: The effect of indoor dwelling problems on health is less severe for those tenants less exposed to dwelling specific effects

Furthermore, it is relevant to examine the relation between housing and health among the most financially constrained: social tenants. The social housing sector consists of the least wealthy population. Given that moving between rental dwellings is both difficult and expensive in the Netherlands (Weinhold, 2015), this study expects that these individuals are less able to avoid exposure to adverse environmental hazards in the home environment. As such, the negative causal effect for rental dwellings on health is expected to be even more pronounced for the social segment. This leads to the following hypothesis:

H5: The adverse health effects of dwelling problems are stronger for occupants of social housing than for tenants in general

Hypothesis 5 is expected to hold for all measures of dwelling quality and health, including both self-assessed health measures and demand for healthcare services. This hypothesis, therefore, implicates hypotheses 1 through 4 to hold for tenants in the social housing segment.

Can the analyses provide evidence for the hypotheses described above, one may conclude housing quality to be a significant determinant of health status, economic productivity, and demand for health care services for tenants in general as well as social tenants. This may have both academic and policy implications in examining the pressure on the affordability of health care services and financial valuation of dwellings. The next section focuses on the data upon which this research is based and provides descriptive statistics.

5 Data

This research attempts to identify the relationship between rental housing conditions and health. As such, the data employed in this study concerns longitudinal probability panel data, containing information on housing conditions, occupant health, and other individual characteristics likely to affect health. The data is retrieved from the Longitudinal Internet Studies for the Social sciences (LISS) Core Panel, providing a large person-level dataset for the Netherlands. Access to the panel has been granted by CentERdata for educational research purposes[1]. The methodological construction of the data ensures a representative, generalizable dataset for the Dutch population (Scherpenzeel, 2011). The LISS combines online surveys with a true probability sample of households drawn from the population register by the Dutch Central Statistics, thereby avoiding selection biases. The LISS panel is an ongoing survey with multiple waves of questionnaire categories (modules) sent to participants throughout the year. It is comprised of yearly observations from 7,000 adults in the Netherlands since 2007 (CentERdata, 2017). Thereof, approximately 2,300 respondents represent tenants of rental dwellings. The survey consists of various modules which are repeated in yearly waves, at different intervals throughout the year. The timing of the modules ensures psychological separation between the dependent and treatment variables, avoiding priming biases. The panel consists of household data in the Netherlands, including extensive socio-economic, demographic, housing, and health information. This research focuses on the relationship between over-time variation in housing conditions and individual health. Therefore, the longitudinal nature of the data allows to control for unobserved individual characteristics.

The constructed dataset comprises of data from all available waves for the Netherlands, covering the period from 2007 through 2016. The entire set consists of 12,159 unique individuals (52,134 observations), including both tenants and homeowners (6,533 women and 5,633 men). The full sample of tenants includes a total of 7,851 observations, representing 2,332 individuals (1,321 women and 1,011 men) inhabiting rental dwellings (though not all respondents answer all questions or respond in all years, so sample size varies by regression). The subanalysis on social tenants consists of 2,259 observations, representing 803 individuals (282 women and 521 men). The average duration an individual participates in the entire sample of the survey is 4.28 years (std. dev. = 2.62), with a maximum of 9 years (irrespective of tenancy status). Tenants on average participate 3.37 years in the survey (std. dev. = 2.39), while social tenants participate 2.81 years (std. dev. = 2.43).

[1] More information about the LISS panel can be found at: www.lissdata.nl.

The sample is constructed as such to isolate the effect of the treatment variable, housing, on the dependent variable, health. Therefore, the sample consists of all observations from the health module. The health module contains self-assessed measures of health. The housing module consists of questions concerning the dwelling type, and housing conditions. Socio-demographic and economic factors, and lifestyle and health behaviour are used as control variables. The information has been merged into the dataset based on whether or not in a given wave an individual participated in the health module, as the primary interest of the research attempts to test for causality.

5.1 Health outcomes

The health module of the LISS panel provides information on a broad variety of health metrics. The questionnaire is included in LISS from 2007 through 2016 in yearly waves and includes general and specific questions about health. This study focuses on four indicators of health to establish the relationship between the treatment variable housing and the dependent variable health. These are: health status, well-being, utilization of medical services, and variations in productivity resulting from health-related issues. These measures are constructed based on the answers to the questionnaires.

Occupant health status is defined by individuals' self-assessed health questions in the survey. Self-assessed health is commonly used in empirical studies as a measure to explore the dynamics of health (Aydin et al., 2017). The variables which proxy for physical health status are *General Health* perception and the *Poor Health* status. *General Health* perception is measured in the health module with the question "How would you describe your health, generally speaking?", of which the answers range from "poor" to "excellent" on a five-point Likert scale. Additionally, for *Poor Health* status, the answers to this question are transformed as such that "poor health" is coded with a "1" (consisting of "poor" and "moderate"), and "good health" is coded a "0" (consisting of "good", "very good" and "excellent").

In addition, this study includes individual well-being as a measure of health. The *Happiness* measure is a thoroughly reviewed and widely accepted indicator of subjective well-being (Stiglitz, Sen, & Fitoussi, 2009). This measure is included in all waves of the personality module of LISS. Happiness is measured by the question "On the whole, how happy would you say you are?", with answers on a rating scale (0-10) ranging from "totally unhappy" through "totally happy". This scale is adopted into the analysis.

In addition to self-reported subjective measures of health, this study uses the objective measures of utilization of medical services as an indicator of economic health consequences. Survey respondents are asked to report the number of times they visited each their *General Practitioner*, *Mental Healthcare* services (visits to a psychologist and/or psychiatrist) and a *Medical Specialist* at a hospital in the past 12 months. Number of doctor visits is a widely used measure in empirical research to explore the variation in demand for health care. Therefore, these three categories, as well as a total number of visits to providers of healthcare services, are included in the empirical analyses.

Following Grossman's (1999) extension to human capital theory, we expect that poor health is negatively related to human productivity. As such, we are interested in the relationship between housing conditions and productivity loss resulting from health problems, as this is a proxy for the impact of poor health on productivity. The following question concerning productivity loss is included in the questionnaire: "To what extent did your physical health or emotional problems hinder your work over the past month, for instance in your job, the housekeeping, or in school?". Respondents can answer this question with categories ranging from "not at all" through "very much" on a five-point Likert scale. The variable is included as a proxy for *Work Hindrance*. Similarly, the questionnaire includes whether or not individuals have experienced hindrance in their *Daily* and *Social Activities* from their health problems. As the consensus in prior literature is that poor health causes hindrance, these variables are included in the study as a measure of health.

Finally, various health-related individual characteristics are used in the research as a measure of healthy behaviour and lifestyle. The literature on health economics commonly relies on *Body Mass Index (BMI)* to explore the effect of good health behaviour on health. This study composes BMI based on respondent height and weight in the period of the health questionnaire. Furthermore, health investments are shown to increase individual stock of health capital and are thus included in the analyses to account for the "healthiness" of individual lifestyle. Therefore, the binary responses to questions which capture the variables whether an individual practices *Sports*, has *Ever Smoked* and *Currently Smokes*, as well as the frequency of consuming alcohol (*Regular Drinker*) are incorporated.

5.2 Housing measures

This study investigates the explanatory power of poor dwelling conditions on health. Therefore, housing condition is evaluated based on various metrics from the housing module of the LISS panel. The questionnaire is repeated in yearly waves from 2008 through 2017, including general

questions concerning dwelling characteristics and specific questions on satisfaction and problems in and around the home environment. This study evaluates the condition of participants' dwellings based on self-assessed housing conditions, incorporating dwelling satisfaction and the presence of specific problems within the dwelling as treatment variables.

The *Dwelling Satisfaction* of occupants is reflected by occupants' rating of their satisfaction with the current dwelling they currently inhabit, on a ten-point scale question (from 0 to 10). Furthermore, the binary responses to the question "Does your dwelling have one or more of the following problems?" are included as proxies for poor dwelling condition. The dwelling problems included in the questionnaire are "*Too Small*", "*Too Dark*", "*Inadequate Heating*", "*Damp Walls or Floors*", "*Rotten Window Frames or Floors*", and "*Too Noisy*". The formerly described dichotomous variables take the value "1" if respondents indicated that these problems are present at the time of answering the housing module in a given wave and "0" otherwise. Table 1 below shows the total number of observations per dwelling problem.

Table 1: Frequency table simultaneous reporting of dwelling problems

Dwelling Problems	Total number of observations						
Too small	1,704						
Too dark	131	529					
Leaking roof	153	91	772				
Inadequate heating	60	29	86	434			
Damp walls or floors	176	61	178	118	1,008		
Rotten frames or floors	106	41	177	117	226	771	
Too noisy	581	179	326	130	379	276	3,019

The specific dwelling problems account for a small number of total observations. Therefore, specific problems are aggregated in accordance to similarity of the problem. As such, the following dwelling problem categories are constructed: comfort-related, hazardous, and noise-related. *Comfort Problems* consist of problems related to size (*Too Small*) and light (*Too Dark*), accounting for 27 percent of the observations. *Hazard Problems* consist of leakages (*Leaking Roof*), cold (*Inadequate Heating*), damp (*Damp Walls or Floors*) and rot (*Rotten Frames or Floors*), and represents 36 percent of the observations. *Noise Problems* consists of all observations related to noise (*Too Noisy*), representing 37 percent of reported dwelling problems. Additionally, whether a *Dwelling Problem* of any kind is present in the home environment is included in the study. Out of the 6,810 participants in the dataset for whom the housing condition information is available, 52 (1,598) are not at all (entirely) satisfied with their

dwelling. Of the 2,318 tenants who reported on their dwelling satisfaction, 40 (409) are not at all (entirely) satisfied with their dwelling. Similarly, of the 797 social tenants in the subanalysis, 21 (153) are not at all (entirely) satisfied.

The housing module includes information on housing characteristics. Respondents are asked to report the *Dwelling Type* they inhabit. These are recoded to "*Detached*", "*Corner Lot*", "*Duplex House*", "*Row House*", "*Apartment*", and "*Other*". This allows the research to investigate which types of dwellings are more prominent in the relationship between housing and health. Furthermore, the research incorporates the year of residency to study how long an occupant on average inhabits a dwelling (on average 16.12 years, std. dev. = 13.12). In addition, the study incorporates the number of *Rooms* inside the dwelling. Furthermore, the study incorporates the financial value of the dwelling by means of including *Monthly Rent* (incl. all expenses) and the *Dwelling Value* (both in euros).

Various control variables related to housing characteristics are included in the study. First, following Weinhold (2015), this research addresses the possibility that respondents who move residency may be both differentially affected by dwelling problems and be either healthier or sicker on average. Based on whether a respondent has moved at any time during the survey period (derived from the year of residency information), the dummy variable "*Moved Ever*" has been constructed. Likewise, the research controls for frequent absence from the home environment, as these individuals are less exposed to potential environmental problems in the dwelling. The study therefore incorporates the binary response to the question whether respondents are regularly *Absent* from the home, apart from holidays and short stays.

5.3 The external environment

Previous literature finds that the external environment significantly influences health status (e.g. Currie et al., 2009; Deschenes et al., 2009; Hanna & Oliva, 2015). Given the position of a dwelling within a certain external environment, one may expect the vicinity to interact with internal housing conditions. Therefore, the external environment is both included and controlled for in the study. Occupant *Vicinity Satisfaction* is measured with a rating of the respondent on a scale from 0 to 10. In addition, the housing module asks respondents whether they experience problems in their homes, related to the external environment. These include "*Noise Annoyance caused by Neighbours*", "*Noise Annoyance caused by Street Noise*", "*Air Quality"* (by means of stench, dust or dirt), and "*Vandalism or Crime*".

5.4 Socioeconomic and demographic characteristics

In addition to the key variables of interest, this study controls for various socio-economic and demographic characteristics provided by LISS. These are collected monthly, and therefore calibrated to the period in which the health wave surveys are collected. First, the research distincts between *Tenants* (including sub-tenants) and *Homeowners* (including co-owners), including the *Year of Residency* (moving into the current inhabited dwelling). The socio-demographic characteristics include information on respondent *Age*, *Gender*, *Household Size* (number of individuals living in the household), whether the respondent has a *Partner*, is *Living Together* with this partner, *Marital Status*, whether *Children* live in the household and the corresponding *Number of Children*. In addition, the *Ratio of Household Members to Rooms* in the dwelling has been constructed as a measure of crowdedness.

The study includes a set of variables describing respondents' economic situation. Therefore, the study includes information on total *Net Monthly Household Income* (in euros), labour force status (whether the respondent is *Working* or *Studying*), and *Higher Education* (whether the respondent holds a degree from Dutch Higher Education university). These variables are included as control variables, since they are commonly employed in empirical studies as determinants of health outcomes and demand for health care services (Aydin et al., 2017). Furthermore, respondents are asked whether they receive rent benefit, which according to Dutch legislation is only awarded to occupants of dwellings in the social housing segment. This allows the research to perform a sub-analysis specifically in the Dutch social rental housing segment.

5.5 Descriptive statistics

This section reports on the descriptive statistics of this study and thereby provides an initial presumption on the expected relationships. First, summary statistics and information for the general sample at hand is provided. This strengthens the motivation to focus on the chosen sample under review: tenants. Health measures, dwelling characteristics, and socio-economic descriptive statistics are provided below.

5.5.1 Health, dwelling characteristics, and SES

Table 2 (appendix) provides summary statistics for all respondents in the dataset from 2007 to 2016. The average current general health perception is 3.12 on a scale of 1 to 5. The average scale on well-being, as defined by *Happiness*, is 7.57 out of a maximum of 10. Of all

participants, 16 percent report poor general health. Individuals report an average of 4.17 total doctor visits in the last year preceding the survey. Thereof, the majority of visits are paid to general practitioners (mean visits 2.31). This is a representation for the utilization of healthcare services and consists of visits to a general practitioner, psychologist and/or psychiatrist, and medical specialist. Furthermore, 33 percent of all respondents indicate that they experience hindrance (in daily-, social-, and work activities) as a result of their current health status.

Respondents report an average dwelling satisfaction of 7.95 on a scale of 0 to 10. Regarding dwelling condition, 77 percent of participants indicate to experience no problem at all. Thus, 23 percent report the prevalence of at least one dwelling problem in their home environment. With respect to the defined problem categories, respondents indicate that comfort, hazards and noise account for 8, 9 and 12 percent respectively. The latter occurs most frequent in the sample of observations. As to get an indication of the relationship between individual health and dwelling conditions, this research first compares indicators of health and well-being based on the prevalence of at least one dwelling problem.

Table 3: Health outcomes conditional on dwelling problems

Health measures	(1) No problem	(2) Problem
General health perception (1-5)	3.09	2.97
	(0.74)	(0.79)
Bad/Poor health (1=yes)	0.17	0.24
Happiness (0-10)	7.62	7.14
	(1.24)	(1.47)
Healthcare utilization (last year):		
Total health care utilization	4.19	5.08
	(8.57)	(11.26)
General practitioner (visits)	2.32	2.53
	(5.30)	(3.75)
Mental healthcare (visits)	0.49	1.15
	(4.23)	(8.81)
Medical specialist (visits)	1.40	1.44
	(4.16)	(3.49)
Hindrance of health status:		
Total hindrance	0.32	0.43
Daily activity hindrance	0.24	0.30
Social hindrance	0.18	0.29
Work hindrance	0.22	0.34

Notes: Standard deviation for continuous variables in parentheses.

Table 3 indicates that individuals who inhabit a dwelling in which at least one dwelling problem prevails, systematically report poorer health, experience more hindrance (especially work-related) and make more use of health care services. These descriptive statistics indicate that there might be a relation between health and the presence of dwelling problems.

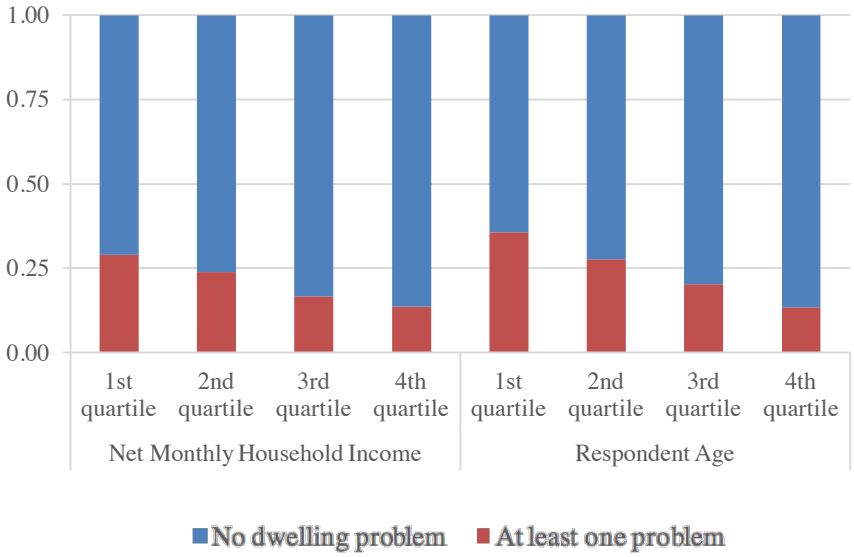
The presence of dwelling problems, however, is not independent of dwelling, external environmental, household, and respondent characteristics. Respondents are therefore not equally likely to experience dwelling problems. Table 4 (appendix) shows systematic variations between housing conditions. Dwellings with at least one problem are more likely to be apartments, consist of a fewer number of rooms, and have considerable lower monthly rents and values than dwellings without any problems. Furthermore, occupants of housing with dwelling problems report lower satisfaction with the external environment. In particular, participants living in dwellings with problems report lower levels of household income, are more likely to be tenants than homeowners, and are younger. The relation between dwelling status and health could therefore potentially be driven merely by SES, both influencing dwelling typology and health. Prior research indeed finds that household income is a main determinant of demand for health care services (Frijters et al., 2005). Individual wealth, as reflected by income, is also evidently related to age through the human lifecycle. Furthermore, individuals who possess more financial means are expected to inhabit higher quality dwellings. In order to examine whether the apparent relationship between dwelling conditions and health may be driven by differences in SES, monthly household income and respondent age quartiles are constructed. Based on the sample at hand, the following mean, minimum and maximum values per quartile are obtained.

Table 5: Net monthly household income and age quartiles

	Household Income			Respondent Age		
	Mean	Min.	Max.	Mean	Min.	Max.
1st quartile	773.08		1,660.17	26.3	16	36
2nd quartile	2,129.99	1,660.83	2,587.50	43.7	37	50
3rd quartile	3,082.59	2,587.58	3,624.00	56.6	51	62
4th quartile	5,794.03	3,624.08		70.6	63	98

Table 5 shows the distribution of household income and respondent age per quartile. It is of interest to examine the proportion of respondents who indicate to experience dwelling problems among these quartiles. Figure 4 shows this distribution per income and age quartile.

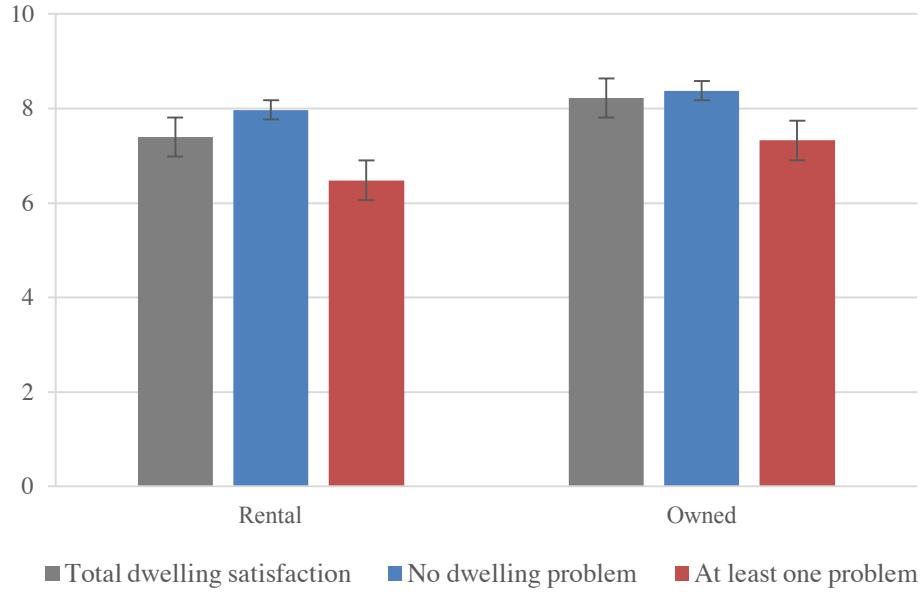
Figure 4: Dwelling condition, household income, and respondent age quartiles



The proportion of respondents indicating to experience dwelling problems are situated in the lowest household income and age quartiles. Furthermore, a negative relationship between the quartiles and reporting dwelling problems appears present. Moving up the income and age quartiles, less respondents report the presence of problems in their home environment. This is in line with prior research. Dunn and Hayes (2000) conclude that the general consensus in empirical research is that housing is a manifestation of SES. Constrained financial capacities, therefore, may lead to variations in housing choice (tenancy status) and condition (prevalence of dwelling problems).

Less wealthy individuals are more likely to be tenants. Pollack et al. (2004) find that rental dwellings tend to be less well-maintained than owned housing. Table 4 (appendix) shows that participants in the dataset inhabiting dwellings with problems are more likely to be tenants than homeowners. It is therefore of interest to examine whether there is a difference between dwelling satisfaction and tenure. Figure 5 shows average dwelling satisfaction conditional on a dwelling being rented or owned. Specifically, a subcategorization was made between total dwelling satisfaction, dwelling satisfaction in case the respondent indicated to experience none, as well as at least one problem in the dwelling.

Figure 5: Dwelling satisfaction and homeownership



Tenants are on average less satisfied with their dwelling than homeowners, respondents from these categories report a score of 7.4 and 8.2 on a scale from 1 to10, respectively. This is in line with Pekkonen, Du, Skön, Raaitkainen and Haverinen-Shaughnessy (2015), who find that individuals living in rental houses and apartments report being less satisfied with their housing conditions than those living in owner-occupied dwellings. Furthermore, irrespective of tenure, respondents who indicate to experience problems in the home environment report lower dwelling satisfaction than those individuals who report no dwelling problems. The variance between dwelling satisfaction of dwelling with and without problems is larger for tenants than homeowners and equals a difference of 1.5 in the score. Moreover, tenants who report at least one problem in their home report the lowest average dwelling satisfaction.

The research study at hand is focused on examining the causal relation between dwelling problems and health level. As table 4 (appendix) indicates, 53 and 45 percent of the observed problems are reported by tenants and homeowners, respectively. It is, however, interesting to examine what proportion of homeowners and tenants report problems. Respondents inhabiting rental dwellings are more likely to report experiencing problems in the home environment than homeowners. Specifically, of the tenants in the sample, 39 percent report the presence of at least one problem (versus 15 percent of homeowners). This strengthens the expectation of the study that tenants are more prone to be exposed to harmful indoor environments.

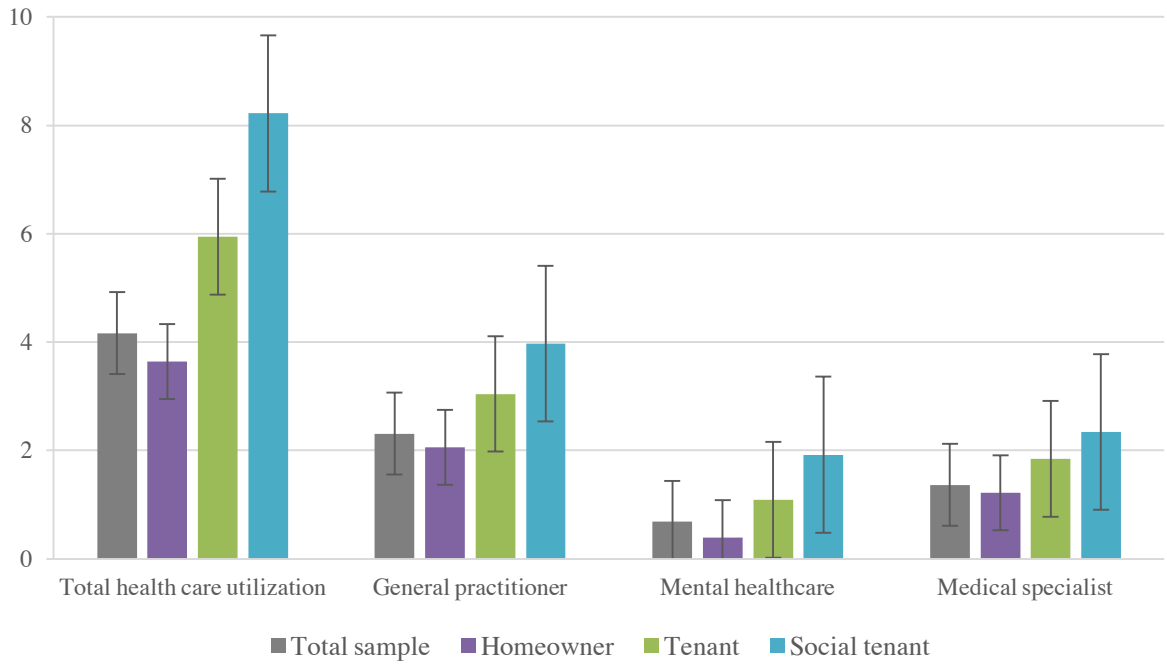
The previous findings suggest that differences in income, age, and tenancy status are related to the likelihood of experiencing poor dwelling condition. Therefore, the research constructs descriptive statistics for health and housing, conditional on income and age quartiles as well as tenure. Panel A through E in table 6 (appendix) shows the relation between the employed health indicators (general health perception, happiness, poor health, hindrance as a result of health problems, and total healthcare utilization) and dwelling conditions. For all measures of health, the statistics indicate that, as expected, lower net household income, higher age, and tenancy are associated with a poorer health status (and vice versa). Furthermore, the relation is stronger for lower- than higher-income respondents. Nevertheless, from the summary statistics one can observe that irrespective of the explored categories, the presence of at least one problem in the dwelling indoor environment has a detrimental health effect. This holds for all measures of health and for almost all income and age quartiles and tenancy status.

5.5.2 Rental housing

The main contribution of this study is the examination of the relationship between dwelling conditions and health status. The summary statistics described before, in combination with prior literature, strengthen the choice to examine tenants in specific. Therefore, table 7 (appendix) provides descriptive statistics for tenants of rental dwellings from 2007 to 2016. Tenants represent 31 percent of the dataset, which is slightly smaller than the current Dutch distribution (CBS, 2017). Average general health perception for all tenants is 2.93 on a scale of 1 to 5, and well-being equals 6.94 out of 10. Both general health perception and happiness of tenants is therefore lower than the average of the entire sample as well as lower than average health status conditional on the presence of at least one problem. Of all tenants, 26 percent report poor health status. Similar to the results for the entire sample, the proportion of tenants reporting poor health is larger for those who inhabit a dwelling with at least one reported problem than without any problem. The proportion of respondents is, however, larger: 24 and 28 when none and at least one problem is experienced, respectively.

With respect to health care utilization, tenants report an average of 5.95 total doctor visits in the year preceding the surveys. Figure 6 below shows the distribution of health care services (total health care, general practitioner, mental health care, medical specialist) per total sample, homeowners, tenants, and social tenants, respectively.

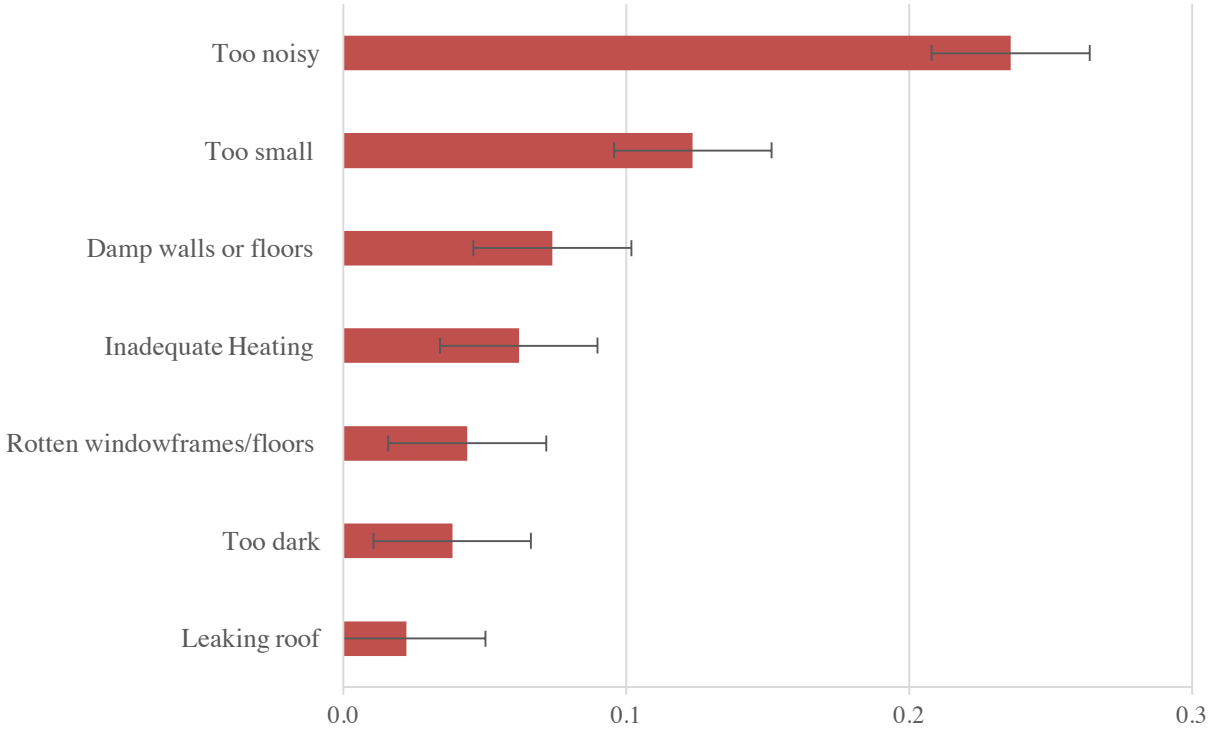
Figure 6: Health care services utilization (visits) per tenancy status



Tenants and social tenants, on average, make more use of all measures of health care services employed in the research. This is in line with prior research, which concludes that occupants of rental dwellings are in general less healthy than homeowners (e.g. Macintyre et al., 2003; Pollack et al., 2004; Shaw, 2004). Furthermore, 45 percent of all tenants indicate to experience hindrance from their health. Specifically, productivity related hindrance (work) is experienced by 34 percent of the sample.

Tenants report an average dwelling satisfaction of 7.39. With respect to the quality of the dwelling, 39 percent of all tenants experience at least one problem in the home environment. These are composed of comfort (15%), hazardous (15%), and noise (24%) related problems, respectively. Figure 7 below shows the distribution of reported problems per specific dwelling problem, as defined in section 5.2.

Figure 7: Distribution of reported dwelling problems for tenants



Tenants experience most of the problems in their dwellings related to excessive noise, 24 percent of tenants report '*Too Noisy*' as a dwelling problem. This is followed by spatial problems ('*Too Small*'), which is classified with inadequate lighting ('*Too Dark*') as a comfort-related dwelling problem. Hazard-related problems is comprised of problems related to damp, inadequate heating ('*Cold*'), rot, and leakage, which are experienced by 7, 6, 5, and 2 percent of tenants, respectively.

Table 8 (columns 1, 3, 5, 7, and 9) in the appendix shows systematic variations between housing conditions (dwelling with and without problems, and the categories) conditional on the respondent being a tenant. With respect to dwelling typology, one can observe that dwellings without any problems are most likely detached homes. Experiencing at least one problem, a hazardous problem and noise appears equally likely for the dwelling types. Comfort-related problems, however, are most likely to be experienced by tenants who live in apartments. Similarly, tenants who report at least one problem inhabit dwellings which consist of a fewer number of rooms, especially for comfort-related reported problems. Irrespective of problem category, dwellings with problems have considerable lower monthly rents, occupants report lower vicinity satisfaction, and the monthly net household income is lower. Likewise, tenants experiencing dwelling problems are younger, especially in case the dwelling problems are related to comfort.

Consecutively, the research constructs summary statistics for occupants of rental dwellings for health and housing. Panel A and B of table 9 (columns 1, 3, 5, 7, and 9) in the appendix show the relation between the various health measures and dwelling conditions. The latter, therefore, consists of experiencing at least one problem and the dwelling problem categories, comfort, hazard, and noise, respectively. The statistics indicate that, for all measure of health of tenants, irrespective of problem category, the prevalence of at least one problem in the dwelling is related to poorer health status. Tenants who experience problems report lower average general health perception, report lower happiness, are more likely to report poor health, make more use of health care services and are more hindered as a result of health problems. With respect to usage of medical services, especially the number of visits to a psychologist or psychiatrist appears considerable: tenants who do not report a dwelling problem on average report 0.81 visits in the preceding year, versus 1.51 visits when at least one problem is reported. Similarly, the proportion of tenants experiencing dwelling problems reporting social and work-related hindrance, is approximately 10 percent larger. Differences between the problem categories are small and similar to experiencing a problem at all. An exception thereof concerns psychologist visits of tenants reporting noise-related problems: on average, they utilized this type of health care service 1.82 times in the preceding year.

5.5.3 Social tenants

A subanalysis will be performed on the social tenants in the sample. Therefore, descriptive statistics of social tenants for the period of 2007 to 2016 are provided in table 10. Social tenants represent 35 percent of tenants in the sample. This proportion is representative for the Dutch population, given that it is only slightly higher than recent national data (Dutch Ministry of Foreign Affairs, 2013; 2016). Social tenants report average health of 2.77 (scale of 1 to 5) and average happiness of 6.94 (scale of 0 to 10). Of social tenants, 34 percent report poor health status. Thus, respondents from this population are considerably more likely to report poor health than the entire dataset (16%), owners (15%), and the entire sample of tenants (26%). The data furthermore indicate that 56 percent of social tenants experience hindrance as a result of health problems. Specifically, 44 percent thereof are hindered in their productivity (work behaviour).

With respect to dwelling conditions, social tenants report similar values to tenants in general (including dwelling satisfaction, prevalence of problems as well as problem categories). Similarly, the distribution of reported specific dwelling problems resembles all tenants. Conditional on social tenants, table 8 (columns 2, 4, 6, 8, and 10) in the appendix shows systematic variations between housing conditions. There appears to be little variation between

dwelling type and the presence of at least one problem as well as the problem categories. However, again, comfort related problems are most likely to prevail amongst occupants of apartments. Interestingly, only tenants who indicate to experience comfort related dwelling problems inhabit dwellings with fewer number of rooms than those tenants who experience no problems at all. Irrespective of problem category, alike tenants in general, social tenants experiencing dwelling problems pay lower monthly rents, are less satisfied with the vicinity, have lower monthly net household income, and are younger. The difference appears strongest for comfort-related dwelling problems.

Panel A and B of table 9 (columns 2, 4, 6, 8, and 10) in the appendix show, similar to tenants in general, the relation between health measures and dwelling conditions of social tenants. Those experiencing problems in the home environment appear to report a poorer health status than those who do not. Interestingly, with respect to general health perception, happiness, and the reporting of poor health, the variation between social tenants who do not experience problems and those who do, appears strongest for those experiencing hazardous dwelling problems. Social tenants experiencing noise problems most utilize health care in total, reporting a total of 9.36 visits in the preceding year. Social tenants suffering from hazardous problems in the home environment are the only ones visiting general practitioners slightly more often than those who do not experience problems at all, namely 4.20 versus 4.05 visits. Similarly, social tenants who do experience problems are more likely to report any kind of hindrance as a result of health status.

The previous section highlights the descriptive statistics for the sample at hand. To summarize, the data indicate that a relationship between rental dwelling quality and health may exist. Tenants and social tenants appear likely to experience poorer health and dwelling conditions. A proper investigation thereof requires empirical analysis incorporating individual SES and demographics. Household and individual characteristics (both observable and unobservable) may drive health investment decisions and choice for specific dwelling type. Therefore, these need to be controlled for to disentangle the effect of dwelling condition on health.

6 Methodology

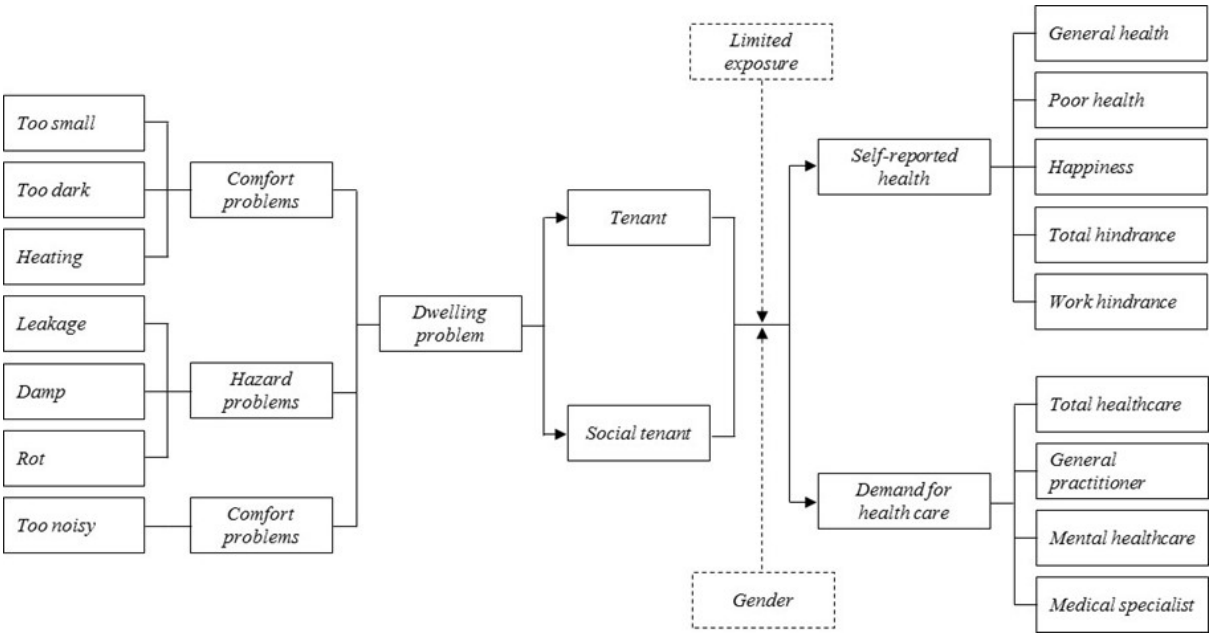
The research question calls for a longitudinal study as to determine causality in the relationship between housing condition and health status for (social-) tenants. As such, over-time variation in both variables can be analysed empirically. Estimating the effect of housing condition on health status requires the isolation of poor housing conditions. Therefore, dwelling problems, as reported by tenants, are used as a proxy for poor dwelling conditions. Various measures of health are used as an indication of tenant health status. Furthermore, it is necessary to include and control for confounding variables, such as socioeconomic and environmental factors, which are known to have a significant causal effect on health. The decision of health investments and housing preferences are driven by various observed and unobserved household and individual characteristics, which have to be controlled for in the empirical analyses. This section documents the empirical strategy and procedure followed in answering the research question and describes the model and techniques used in the analyses.

6.1 Empirical strategy

The analyses establish the causal relationship between dwelling quality and health status. In order to investigate the relationship between dwelling quality and health, both subjective and objective measures are incorporated. Prior literature frequently relies on self-reported health perception as a measure of health status and well-being (see e.g. Evans, 2003; Leventhal & Brooks-Gunn, 2003; Weinhold, 2015). Therefore, this research investigates general health perception, poor health status, happiness, and health-related hindrance as independent measures of subjective health status. Furthermore, physical health status is an important determinant of demand for healthcare as well as production of health capital. It is therefore a measure of high interest for previous academic work (see e.g. Aydin et al., 2017; Weinhold, 2015). In this research, total visits to providers of health care services is used as a measure of demand for health care. Therefore, total visits, general practitioner visits, visits to mental healthcare services, and medical specialist visits are the independent variables which proxy for (social-) tenant health care demand. In order to identify a causal relationship, poor dwelling quality in the previous period is compared to current health status. As to empirically test the proposed relationship, a stepwise approach is taken with respect to dwelling quality. First, the effect of the presence of at least one problem on health status is explored, followed by the problem categories (comfort, hazard, noise) and last the specific problem types (small, dark, inadequate heating, leaking roof, damp walls/floors, rotten frames/floors, noisy).

Tenants who moved at least once and are frequently absent from the home environment are excluded from the analyses. Home-movers pose a primary threat to inference in the baseline estimates. These individuals are less exposed to overt-time variation in the condition of a specific dwelling and, therefore, excluding these observations allows for the isolation of dwelling specific effects. Furthermore, an extensive set of controls are included in the analyses. These include dwelling characteristics, neighbourhood effects, household as well as individual characteristics and individual health behaviour. Considerable variation may arise between gender. Therefore, the effect of problems in the dwelling on demand for healthcare services is re-estimated conditional on the (social-)tenant being a male or female. Last, to test whether the results are indeed dependent on dwelling specific living conditions, this research analyses the relation between dwelling problems and demand for health care for those individuals who changed residency throughout the sample period, as to examine to effect of limited exposure to indoor hazards. Figure 8 shows the conceptual model, by which the expectations are tested.

Figure 8: Conceptual model of the relation between housing and health



Notes: The hypotheses developed in section 4 are tested following the conceptual model. Additional information w.r.t. variables is documented in section 5. The solid lines represent a direct expected relationship, the dashed lines show effects expected to influence these. Confounding factors determining health are controlled for in the analysis.

6.2 Model specification

The econometric technique used in this research is a pooled multiple linear regression model estimated using ordinary least squares (OLS). The model is extended with time fixed effects and various control variables. The parameter estimates from the model are thus obtained by minimizing the sum of squared errors. The model for individual $i = 1, \ldots, N$ observed in period $t = 1, \ldots, N$ is denoted as follows

$$H'_{i,d,t} = \alpha_i + \beta Q'_{i,d,t-1} + \gamma D'_{d,t} + \delta E_{i,d,t} + \theta X'_{i,d,t} + \lambda Z'_{i,t} + t_t + \varepsilon_{i,d,t} \quad (1)$$

For

$$Moved\ Ever_i = 0 \quad (2)$$

$$Absence_i = 0 \quad (3)$$

Where $H'_{i,d,t}$ represents the vector of dependent health measure variables of individual i, tenant of dwelling d, in year t. As described before, the various health measures proxy for (social-) tenant health status. The parameter of interest in this research is β, which represents the effect of the presence of dwelling problems in the home environment on individual health status. The dwelling condition of dwelling d at time *t-1* is represented by the vector $Q'_{i,d,t-1}$. The vector includes three sets of dummy variables. The first set consists of one dummy variable, taking the value of one if there is at least one problem reported in the dwelling, and zero otherwise. The second set of dummy variables includes the problem categories (described in section 5.2), with all dummies taking a value of one if the problem category is experienced by the individual and zero otherwise. The third set of dummy variables indicating poor dwelling condition consist of the specific dwelling problems (section 5.2) and take on a value of one if a problem is reported, and zero otherwise. The latter set, thus, provides most information with respect to the specific dwelling problems experienced by individuals in period *t-1*.

Investigating the relation between housing and health is empirically challenging, due to the existence of multiple confounders and interacting variables affecting both individual preference and behaviour with respect to housing and health capital. Therefore, this research includes an extensive variety of control measures similar to previous academic research (see e.g. Aydin et al., 2017; Weinhold, 2015). The vectors $\gamma D'_{d,t}$, $\delta E_{i,d,t}$, $\theta X'_{i,d,t}$, and $\lambda Z'_{i,t}$ include all observable control variables. Included are all dwelling characteristics, a dummy for outdoor

environmental problems if the individual reported at least one vicinity problem, all household and individual characteristics, and health behaviour variables, respectively. The unobserved components of the model include the time-invariant idiosyncratic effects as denoted by α_i, the time (year) fixed effects t_t as to control for unobserved time-variant characteristics, and the normally distributed idiosyncratic error term $\varepsilon_{i,d,t}$. As previously discussed, individuals who ever moved and those frequently absent are excluded from the analyses.

As to estimate the relation between housing and health conditional on gender, the model as denoted in equation 1 is re-estimated alternately including the constraints as denoted in equations 4 and 5 below. The demand for healthcare services for males is therefore estimated by extending the model described in equation 1 and the first two conditions in equations 2 and 3 by including the following constraint

$$Male_i = 1 \tag{4}$$

Alternately, demand for healthcare services for females is estimated with

$$Female_i = 1 \tag{5}$$

Whereas individuals who moved ever and are frequently absent from the dwelling have been excluded so far using equations 2 and 3, demand for healthcare services is re-estimated for movers only. Therefore, the model in equation 1 is extended with

$$Moved\ Ever_i = 1 \tag{6}$$

Furthermore, as to perform the subanalysis on the social housing sector, the model denoted in equation 1 and the constraints in equation 2 through 6 are re-estimated conditional on the individual being a social tenant. Therefore, the research extends these with

$$Rent\ Benefit_i = 1 \tag{7}$$

Moreover, equations 1 through 7 denote the model and alternate constraints included in the forthcoming analyses.

The data available for analyses concerning reported health status and problems in the home environment do not show much intragroup variation. Albeit estimating a fixed effects model is attractive in theory and commonly included in prior literature, in practice, an individual fixed effect panel model cannot be estimated properly based on the LISS data sample in this research. Effective sample sizes are reduced below inferential levels as the fixed effect model considers only those individuals whose health status and dwelling condition has changed over time. Furthermore, not all individuals had answered each module in each year, resulting in an unbalanced panel. As the effect of dwelling condition on health is the focus, this research foregoes fixed effects estimation and instead relies on intergroup variation. The results are robust to a variety of specifications for health status and dwelling conditions and an extensive set of control variables is included. Additional analysis confirms the impact of dwelling specific effects. Furthermore, multicollinearity in the independent variables is not an issue in the empirical analyses.

Section 6 describes the empirical design and procedure of this research. The methodology allows to provide answers to the research question *"What is the effect of poor housing condition on health?"*. The empirical approach of this research is based primarily on recent academic work by Weinhold (2015) and Aydin et al. (2017). The next section documents the results.

7 Empirical results

This section provides the results of the estimated model. The empirical analysis consists of two parts; exploring the entire population of tenants as well as social tenants specifically. The results are summarized in tables 11 through 18 of this paper. For all models, the primary objective is to explore the causal effect of the presence of problems in the home environment in period *t-1* on current health status. Therefore, a variety of controls including dwelling characteristics, vicinity problems, socio-economic status, demographics and health behaviour are incorporated in the model (see appendix for results incl. *all* controls). The analysis addresses both subjective health perception as well as economic health consequences, in terms of health care services utilization during the year prior to the survey. Furthermore, the role of gender in the relationship is explored. Last, the model is re-estimated for individuals who have ever moved during the sample period to address the potential mover effect.

7.1 The effect of problems in the home on health

The model specified in equation 1 is estimated using pooled OLS regression analysis. First, the effect of housing quality on subjective health measures (*General Health* perception, *Poor Health* status, *Happiness*, *Hindrance* and *Work Hindrance* as a result of health-related problems) is investigated. In order to ensure that variation in subjective health status is not influenced by a change of dwelling or a specific time period, year fixed effects are included and those individuals who moved at least once during the sample period and/or are frequently absent from the home are excluded. The results for all tenants and social tenants are reported in tables 11 and 12, respectively. First, whether a *Dwelling Problem* at all affects subjective health is explored (columns 1, 4, 7, 10, and 13), followed by the problem categories *Comfort*, *Hazard*, and *Noise Problems* (columns 2, 5, 8, 11, and 14) and last the specific dwelling problem types: *Too Small*, *Too Dark*, *Inadequate Heating*, *Leaking Roof*, *Damp Walls/Floors*, *Rotten Frames/Floors*, and *Too Noisy* (columns 3, 6, 9, 12, and 15).

For all tenants, the results in table 11 indicate that experiencing at least one problem in the home environment has a significant detrimental effect on subjective health status for all five measures. Individuals report a 0.163 lower general health perception (1-5 scale), are 10.5% more likely to report poor health, report a 0.488 lower happiness score (0-10 scale), are 7.2% more likely to report hindrance as a result of health-related problems and report 8.4% more work hindrance (as a measure of productivity).

Table 11: Estimation results of dwelling problems on health status for tenants

	General health			Poor health			Happiness			Hindrance			Work hindrance		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Dwelling problems (1=yes)	-0.163***			0.105***			-0.488***			0.072**			0.084***		
	(0.000)			(0.000)			(0.000)			(0.020)			(0.004)		
Dwelling problem categories:															
Comfort problems		-0.159**			0.086**			-0.589***			0.017			-0.007	
		(0.024)			(0.046)			(0.000)			(0.715)			(0.885)	
Hazard problems		-0.017			0.007			-0.028			0.025			0.028	
		(0.789)			(0.852)			(0.811)			(0.547)			(0.473)	
Noise problems		-0.180***			0.129***			-0.352***			0.096***			0.099***	
		(0.001)			(0.000)			(0.001)			(0.009)			(0.004)	
Dwelling problems:															
Too small			-0.082			0.086*			-0.578***			-0.009			-0.028
			(0.337)			(0.096)			(0.000)			(0.872)			(0.601)
Too dark			-0.055			-0.050			-0.196			0.003			-0.034
			(0.593)			(0.416)			(0.309)			(0.965)			(0.606)
Inadequate heating			-0.130			0.107*			-0.232			0.036			-0.007
			(0.151)			(0.052)			(0.176)			(0.556)			(0.908)
Leaking roof			-0.252			0.196			0.008			-0.085			-0.074
			(0.252)			(0.140)			(0.985)			(0.566)			(0.596)
Damp walls/floors			-0.017			0.002			-0.048			0.070			0.131**
			(0.834)			(0.972)			(0.758)			(0.211)			(0.013)
Rotten frames/floors			0.223*			-0.185**			0.001			-0.086			-0.077
			(0.064)			(0.011)			(0.996)			(0.293)			(0.319)
Too noisy			-0.196***			0.141***			-0.350***			0.100***			0.100***
			(0.000)			(0.000)			(0.001)			(0.006)			(0.004)
Observations	5,019	5,019	5,019	5,019	5,019	5,019	4,111	4,111	4,111	5,019	5,019	5,019	5,015	5,015	5,015
R-squared	0.153	0.157	0.159	0.146	0.151	0.158	0.208	0.210	0.209	0.139	0.142	0.143	0.118	0.119	0.124
Number of individuals	1,255	1,255	1,255	1,255	1,255	1,255	1,225	1,225	1,225	1,255	1,255	1,255	1,255	1,255	1,255
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dwelling characteristic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
External environment control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health behaviour control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are reported for the most extensive model including all dwelling problems (columns 3, 6, 9, 12, 15) in the appendix. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Examining the problem categories, one can observe that the relationship is driven mainly by those individuals experiencing comfort and noise problems. Individuals report 0.159 and 0.180 lower general health perception respectively; 8.6% and 12.9% poorer health; and 0.589 and 0.352 lower happiness. Furthermore, tenants experiencing noise problems are 9.6% and 9.9% more likely to report hindrance and work hindrance, respectively.

The most extensive model includes all specific dwelling problems. With respect to general health, the results indicate that individuals experiencing rotten frames and/or floors report a 0.223 better health score, while a dwelling being too noisy has a negative effect of 0.196. Tenants inhabiting a dwelling which is too small, has inadequate heating and is too noisy report 8.6%, 10.7%, and 14.1% poorer health, respectively. Happiness, as a measure of well-being, is negatively affected by a too small (0.578) and noisy (0.350) dwelling. Hindrance increases as a result of experiencing excessive noise (10.0%), while work hindrance increases by both damp walls/floors (13.1%) and noise (10.0%). Table 11 (appendix) reports coefficients for dwelling characteristics, vicinity related problems, socio-economic and demographic characteristics and health behaviour. As expected, experiencing vicinity problems has adverse subjective health effects. Income, SES, age and a healthy lifestyle positively affect self-reported health status and reduce (work-)hindrance.

For social tenants, the results documented in table 12 show that individuals experiencing at least one problem report lower health for all measures but work hindrance. Social tenants report 0.139 lower general health, are 14.0% more likely to report poor health, report 0.539 lower happiness, and are 11.3% more likely to experience hinder. Comfort problems negatively influence general health status and happiness by 0.216 and 0.562, respectively. Experiencing noise problems negatively affects general health (0.215), increase poor health (20.7%), and reduces happiness (0.487). With respect to specific problem types, the relationships are less pronounced for social tenants than for all tenants. A dwelling which is too noisy has a negative effect on general health perception of 0.223, a positive effect of 21.3% on the likelihood to report poor health, and negatively influences the happiness score by a coefficient of 0.527. The prevalence of rot in a dwelling increases both hindrance and work-related hindrance by 33.5% and 40.1% respectively. Table 12 in the appendix documents coefficients all control measures. Similar to tenants in general, experiencing vicinity problems has adverse subjective health effects, however of a higher magnitude. Interestingly, income, age and health behaviour are not related to subjective health for social tenants, whereas SES is more strongly related to health than for tenants in general.

Table 12: Estimation results of dwelling problems on health status for social tenants

	General health			Poor health			Happiness			Hindrance			Work hindrance		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Dwelling problems (1=yes)	-0.139*			0.140***			-0.539***			0.113**			0.067		
	(0.079)			(0.006)			(0.002)			(0.039)			(0.218)		
Dwelling problem categories:															
Comfort problems		-0.216*			0.108			-0.562**			0.104			0.004	
		(0.076)			(0.164)			(0.032)			(0.220)			(0.963)	
Hazard problems		0.031			0.023			0.006			0.104			0.094	
		(0.775)			(0.741)			(0.978)			(0.175)			(0.217)	
Noise problems		-0.215**			0.207***			-0.487**			0.098			0.046	
		(0.033)			(0.001)			(0.024)			(0.163)			(0.509)	
Dwelling problems:															
Too small			-0.039			0.084			-0.145			0.069			0.031
			(0.791)			(0.378)			(0.650)			(0.503)			(0.763)
Too dark			-0.229			0.053			-0.678			0.175			-0.048
			(0.224)			(0.663)			(0.100)			(0.181)			(0.710)
Inadequate heating			-0.199			0.014			-0.239			0.017			-0.061
			(0.273)			(0.907)			(0.536)			(0.894)			(0.626)
Leaking roof			0.013			-0.019			-2.470			-0.349			-0.145
			(0.980)			(0.956)			(0.129)			(0.343)			(0.688)
Damp walls/floors			0.194			-0.005			0.168			0.035			0.072
			(0.168)			(0.953)			(0.573)			(0.720)			(0.454)
Rotten frames/floors			-0.218			0.045			-0.659			0.335**			0.401**
			(0.354)			(0.767)			(0.195)			(0.041)			(0.013)
Too noisy			-0.223**			0.213***			-0.527**			0.105			0.049
			(0.028)			(0.001)			(0.016)			(0.135)			(0.484)
Observations	1,490	1,490	1,490	1,490	1,490	1,490	1,190	1,190	1,190	1,490	1,490	1,490	1,490	1,490	1,490
R-squared	0.232	0.244	0.248	0.209	0.225	0.223	0.297	0.300	0.305	0.153	0.160	0.170	0.163	0.166	0.183
Number of individuals	416	416	416	416	416	416	407	407	407	416	416	416	416	416	416
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dwelling characteristic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
External environment control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health behaviour control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are reported for the most extensive model including all dwelling problems (columns 3, 6, 9, 12, 15) in the appendix. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

7.2 Dwelling problems and demand for healthcare

To investigate the economic consequences of poor housing condition on health, this research explores the relation between housing quality and objective health measures. These include the following four measures: *Total Healthcare* utilization as measured by total number of visits (irrespective of service type), visits to the *General Practitioner*, *Mental Healthcare* services (visits to psychologist and/or psychiatrist), and *Medical Specialist* visits. The data allow for an investigation of the types of healthcare services, which each weigh differently on public healthcare spending. Again, year fixed effects are included and movers and those frequent absent are excluded. The results for all tenants and social tenants are reported in tables 13 and 14, respectively. First, whether a dwelling problem at all affects demand for healthcare services is explored (columns 1, 4, 7, and 10), followed by the problem categories (columns 2, 5, 8, and 11) and last the specific dwelling problems (columns 3, 6, 9, and 12).

The results in table 13 show that, for all tenants, experiencing at least one problem in the dwelling has a significant negative effect on total healthcare utilization (1.232) and visits to a general practitioner (0.858). Evaluating the problem categories, the latter observation appears driven by comfort related problems. Individuals who report to experience this type of problems paid 1.233 less visits the general practitioner during the previous year. The most precise model, including all specific dwelling problems, reports that individuals who indicate their dwelling to be too dark made less use of total healthcare services (2.800) during the last year. Cofounding effects related to SES may play a role in this relationship. The results document a strong significant positive relationship between the presence of rotten window frames and/or floors and the number of medical specialist visits. Individuals who report this problem in the home environment utilize this type of healthcare service 1.537 times more. Age increases the visits paid to general practitioners and medical specialists, and decreases visits to mental healthcare.

Table 14 documents the results for social tenants. Similarly, experiencing at least one problem has a significant negative effect on total healthcare demand (3.123) and visits to the general practitioner (2.366). The decrease in healthcare utilization for social tenants, however, appears driven by noise related problems (3.775). The most precise model, incorporating all specific problems, reinforces this observation as dwellings which are too noisy lead to a reduction of total healthcare of 3.796. The relation between rot and medical specialist visits is stronger for social tenants: experiencing this problem leads to 5.641 more visits. Additionally, increased age increases utilization of this service. The economic consequence of poor dwelling quality, thus, appears to materialize most in terms of medical specialist visits.

Table 13: Estimation results of dwelling problems on demand for health for tenants

	Total healthcare			General practitioner			Mental healthcare			Medical specialist		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dwelling problems (1=yes)	-1.232*			-0.858*			-0.532			0.123		
	(0.077)			(0.071)			(0.115)			(0.653)		
Dwelling problem categories:												
Comfort problems		-1.240			-1.233*			-0.032			-0.011	
		(0.253)			(0.095)			(0.951)			(0.979)	
Hazard problems		-0.367			0.129			-0.629			0.135	
		(0.698)			(0.841)			(0.171)			(0.718)	
Noise problems		-0.921			-0.537			-0.448			0.017	
		(0.267)			(0.343)			(0.266)			(0.957)	
Dwelling problems:												
Too small			-0.451			-0.759			-0.033			0.316
			(0.729)			(0.393)			(0.958)			(0.536)
Too dark			-2.800*			-1.752			-0.515			-0.590
			(0.076)			(0.102)			(0.501)			(0.337)
Inadequate heating			-0.351			0.280			-0.527			-0.118
			(0.801)			(0.768)			(0.434)			(0.829)
Leaking roof			-0.151			0.325			0.323			-0.730
			(0.964)			(0.888)			(0.843)			(0.580)
Damp walls/ floors			0.336			0.761			-0.346			-0.065
			(0.790)			(0.378)			(0.572)			(0.896)
Rotten frames/floors			0.480			-0.922			-0.133			1.537**
			(0.794)			(0.465)			(0.882)			(0.034)
Too noisy			-1.027			-0.535			-0.482			-0.051
			(0.215)			(0.344)			(0.231)			(0.876)
Observations	4,873	4,873	4,873	4,973	4,973	4,973	4,879	4,879	4,879	4,920	4,920	4,920
R-squared	0.080	0.080	0.082	0.052	0.052	0.054	0.101	0.102	0.102	0.066	0.063	0.067
Number of individuals	1,239	1,239	1,239	1,251	1,251	1,251	1,241	1,241	1,241	1,250	1,250	1,250
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dwelling characteristic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
External environment control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health behaviour control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are reported for the most extensive model including all dwelling problems (columns 3, 6, 9, 12) in the appendix. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 14: Estimation results of dwelling problems on demand for health for social tenants

	Total healthcare			General practitioner			Mental healthcare			Medical specialist		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dwelling problems (1=yes)	-3.123*			-2.366*			-1.136			0.363		
	(0.064)			(0.060)			(0.164)			(0.570)		
Dwelling problem categories:												
Comfort problems		-1.627			-2.100			-0.338			0.787	
		(0.531)			(0.279)			(0.789)			(0.424)	
Hazard problems		-1.448			-0.757			-0.834			0.200	
		(0.538)			(0.666)			(0.464)			(0.823)	
Noise problems		-3.775*			-2.046			-1.129			-0.651	
		(0.080)			(0.202)			(0.279)			(0.425)	
Dwelling problems:												
Too small			-1.676			-1.122			-1.630			1.057
			(0.600)			(0.638)			(0.292)			(0.378)
Too dark			-2.050			-3.463			1.277			0.108
			(0.612)			(0.252)			(0.514)			(0.943)
Inadequate heating			-2.223			-0.518			-0.666			-0.987
			(0.568)			(0.859)			(0.724)			(0.499)
Leaking roof			3.486			5.475			2.449			-4.424
			(0.759)			(0.518)			(0.656)			(0.299)
Damp walls/ floors			-0.471			0.688			-0.285			-0.801
			(0.876)			(0.759)			(0.845)			(0.478)
Rotten frames/floors			1.852			-2.655			-1.164			5.641***
			(0.714)			(0.481)			(0.634)			(0.003)
Too noisy			-3.796*			-2.235			-1.010			-0.603
			(0.082)			(0.169)			(0.338)			(0.460)
Observations	1,456	1,456	1,456	1,478	1,478	1,478	1,460	1,460	1,460	1,465	1,465	1,465
R-squared	0.122	0.127	0.128	0.092	0.094	0.096	0.205	0.206	0.210	0.083	0.085	0.107
Number of individuals	412	412	412	414	414	414	414	414	414	414	414	414
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dwelling characteristic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
External environment control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health behaviour control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are reported for the most extensive model including all dwelling problems (columns 3, 6, 9, 12) in the appendix. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

7.3 Gender effects

Next, the role of gender is investigated in the relationship between problems in the home environment and tenant health status. Specifically, the research focuses on objective measures of health; demand for healthcare services. Again, year fixed effects are incorporated and movers and those frequently absent from the home are excluded. The main interest lies in the effect specific dwelling problems on demand for health for male and female (social-)tenants. The results for all tenants are reported in table 15 and in table 16 for social tenants. Corresponding coefficients for dwelling characteristics, vicinity related problems, socio-economic and demographic characteristics and health behaviour can be found in the appendix.

For all tenants, table 15 below documents significant differences between males and females in the causal relationship between dwelling quality and health.

Table 15: Estimation results of dwelling problems on demand for health for tenants by gender

	Total healthcare		General practitioner		Mental healthcare		Medical specialist	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Male	Female	Male	Female	Male	Female	Male	Female
Dwelling problems:								
Too small	1.828	-1.739	-0.569	-0.162	1.996***	-2.195*	0.410	0.584
	(0.295)	(0.395)	(0.676)	(0.895)	(0.000)	(0.076)	(0.524)	(0.487)
Too dark	-3.946*	-2.026	-1.921	-1.774	-0.926	-0.630	-1.116	0.320
	(0.070)	(0.380)	(0.254)	(0.200)	(0.107)	(0.652)	(0.161)	(0.736)
Inadequate heating	-2.404	1.364	-1.203	1.799	-0.968*	-0.299	-0.282	-0.087
	(0.227)	(0.505)	(0.440)	(0.142)	(0.065)	(0.809)	(0.702)	(0.917)
Leaking roof	-3.115	1.910	-0.039	0.924	-3.039**	2.103	0.092	-1.046
	(0.576)	(0.660)	(0.993)	(0.722)	(0.039)	(0.423)	(0.965)	(0.558)
Damp walls/ floors	0.993	0.816	1.128	0.703	0.200	-0.469	-0.341	0.609
	(0.624)	(0.632)	(0.478)	(0.491)	(0.708)	(0.649)	(0.650)	(0.384)
Rotten frames/floors	-0.525	1.775	-0.751	-1.397	-0.723	0.962	0.979	2.189**
	(0.873)	(0.451)	(0.770)	(0.322)	(0.402)	(0.500)	(0.420)	(0.024)
Too noisy	0.042	-2.167*	-0.410	-0.791	-0.315	-0.676	0.735*	-0.746
	(0.971)	(0.068)	(0.659)	(0.265)	(0.314)	(0.346)	(0.095)	(0.126)
Observations	2,124	2,749	2,181	2,792	2,125	2,754	2,151	2,769
R-squared	0.073	0.153	0.047	0.120	0.118	0.160	0.129	0.093
Number of individuals	593	646	601	650	593	648	600	650
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dwelling characteristic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
External environment control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health behaviour control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are reported in the appendix. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Males reporting the dwelling they inhabit to be too dark make 3.946 times less use of total healthcare service. However, males who indicate their dwelling to be too dark, visit mental healthcare services 1.996 times more. Inadequate heating and the presence of a leaking roof reduce mental healthcare utilization by 0.968 and 3.039, respectively. Last, males who report too noisy as a dwelling problem pay 0.735 more visits to a medical specialist. The results show significant different effects for females. Females who report a dwelling to be too noisy, overall, make 2.167 less use of total healthcare services. Females who experience a dwelling to be too small, on the contrary from males, pay 2.195 less visits to mental healthcare services. The results also document an increasing effect of rot on visits to medical specialists of 2.198.

It appears, thus, that the results documented in table 13 in part are a result of gender variation. The negative relationship between dwelling problems and total healthcare utilization seems to stem from males experiencing comfort related problems in the home environment. While table 13 does not documents a relationship between dwelling problems and mental health, table 15 indicates that there is in fact a positive relationship for males, while a negative relationship is evident for females. Furthermore, the adverse health effect of rot as indicated by medical specialist visits stems mainly from females.

Table 16 on the next page reports the results for social tenants. For males, no significant adverse effect of dwelling quality on health is observed when focusing on this subsample. For females, however, the following observations are made. Female social tenants who report their dwelling to be too noisy make less use of total healthcare services by 6.393 visits. This stems mainly from a reduction in visits to a general practitioner over the last year of 2.921. With respect to medical specialists, however, the results indicate a positive causal effect of 3.121 visits when females indicate their dwelling to be too small. Additionally, and more pronounced than for tenants in general, female social tenants who inhabit a dwelling where rotten window frames and/or floors are present are more likely to visit a medical specialist. The effect is large and significant with an increase of 11.842 visits.

The conclusion from these results are that there are large differences in the relationship between housing quality and health dependent on gender. For social tenants, the relationship for males appears insignificant based on the results, while the observations from table 13 are driven by females. Based on tables 15 and 16, females appear more prone to the adverse effect of hazardous problems in their home on their health, as measured by medical specialist visits. The effect is, as expected, stronger for social tenants, who are in general less healthy, demand more healthcare and enjoy a lower SES.

Table 16: Estimation results of dwelling problems on demand for health for social tenants by gender

	Total healthcare		General practitioner		Mental healthcare		Medical specialist	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Male	Female	Male	Female	Male	Female	Male	Female
Dwelling problems:								
Too small	1.796	2.318	-0.550	1.267	1.339	-2.115	1.007	3.121*
	(0.790)	(0.595)	(0.932)	(0.646)	(0.130)	(0.401)	(0.541)	(0.089)
Too dark	0.909	-2.975	3.600	-4.854	-1.215	0.751	-1.475	1.136
	(0.917)	(0.535)	(0.665)	(0.111)	(0.287)	(0.786)	(0.489)	(0.573)
Inadequate heating	3.295	2.348	5.289	1.573	-0.932	1.211	-1.061	-0.387
	(0.671)	(0.678)	(0.475)	(0.661)	(0.358)	(0.711)	(0.576)	(0.870)
Leaking roof		4.272		9.166		2.339		-7.492
		(0.727)		(0.238)		(0.741)		(0.146)
Damp walls/ floors	-1.009	4.055	-0.284	2.705	0.892	1.110	-1.617	0.224
	(0.865)	(0.317)	(0.960)	(0.290)	(0.250)	(0.635)	(0.265)	(0.895)
Rotten frames/floors	-3.378	8.367	-2.045	-4.466	-1.214	1.007	-0.119	11.842***
	(0.657)	(0.267)	(0.778)	(0.349)	(0.223)	(0.817)	(0.949)	(0.000)
Too noisy	-5.179	-6.393**	-4.170	-2.921*	-0.604	-2.646	-0.405	-0.833
	(0.225)	(0.022)	(0.305)	(0.098)	(0.278)	(0.101)	(0.697)	(0.476)
Observations	455	1,001	460	1,018	455	1,005	458	1,007
R-squared	0.182	0.211	0.144	0.190	0.511	0.281	0.326	0.176
Number of individuals	141	271	141	273	141	273	141	273
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dwelling characteristic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
External environment control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health behaviour control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are reported in the appendix. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

7.4 Moving effects

Individuals who have changed residency have so far been excluded, as inclusion reduces the inferred relationship between dwelling quality and health. Individuals who have moved from their dwelling or are frequently absent from the home environment are less exposed to adverse health effects of poor dwelling quality. To explore whether the results reported in tables 11 through 16 are dependent on the dwelling, the model specified in equation 1 is re-estimated for tenants who have moved at least once during the sample period. The dependent variables are objective measures of health, measured by demand for healthcare services. As before, first a dwelling problem at all is explored (columns 1, 4, 7, and 10), followed by the problem categories (columns 2, 5, 8, and 11) and last the specific dwelling problems (columns 3, 6, 9, and 12). Results for tenants and social tenants are reported in tables 17 and 18 respectively. Coefficients for dwelling characteristics, vicinity related problems, socio-economic and demographic characteristics and health behaviour can be found in the appendix.

Table 17: Estimation results of dwelling problems on demand for health for tenants who moved during the period

	Total healthcare			General practitioner			Mental healthcare			Medical specialist		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dwelling problems (1=yes)	0.539			0.866*			0.172			-0.492		
	(0.634)			(0.010)			(0.547)			(0.617)		
Dwelling problem categories:												
Comfort problems		1.645			0.354			0.218			1.064	
		(0.233)			(0.384)			(0.530)			(0.376)	
Hazard problems		0.730			0.890**			-0.159			-0.009	
		(0.625)			(0.045)			(0.675)			(0.994)	
Noise problems		0.377			0.779**			0.359			-0.725	
		(0.766)			(0.040)			(0.265)			(0.513)	
Dwelling problems:												
Too small			1.913			0.522			-0.058			1.439
			(0.189)			(0.222)			(0.872)			(0.256)
Too dark			0.802			0.024			1.652**			-0.851
			(0.767)			(0.976)			(0.015)			(0.718)
Inadequate heating			0.288			0.397			-0.155			0.028
			(0.886)			(0.506)			(0.760)			(0.987)
Leaking roof			-2.105			-0.975			-0.951			-0.142
			(0.523)			(0.319)			(0.251)			(0.961)
Damp walls/ floors			1.033			0.197			-0.439			1.266
			(0.651)			(0.771)			(0.445)			(0.525)
Rotten frames/floors			1.085			1.794*			1.553**			-2.266
			(0.726)			(0.051)			(0.046)			(0.401)
Too noisy			0.272			0.791**			0.305			-0.788
			(0.834)			(0.040)			(0.348)			(0.484)
Observations	2,612	2,612	2,612	2,652	2,652	2,652	2,619	2,619	2,619	2,629	2,629	2,629
R-squared	0.133	0.136	0.138	0.156	0.165	0.169	0.107	0.109	0.125	0.095	0.096	0.099
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dwelling characteristic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
External environment control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health behaviour control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are reported for the most extensive model including all dwelling problems (columns 3, 6, 9, 12) in the appendix. Estimation results exclude individuals who did not move during the sample period. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

The results for all tenants who moved at least once are reported in table 17. Contrary to results reported in table 13, experiencing at least one problem in the home environment leads to an increase of 0.866 general practitioner visits. The relationship between dwelling problems and visits to a general practitioner appears driven by hazard (0.890) and noise (0.779) related problems. Evaluating the specific dwelling problems, the results show that individuals pay an additional 1.794 and 0.791 visits to a general practitioner when reporting rot and excessive noise, respectively. While no significant relationship can be observed between dwelling quality and mental healthcare for tenants who never moved, significant positive relationships are thereof observed in table 17. Tenants who report that their dwelling is too dark pay 1.652 more visits to providers of mental healthcare services. This is in line with Evans (2003), who finds that individuals inhabiting dwellings with poor lighting experience adverse mental health effects. Additionally, tenants experiencing rot pay 1.553 more visits to mental healthcare services. Contrary to tenants who never moved, the results indicate that no relationship exists between dwelling condition and medical specialist visits.

Table 18 reports the results for social tenants who moved at least once during the sample period. Again, considerable differences are observed between those individuals who moved and those who did not (table 14). No significant relationships between dwelling problems and demand for healthcare can be observed for experiencing at least one problem nor the dwelling problem categories. However, investigating the specific dwelling problems, the results indicate that experiencing rot is significantly and positively related to general practitioner visits and usage of mental healthcare services. Thereof, social tenants pay 4.874 and 4.119 more visits, respectively. The relationship is therefore similar, however much stronger, when focusing on social tenants rather than tenants in general. No significant relationship between dwelling problem and visits to a medical specialist can be observed from the results. These results are considerable different from table 14, where no relationship is apparent for general practitioner visits and mental healthcare services, while a significant positive relationship for medical specialist visits is observed.

The results for both tenants in general and social tenants are strikingly different when focusing on either individuals who have been exposed to the same dwelling during the entire sample period or those who did not. These results, therefore, strengthen the conclusions from the previous analysis that severe health effects are observed when individuals are exposed for extended periods of time to indoor environmental hazards.

Table 18: Estimation results of dwelling problems on demand for health for social tenants who moved during the period

	Total healthcare			General practitioner			Mental healthcare			Medical specialist		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dwelling problems (1=yes)	-2.609			0.273			0.539			-3.421		
	(0.388)			(0.732)			(0.340)			(0.235)		
Dwelling problem categories:												
Comfort problems		-0.592			-0.693			0.819			-0.718	
		(0.886)			(0.524)			(0.286)			(0.855)	
Hazard problems		-2.502			0.897			-0.252			-3.147	
		(0.567)			(0.436)			(0.756)			(0.449)	
Noise problems		-1.187			0.373			0.517			-2.077	
		(0.716)			(0.664)			(0.393)			(0.503)	
Dwelling problems:												
Too small			0.517			-0.302			0.782			0.037
			(0.908)			(0.795)			(0.330)			(0.993)
Too dark			-1.014			-1.046			0.954			-0.922
			(0.903)			(0.628)			(0.522)			(0.907)
Inadequate heating			-0.978			0.223			0.890			-2.091
			(0.892)			(0.905)			(0.490)			(0.760)
Leaking roof			14.446			2.242			0.456			11.748
			(0.292)			(0.526)			(0.852)			(0.366)
Damp walls/ floors			-5.564			-0.797			-1.741			-3.025
			(0.389)			(0.632)			(0.132)			(0.621)
Rotten frames/floors			-2.196			4.784**			4.119**			-11.099
			(0.811)			(0.045)			(0.013)			(0.203)
Too noisy			-0.440			0.647			0.695			-1.782
			(0.899)			(0.470)			(0.262)			(0.587)
Observations	737	737	737	748	748	748	739	739	739	742	742	742
R-squared	0.222	0.222	0.229	0.203	0.210	0.245	0.187	0.195	0.262	0.173	0.173	0.186
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dwelling characteristic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
External environment control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-economic control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Health behaviour control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are reported for the most extensive model including all dwelling problems (columns 3, 6, 9, 12) in the appendix. Estimation results exclude individuals who did not move during the sample period. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level

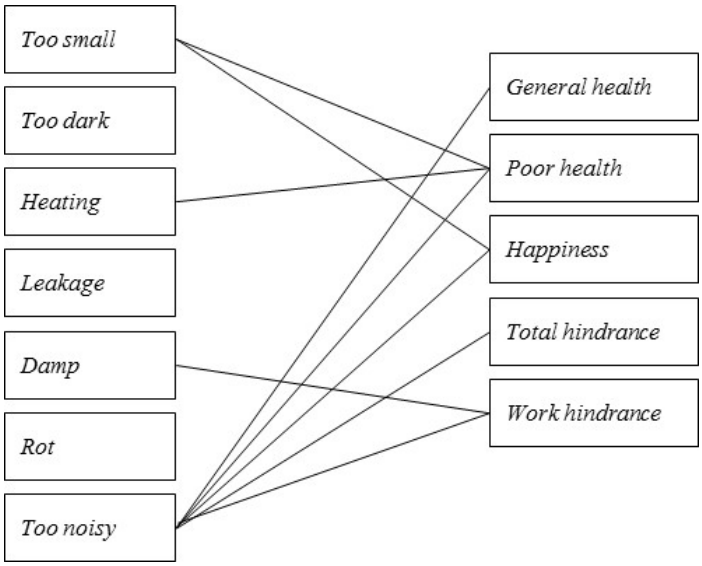
8 Discussion

The previous section provides the results for the relationship between dwelling conditions and health for (social-)tenants. The regressions presented in section 7 provide strong suggestive evidence for a causal impact of poor dwelling condition on tenant health. The results are in line with the limited theoretical and empirical work exploring the causal relation between housing and health. This research furthermore provides high confidence, following the exploitation of different measures, specifications of the model, and the inclusion of an extensive set of control variables. This section interprets and discusses implications of the main results. Furthermore, limitations of the analysis are discussed, followed by suggestions for future research.

8.1 Health perception

The results with respect to self-reported health measures indicate a strong effect of problems in the home environment on health perception. For tenants in general, the presence of at least one problem leads to lower self-reported general health status, increases the likelihood of reporting poor health, reduces happiness, and increases (work-)related hindrance. This is in line with prior literature (see i.e. Aydin et al., 2017; Evans, 2003; Leventhal & Brooks-Gunn, 2003; Weinhold, 2015). Comfort related problems affect general health, poor health, and happiness as expected, however, are unrelated to (work-)hindrance. Specifically, dwellings which are experienced to be too small lead to a poor health and reduced well-being. Inadequate heating in the home, or a dwelling which is too cold, increases the likelihood of a tenant to report poor health. A lower temperature is related to indoor dampness due to the incapability of the indoor environment to contain moist. If a dwelling suffers from damp issues in the walls or floors, tenants are more likely to experience work-related hindrance. Therefore, individuals inhabiting a dwelling with dampness are more likely to be less productive. In line with recent work by Weinhold (2015), the results indicate that noise related problems have a strong adverse effect on all measures of self-reported health. Figure 9 summarizes the dwelling problems which are shown to have adverse self-reported health effects.

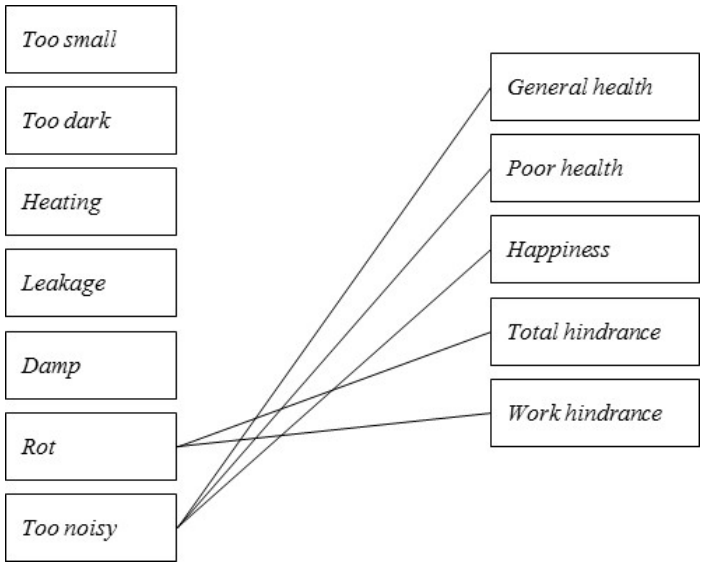
Figure 9: Indoor hazards related to poorer self-assessed health for tenants



The results for tenants in general are consistent with as well as a confirmation of prior research. Furthermore, a considerable number of control variables turns out to play a significant role in the relationship. Experiencing problems with the vicinity is an important confounding factor and influences all health measures as expected. Similarly, the results indicate SES, age, and health behaviour to be significant predictors of health status and productivity, confirming prior literature in health economics.

The adverse health effects of poor housing condition are, as expected, more severe for individuals in the social housing segment. This implies that social tenants are more likely to be more severely deprived of health when experiencing hazards in the home environment. With respect to specific dwelling problems, the results indicate a different pattern for social tenants than for tenants. Social tenants experience significant hindrance in both daily activities and work-related tasks in case the inhabited dwelling has rotten window frames or floors, while this relation is non-existent for tenants in general. The results are considerable large with increases of 40.1 and 33.5 percent for (work-)hindrance, respectively. The loss in human productivity as a result of indoor hazards is thus an especially relevant consideration for social tenants. Figure 10 summarizes the dwelling problems which are shown to have adverse self-reported health effects for social tenants.

Figure 10: Indoor hazards related to poorer self-assessed health for social tenants



Vicinity problems have, again, large and pronounced adverse effects on self-reported health. Dwelling and household characteristics turn out to be less confounding factors determining health for occupants of social housing. This corresponds to the self-sorting bias based on income in the social housing sector (Algan et al., 2016). Whether an individual is working as well as health behaviour strongly influence health for all measures, which is in line with social tenants in general possessing less health capital.

8.2 Economic health consequences

The relation between housing and demand for healthcare is less pronounced than the relation between housing and self-reported health measures. Individuals inhabiting a dwelling with comfort-related problems such as small size and poor lighting, in fact, make less use of total healthcare services and pay less visits to general practitioners. While puzzling on a first notice, comfort-related dwelling problems do not pose immediate threats to individual physical health. Rather, prior literature finds a direct effect thereof on mental health (Evans, 2003). While the regression analyses do not support this, descriptive statistics do indicate that on average, individuals reporting comfort problems make more use of mental healthcare services, whereas they pay less visits to other types of health care (table 9 panel B in the appendix).

A strong causal effect is found to exist of the presence of rot in the home environment and medical specialist visits. An increase of 1.537 visits is observed. The presence of rot implies that the dwelling, at least preceding, experienced damp, mould, and moisture indoor. While the

results do not show a significant relation between damp problems and medical specialist visits, therefore, the effect of rot implies an indirect causal relationship thereof. The biological impact of mould in the home materializes in respiratory diseases (Pega & Wilson, 2016), allergies (Mendell, Mirer, Cheung, Tong, & Douwes, 2011), and symptoms associated with fever (Wilkinson, 1999). Thus, tenants inhabiting dwellings which contain either damp or rot make more use of medical specialist services. In the Netherlands, individuals are entitled to make use of specialist health care services only with a referral from a general practitioner (Rijksoverheid, n.d.a). The latter will only provide a referral letter in case of medical necessity. As such, given the relation between indoor environmental hazards and medical specialist visits, the inference can be extended to general practitioner visits. Addressing hazardous dwelling problems in the home will therefore reduce the burden on national healthcare expenditure in twofold.

Social tenants appear to make less use of total health care services as a result of noise related dwelling problems. However, following Weinhold (2015), the presence of indoor noise depends to a high degree on outdoor noise annoyance. The prevalence of vicinity problems, including neighbourhood noise, show a high correlation with indoor noise and has a positive effect on total health care utilization and general practitioner visits. Inferential statistics indicate that social tenants make more use of healthcare when experiencing noise related problems (table 9, panel B in the appendix). This increase is largest for mental healthcare services. Namely, social tenants almost doubled their visits to 3.59 during the last year.

The strong relationship between hazards in the home and specialist visits is also observed for social tenants. The relation is even more pronounced: rot in the home leads to an increase of 5.641 visits for social tenants, versus 1.537 for tenants in general. The previously observed relation for tenants in general, therefore, may partially be driven by the findings for social tenants. Individuals in the social housing segment experience poorer health condition (see e.g. tables 9 and 10 in the appendix) and are therefore more prone to the adverse health impact of hazards in the home. Interestingly, monthly rent is positively related to medical specialist visits for social tenants. Corresponding to the European trend of the less-financially constrained to seek more care of specialist health services (Mladovsky et al., 2009), social tenants paying higher rents, although under the rent benefit maximum, thus pay more visits to medical specialists.

8.3 Demand sensitivity to gender

The effects of poor dwelling quality on demand for health care services are in part driven by gender differences. With respect to total healthcare utilization, males inhabiting dwellings which are considered too dark make less use of total services. The results for tenants in general (section 8.2), therefore, are driven in part by males. Furthermore, an opposite gender conditional effect is observed of dwellings considered too small on mental health care utilization. Previous findings suggest a strong and direct effect of insufficient dwelling size on mental health status (Evans, 2003), especially for women (Leventhal & Brooks-Gunn, 2003). The findings, however, indicate that males are likely to pay more visits to either a psychologist or psychiatrist if they consider their dwelling too small, while females pay approximately the same amount less visits. Nevertheless, on average, female tenants pay almost twice the number of visits to mental healthcare facilities than males (table 19).

Table 19: Average healthcare utilization by gender

	Tenants		Social tenants	
	Male	Female	Male	Female
Total health care utilization	4.76	6.89	6.23	9.19
	(8.97)	(15.32)	(12.13)	(20.16)
General practitioner (visits)	2.43	3.54	2.94	4.47
	(5.10)	(7.15)	(7.62)	(7.53)
Mental healthcare (visits)	0.76	1.34	1.56	2.10
	(3.83)	(10.83)	(5.59)	(15.03)
Medical specialist (visits)	1.62	2.03	1.75	2.63
	(3.84)	(6.91)	(3.89)	(10.37)

Notes: Standard deviation in parentheses.

Thus, while females on average pay more visits to psychologists or psychiatrists, in the case of inhabiting a too small dwelling, they are likely to make less use of mental healthcare. The positive relation for males and the negative relation for females as such, cause the inability to observe a relation for these factors for tenants in general (section 8.2).

Utilization of specialist healthcare services, also, varies by gender. Hazards in the home in the form of rot adversely affect females, with a higher magnitude for females than tenants in general. This is in line with existing literature, which finds that females are more prone to health hazards and make more use of health care (see e.g. Anderson, 1973; Bertakis et al., 2000). The health deprivation resulting from rot, as described earlier, is therefore more pronounced for females. In part, this may be a result of increased exposure of females to indoor hazards, as the

proportion of females employed is lower than males and they are thus more exposed to hazards in the home. Interestingly, excessive noise in the home environment results in an increase of medical specialist visits for males. The conclusions therefore complement prior academic work by Weinhold (2015), who finds a strong relation between noise and health outcomes which require specialist health care, such as cardio-vascular disease and auto-immune diseases as arthritis and bone disorders.

The most interesting finding for social tenants is that gender variation to a large extent explains the results observed for the total social housing segment. Female social tenants experience adverse health effects from exposure to dwelling problems, while for males there is no effect of dwelling problems on demand for healthcare. The negative relation between dwelling problems per se, total healthcare utilization, and general practitioner visits stems from females experiencing excessive noise in the home.

Further results (table 20 in the appendix) indicate that females experiencing noise annoyance in the home report significantly poorer health status for self-reported measures[2]. Female social tenants who experience noise-related hinder in the home thus report poorer health, however, make less use of health care services in the form of total health care utilization and general practitioner visits. This raises the question of deprivation of healthcare services for those in need for care, females in particular. Including an interaction variable between noise problems and poor subjective health provides insights (table 21 in the appendix) into this relationship[3]. In fact, poor health status positively and significantly moderates the effect of noise on the number of general practitioner visits and the inclusion even reduces the pure effect of noise. Thus, if social female tenants experience noise *and* report poor health status, a positive relation thereof materializes on total healthcare utilization as well as general practitioner visits. This implies that the causal relationship between indoor hazards and demand for healthcare services in part depends upon the individual reporting poor health.

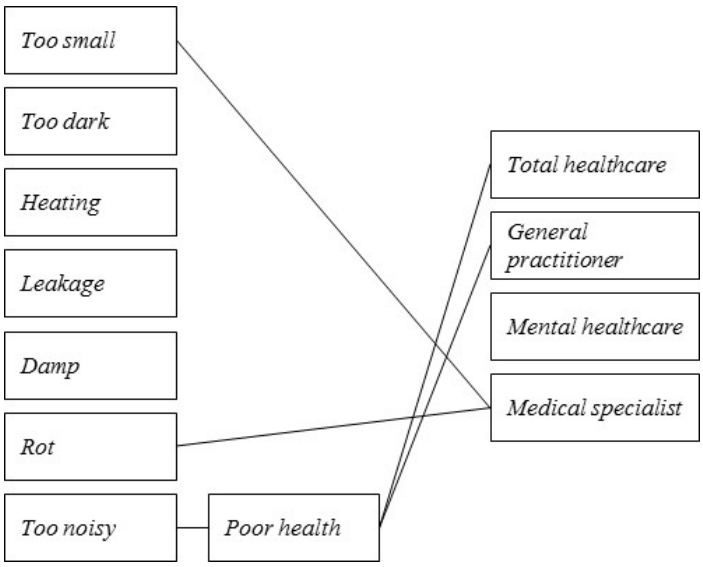
---

[2] The model used in section 7.2 for female social tenants is re-estimated based on general health perception and the poor health measure. See table 20 in the appendix for the estimation results.

[3] The model in section 7.2 for female social tenants is re-estimated by including an interaction term between indoor noise problems and poor health status. See table 21 in the appendix for the estimation results

As expected, the relationship between rot and medical specialist visits is more pronounced and of a higher magnitude for female social tenants. This sample is more prone to hazards in the home and correspondingly are in need of more specialist health care services. Figure 11 below summarizes which dwelling problems are shown to increase demand for healthcare services for female social tenants, and visualizes the relation between noise, the interaction with self-reported health status, and demand for healthcare services. Moreover, prior conclusions for social housing are thus explained in part by gender. Given that these observations are made under the strict model and constraints, the results are robust and representative for female tenants positioned in the social housing segment.

Figure 11: Indoor hazards related to more demand for health by female social tenants



8.4 Reduced exposure

Tenants who changed residency are less exposed to the adverse health effects of a specific dwelling. The relation between problems in the home environment is therefore expected to be different and less severe for these individuals. Whereas dwelling problems have a strong and positive effect on the number of medical specialist visits for (social-)tenants exposed to the same dwelling throughout the sample period, this relation is non-apparent for individuals who moved at least once. Exposure to indoor environmental hazards over a longer time horizon has thus more severe adverse health effects than limited exposure.

For tenants who moved at least once, the prevalence of rot and noise relates positively to general practitioner visits. Likewise, poor lighting and rot increases mental healthcare utilization. Social tenants who moved pay more visits to a general practitioners and mental healthcare if rot is present in the home, with a higher magnitude than tenants. The prevalence of rot in the home environment thus has adverse health effects for both movers and non-movers, resulting in different health outcomes. Those exposed to a limited extent to rot experience economic health consequences in terms of general practitioner visits and mental healthcare, while long-term exposure results in increased medical specialist expenditure. Therefore, limited exposure to poor dwelling conditions appears to have mild physical and mental adverse health effects, whereas extensive exposure leads to severe physical health consequences.

The prevalence of specific dwelling problems in the home environment may vary for movers and non-movers. Table 22 below reports the proportion of tenants and social tenants experiencing either of the specific dwelling problems.

Table 22: Proportion of dwelling problems of tenants who ever moved

	Tenants		Social tenants	
	Never moved	Moved ever	Never moved	Moved ever
Dwelling problems:				
Too small	0.07	0.17	0.08	0.16
Too dark	0.04	0.03	0.04	0.03
Inadequate heating	0.05	0.07	0.04	0.08
Leaking roof	0.02	0.02	0.01	0.01
Damp walls/floors	0.07	0.06	0.09	0.07
Rotten frames/floors	0.04	0.05	0.03	0.04
Too noisy	0.21	0.24	0.19	0.29

Individuals who moved at least once are in general more likely to experience problems in the home. The prevalence of those dwelling problems related to increased demand for healthcare for movers (which are: inadequate lighting, rot, and noise – see tables 17 and 18) is however little different from non-movers, with the exception of noise annoyance. Nevertheless, dwelling problems may be a source of motivation for individuals to change residency. Given the difference in relation between dwelling problems for movers and non-movers, it is of interest to examine whether the specific problems which bear statistical relevance therein explain a change of residency.

Additional analysis (table 23 in the appendix) therefore estimates the effect of dwelling problems on the likelihood of tenants in general as well as social tenants to change residency[4]. Moderating terms are included for the statistical significant relationships in tables 17 and 18 (see appendix). This allows to estimate the effect of experiencing a dwelling problem and utilizing the correspondingly relevant type of healthcare service on the decision to move. Tenants indicating the dwelling to be too small and dark are more likely to change residency. If tenants both report inadequate lighting and make use of mental healthcare services, the likelihood to change residency becomes even stronger. Furthermore, inhabiting a dwelling which suffers from rot and having paid at least one visit to a general practitioner during the last year increases the likelihood to move. Social tenants are likely only to change residency when experiencing excessive noise in the home.

In general, however, likelihood to move for social tenants appears less dependent on dwelling problems, which may be related to the difficulty of changing residency in the social housing segment (Weinhold, 2015) and lower SES. Moreover, experiencing indoor hazards influences the decision to move and thus length of exposure to poor dwelling conditions. These findings therefore strengthen earlier conclusions about the extent of adverse health impacts of indoor hazards. Sections 8.2 and 8.3 are therefore robust to dwelling-specific effects and the decision of individuals to change residency.

Concluding, the analyses support the expectations of the research. In general, occupants of dwellings which contain indoor hazards report lower health status and more hindrance. The same holds for demand for health care services. The relation between indoor hazards and health varies by gender, with adverse health effects being more pronounced for females. Additionally, the results are significantly different for those individuals exposed less to dwelling specific effects, confirming the robustness of prior conclusions. As expected, the adverse health effects for social tenants are of a higher magnitude than tenants in general. Moreover, the main conclusions confirm the adverse health effects of poor housing condition.

---

[4] The analysis is estimated on the likelihood to move ever explained by specific dwelling problems. Interaction terms with types of healthcare service (dummies) are included based on significance of the specific dwelling problems and demand for healthcare following tables 17 and 18. See table 23 in the appendix for the estimation results.

8.5 Rental housing policy

This research finds adverse health effects of poor housing conditions for occupants of rental dwellings. While tenants are to a certain extent responsible for the quality of their dwelling, in general, the responsibility for maintaining housing conditions is outside the individual control and lies with the third-party, the owner. The Dutch rental housing policy includes various instruments regulating the quality of housing. The most important are: building regulations, enforcement options for local authorities, and legal repair duties of landlords (Meijer & Vijverberg, 2017). The Dutch Building Decree requires housing associations to comply with performance-based requirements related to safety, health, energy efficiency and the environment (Netherlands Enterprise Agency, 2012). Furthermore, based on the Housing Act and Building Decree, local authorities can undertake action if deemed necessary and can summon landlords to enhance dwelling quality (Meijer & Vijverberg, 2017). Last, landlords are under the Dutch Rent Regulation legally obliged to guarantee qualitative housing and are responsible to maintain, repair and replace (if necessary) parts of the dwelling.

The Netherlands, however, do not have a regulatory quality instrument in which the minimal quality level of housing is set. The results of this research imply that an enhancement of the quality of poor rental housing benefits tenants directly in terms of improved health. The housing institution making the investment, however, cannot directly benefit from the investment, thus resulting in a split incentive (Chegut et al., 2016). Embedding minimum requirements of housing quality in national housing policy prohibits the materialization of this divergence of interests. However, the Dutch Housing Act and Building Decree do not include insights from recent findings with respect to the adverse health effects of poor housing conditions (see i.e. Weinhold, 2015; Ayden et al., 2017). Incorporating insights thereof in housing policy increases occupant health and simultaneously reduces the economic health consequence of poor housing.

A barrier to developing effective housing policy, however, is the lack of information on indoor quality of the existing rental housing stock. Given the significance of housing condition as a determinant of occupant health, there is a need for increased transparency. The use of incentives and penalties may be incorporated to ensure adequate housing conditions. However, in order to ensure the enhancement of housing conditions, consistent monitoring and thorough inspection of housing quality is required.

8.5.1 The responsibility of social housing institutions

One of the main findings of this research is that the adverse health effects of indoor hazards are strongest for social tenants, even when controlling for all confounding factors. This is in line with the expectations of this study, given that occupants of social housing are those individuals positioned in the lowest income class, are lower educated, are more likely to be unemployed and in general experience poorer health. The results show that, especially with respect to the economic health consequence of poor housing, the magnitude of indoor hazards is considerably higher for social tenants. Improving health of social tenants, therefore, addresses the concern of affordability of healthcare.

Social housing institutions are responsible for the provision of adequate and affordable housing to individuals positioned in the social segment. The social housing institutions, especially, should therefore ensure qualitative housing conditions. However, the issue of a lack of transparency in housing quality is also a concern in the social segment, despite its size and the significant contribution of social tenants to public healthcare expenditure. The Housing Act from 2015 enables social tenants to command rents to be adjusted to housing characteristics[5], however, quality is a subjective measure therein and housing conditions are not required to be monitored on a regular basis. Given the strong relation between housing and health, public housing policy would benefit from more strict inspection of social housing condition.

8.5.2 Financial investments in healthy homes

Financial capital is required to enhance housing conditions and thus, directly, improve tenant health. Under the Housing Act, housing associations are required to split their SGEI[5] and non-SGEI activities. SGEI activities, which include social housing, are financed by secured loans from the Dutch Social Housing Guarantee Fund, non-SGEI activities have to be financed under customary market conditions (Capital Value, 2016). Whereas financiers face different financial considerations in terms of risk profile and required yields, irrespective of the capital provider, investments in housing conditions reduces risk in twofold. First, the value of the underlying collateral increases and, second, directly contributing to improved tenant health reduces public healthcare expenditure and increases human productivity. However, increased transparency of housing quality is required for the financial institution to estimate risk. Thus, indirectly, enhancing public welfare by financing housing improvement is in the financiers' interest.

---

5 Rents are regulated via the points valuation system, based on a variety of dwelling characteristics. See section 3 for more insights.

6 SGEI stands for Services of General Economic Interest. See section 3.2 for more information.

8.6 Limitations and future research

This research is subject to several limitations which should be kept in mind when interpreting the results. *First*, sample sizes are relatively small (2,332 tenants and 803 social tenants) and for the 9 years of available data, not all individuals participate each year[7]. To explore the causal relationship between dwelling condition and health, over-time variation is analysed. The gaps in years for specific individuals necessitate the exclusion of a number of observations, further reducing sample sizes and the potential to analyse overt-time variation. This makes proving causality methodologically challenging. *Second*, whereas the proportion of tenants in the sample is representative for the Dutch housing market, the proportion of social tenants is smaller than the true social segment. Participants can choose whether to indicate being a social tenant or not, thus the sample may be biased and not adequately represent the social segment. Similarly, the gender-ratio for the social sample is skewed towards females. *Third*, the LISS survey includes relatively few objective indoor quality measures. *Fourth*, as a result of limited intragroup variation in the measures of poor dwelling condition and health status, it is not possible to adequately estimate an individual fixed effects model as a robustness measure. The analysis therefore does not account for unobservable individual characteristics and instead relies on intergroup variation.

Future academic work in this field of study should address the data and methodological limitations discussed. In order to strengthen statistical causal inference from the analysis, the sample under research should span a longer timeframe and contain more intragroup variation. Further, the sample in this research is specific to the Dutch rental housing market, which is unique in Europe due to its proportion, the large social housing segment, and strong position of housing associations. As a result, the conclusions drawn may not be representative for other housing markets in developed European countries. It is valuable to extend the current research to countries as France, the United Kingdom, and Germany, in which the rental (and specifically social rental) housing represents a considerable proportion of the market. Furthermore, the results indicate that, while indoor hazards in general have a direct effect on self-reported health, the relation thereof on demand for healthcare services may be both mediated and moderated by poor self-assessed health status. Future research can extend this theory to explore both the direct and indirect effects of indoor hazards and economic health consequences.

---

[7] Tenants on average participate in the panel for 3.37 years (std. dev. = 2.39), social tenants for 2.81 years (std. dev. = 2.43). See section 5 for more information with respect to the data and sample sizes

9 Conclusion

This research contributes to the literature on housing and health by exploring the effect of indoor environmental hazards on occupant health. The adverse impact of poor housing condition on health is often assumed and appears evident. The majority of existing literature, however, explores the health effect of extremely poor dwelling conditions and is often based on developing countries. In addition to different underlying fundamentals, the baseline housing quality is considerable higher in developed countries. Therefore, conclusions drawn from prior work are not generalizable to developed countries. At the time of research, this is one of the first academic studies to explore the health effect of housing specifically for occupants of rental dwellings in the Netherlands with special attention to the social housing segment, the most vulnerable segment of society. Using the Dutch LISS Core Panel survey, the longitudinal character of the data is exploited to identify pathways between housing and health. The research is based on observations of 2,332 tenants and 803 social tenants from 2007 through 2016.

The analysis supports the expectations of the research. Occupants of dwellings which contain indoor hazards report poorer health, lower well-being and experience more hindrance. Tenants experience adverse subjective health effects up to 14% from inadequate heating, damp, and excessive noise. For social tenants, experiencing rot and excessive noise in their homes increases the magnitude of adverse subjective health effects up to 21%. Similar conclusions are drawn with respect to demand for health care services. Both tenants in general and social tenants inhabiting a dwelling which contains rot demand considerably more specialist health care and pay up to 5.6 more yearly visits to a medical specialist. Demand for healthcare varies strong between gender. Male tenants in general make more use of mental healthcare services when experiencing comfort-related dwelling problems. The effect of rot on demand for specialist health care services is most pronounced for females: female tenants, in general and in the social segment, pay 2.2 and 11.8 more yearly visits to a medical specialist, respectively. Furthermore, females experiencing excessive noise demand considerable more healthcare in general and pay more visits to a general practitioner *only if* they report lower subjective health status.

The results control for a variety of socioeconomic, demographic, and health behaviour characteristics. The conclusions hold for dwelling specific effects, as individuals with reduced exposure are excluded from the full model. Estimating the effect only for individuals who changed residency at least once yields considerable different results, indicating that the main results are robust for long-term health effects and dwelling-specific. Individuals who moved are found to pay more visits to a general practitioner and make more use of mental healthcare

services as a result of experiencing indoor environmental hazards. Additional analyses suggest that experiencing rot increases the likelihood for tenants in general, but not for social tenants, to change residency. The fact that no relationship is observed for social tenants may be due to the inability and difficulty of social tenants to change residency. Moreover, these findings strengthen the conclusion that indoor hazards have strong and persistent adverse health effects.

From a theoretical point of view, extending research in the area of housing and health economics provides insights into the health capital investment decision. It is therefore crucial to explore factors which affect demand for units of health. Individuals may face a trade-off between rent, health capital and the availability of financial resources. Social tenants however are limited in their decision-making due to financial constraints. Additionally, the economic health consequences of adverse housing condition appear to depend, in part, on self-assessed health status. As the strand of research is relatively unexplored, this research provides a useful contribution in exploring the effect of poor housing on health.

The conclusions have practical implications for financial investment considerations in rental housing quality. In the Netherlands, housing associations are responsible for providing adequate and affordable housing. These institutions are therefore responsible to limit and prevent tenant exposure to indoor hazards. Using the results of this study, housing associations should consider the quality of their existing stock as influential in health-related outcomes. Moreover, poor housing condition is a source of health deprivation. The adverse health effects are especially strong for social tenants; thus, social housing institutions bear a considerable responsibility to provide healthy housing. Consistent and strict monitoring of housing condition and the prevalence of indoor hazards enhances transparency and reduces the risk of financial investments in housing. Moreover, insights into the economic health consequences of indoor hazards contribute to the discussion of healthcare affordability.

References

Adams, P., Hurd, M., McFadden, D., Merrill, A., & Ribeiro, T. (2003). Health, wealthy, and wise? Tests for direct causal paths between health and socioeconomic status. *Journal of econometrics, 112*(1), 3-56.

Aedes. (2017, 10 18). *Onderzoek passend toewijzen: huurders in de knel*. Retrieved from www.aedes.nl

Alesina, A., & La Ferrara, E. (2000). Participation in Heterogeneous Communities. *Quarterly Journal of Economics, 115*, pp. 847-904.

Algan, Y., Hemet, C., & Laitin, D. (2016). The Social Effects of Ethnic Diversity at the Local Level: A Natural Experiment with Exogenous Residential Allocation. *Journal of Political Economy*, 696-733.

Almond, D. (2006). Is the 1918 Influenza Pandemic Over? Long-Term Effects of In Utero Influenza Exposure in the Post-1940 U.S. Population. *Journal of Political Economy, 114*(4), 672-710.

Anderson, J. (1973). Demographic Factors Affecting Health Services Utilization: A Causal Model. *Medical Care, 11*(2), 104-120.

Antonovsky, A. (1967). Social Class, Life Expectancy and Overall Mortality. *The Milbank Memorial Fund Quarterly, 45*(2), pp. 31-73.

Aydin, E., Eichholtz, P., Kok, N., & Palacios, J. (2017). On the Economics of Health in Homes. Retrieved from http://corporate-engagement.com/files/file/AEKP%20Housing%20EEA%20version.pdf

Barro, R. (1996). *Health, human capital and economic growth*. Pan American Health Organization.

Becker, G. (1962). Investment in Human Capital: A Theoretical Analysis. *Journal of Political Economy. Part 2: Investment in Human Beings, 70*(5), 9-49.

Becker, G. (1964). Human Capital. In N. B. Research. New York: Columbia University Press.

Becker, G. (1966). Human Capital and the Personal Distribution of Income: An Analytical Approach.

Becker, G. (1975). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. New York: NBER.

Ben-Porath, Y. (1967). The Production of Human Capital and the Life Cycle of Earnings. *Journal of Political Economy, 75*(4), 352-365. Retrieved from http://www.jstor.org/stable/1828596

Benzeval, M., & Judge, K. (2001). Income and health: the time dimension. *Social Science & Medicine, 52*(9), 1371-1390.

Bertakis, K., Azari, R., Helms, L., Callahan, E., & Robbins, J. (2000). Gender differences in the utilization of health care services. *The Journal of Family Practice, 49*(2), 147-152.

Bilger, M., & Carrieri, V. (2013). Health in the cities: when the neighbourhood matters more than income. *Journal of Health Economics, 32*(1), 1-11.

Björnberg, A. (2017). *Euro Health Consumer Index 2016*. Health Consumer Powerhouse.

Blackburn, C. (1990). Povert and Health: Working with Families. In M. Keynes. United Kingdom: Open University Press.

Bloom, D., Canning, D., & Sevilla, J. (2004). The Effect of Health on Economic Growth: A production Function Approach. *World Development, 32*(1), 1-13.

Bluhm, G., Nordling, E., & Berglind, N. (2004). Road traffic noise and annoyance - an increasing environmental health problem. *Noise and Health, 6*(24), 43-49.

BPD. (2016). *Duitsland, Frankrijk, Nederland; Woningmarkten in perspectief 2016*.

Bratt, R. H. (2002). Housing and Family Well-being. *Housing Studies, 17*(1), 13-26.

Britten, R. H. (1938). Housing and Health. *American Journal of Public Health, 28*, 957-960.

Broderick, A., Byrne, M., Armstrong, S., Sheahan, J., & Coggins, A. (2017). A pre and post evaluation of indoor air quality, ventilation, and thermal comfort in retrofitted co-operative social housing. *Building and Environment, 122*, 126-133.

Capital Value. (2016). *An analysis of the Dutch residential (investment) market 2016*. ING.

Cattaneo, M., Galiani, S., Gertler, P., Martinez, S., & Titiunik, R. (2009). Housing, Health, and Happiness. *American Economic Journal: Economic Policy, 1*(1), 75-105. Retrieved from http://www.aeaweb.org/articles.php?doi

CBS. (2017). *Voorraad woningen; eigendom, type verhuurder, bewoning, regio*. Retrieved 10 17, 2017, from www.statline.cbs.nl.

CentERdata. (2017). *Abou the Panel*. Retrieved from https://www.lissdata.nl/about-panel

Chegut, A., Eichholtz, P., & Holtermans, R. (2016). Energy efficiency and economic value in affordable housing. *Energy Policy, 97*, 39-49.

Contoyannis, P., Jones, A., & Rice, N. (2004). The Dynamics of Health in the British Household Panel Survey. *Journal of Applied Econometrics, 19*, 473-503.

Cropper, M. (1977). Health, Investment in Health, and Occupational Choice. *Journal of Political Economy, 85*(6), 1273-1294.

Currie, J. (2009). Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development. *Journal of Economic Literature, 47*(1), 87-122.

Currie, J., Neidell, M., & Schmieder, J. (2009). Air pollution and infant health: Lessons from New Jersey. *Journal of Health Economics, 28*, 688-703. doi:doi: 10.1016/j.jhealeco.2009.02.001

Cutler, D., & Lleras-Muney, A. (2006). *Education and Health: Evaluating Theories and Evidence*. NBER Working Paper No. 12352, The National Bureau of Economic Research.

Deschenes, O. (2014). Temperature, human health, and adaption: A review of the empirical literature. *Energy Economics, 46*, 606-619.

Deschenes, O., Greenstone, M., & Guryan, J. (2009). Climate change and birth weight. *American Economic Review, 99*(2), 211-217.

Doiron, D., Fiebig, D., Johar, M., & Suziedelyte, A. (2014). Does self-assessed health measure health? *Journal of Applied Economics, 47*(2), 180-194.

Duflo, E., Greenstone, M., & Hanna, R. (2008). Indoor Air Pollution, Health and Economic Well-being. *1*(1). Retrieved from http://sapiens.revues.org/130

Dunn, J. (1999). Housing and Health Inequalities: Review and Prospects for Research. *Housing Studies*.

Dunn, J., & Hayes, M. (2000). Social inequality, population health, and housing: a study of two Vancouver neighbourhoods. *Social Science & Medicine, 51*(4), 563-587.

Dunn, J., Hayes, M., Hulchanski, D., Hwang, S., & Potvin, L. (2006). Housing as a Socio-Economic Determinant of Health. *Canadian Journal of Public Health, 97*(3), 11-15.

Dutch Ministry of Foreign Affairs. (2013). *Wonen in ongewone tijden: De resultaten van het Woononderzoek Nederland 2012*. Den Haag.

Dutch Ministry of Foreign Affairs. (2016). *Wonen in beweging: De resultaten van het WoonOnderzoek Nederland 2015*. Den Haag.

Ehrlich, I., & Chuma, H. (1990). A model of the demand for longevity and the value of life extension. *Journal of Political Economy, 98*(4), 761-782.

Elsinga, M., & Wassenberg, F. (2007, 7). Social Housing in the Netherlands, Chapter 10. *OTB Research Institute for Housing, Urban and Mobility Studies*.

EU Parliament. (2003). Energy performance of buildings. *Directive 2002/91/EC*, (pp. 65-71).

EU Parliament. (2010). Energy performance of building. *Directive 2010/31/EU*, (pp. 13-35).

European Observatory on the Social Situation. (2005). *Health Status and Living Conditions in an Enlarged Europe*. The London School of Economics and Political Science.

Evans, G. (2003). The Built Environment and Mental Health. *Journal of Urban Health, 80*(4), 536-549.

Evans, G., Kantrowitz, E., & Eshelman, P. (2002). Housing Quality and Psychological Well-Being Among the Elderly Population. *Journal of Gerontology: PSYCHOLOGICAL SCIENCES, 57B*(4), 381-383.

Finance Ideas. (2016). *Onderzoek haalbaarheid gemiddeld label b*.

Finance Ideas. (2017). *De financiele haalbaarheid van een CO2 neutrale energievoorziening in de corporatiesector*.

Fisher, I. (1906). The Nature of Capital and Income.

Frijters, P., Haisken-DeNew, J., & Shields, M. (2005). The causal effect of income on health: Evidence from German reunification. *Journal of Health Economics, 24*(5), 997-1017.

Fuchs, V. (1966). The Contribution of Health Services to the American Economy. *Milbank Memorial Fund, 4*, 65-102.

Fuller-Thomson, E., Hulchanski, D., & Hwang, S. (2000). The Housing/Health Relationship: What Do We Know? *Review on Environmental Health, 15*(1-2), 109-133.

Galama, T. (2011). *A Theory of Socioeconomic Disparities in Health*. University of Tilburg.

Gibson, M., Petticrew, M., Bambra, C., Sowden, A., Wright, K., & Whitehead, M. (2011). Housing and health inequalities: A synthesis of systematic reviews od interventions aimed at different pathways linking housing and health. *Health & Place, 17*(1), 175-184.

Grossman, M. (1972). On the Concept of Health Capital and the Demand for Health. *The Journal of Political Economy, 80*(2), 223-255.

Grossman, M. (1999). *The Human Capital Model of the Demand for Health*. NBER Working Paper no. 7078, The National Bureau of Economic Research.

Hanna, R., & Oliva, P. (2015). The effect of pollution on labor supply: Evidence from a natural experiment in Mexico City. *Journal of Public Economics, 122*, 68–79.

Hanna, R., Duflo, E., & Greenstone, M. (2016). Up in Smoke: The Influence of Household Behavior on the Long-Run Impact of Improved Cooking Stoves. *American Economic Journal: Economic Policy, 8*(1), 68-79.

Hernandez, L., & Blazer, D. (2006). *Genes, Behavior, and the Social Environment: Moving Beyond the Nature/Nurture Debate*. Institute of Medicine (US) Committee on Assessing

Interactions Among Social, Behavioral, and Genetic Factors in Health. Washington: National Academies Press.

Hoekstra, J. (2013). Social Housing in the Netherlands: the development of the Dutch social housing model. *Responder: Linking SCP and Growth Debates*.

Holland, S. (2017). Firm investment in human health capital. *Journal of Corporate Finance, 46*, 374-390.

Hood, E. (2005). Dwelling Disparities: How Poor Housing Leads to Poor Health. *Environmental Health Perspective, 113*(5), 310-317.

Jacobs, D. (2011). Environmental Health Disparities in Housing. *American Journal of Public Health, 101*(1), 115-122.

Keithley, J., Byrne, D., Harrisson, S., & McCarthy, P. (1984). Health and housing conditions in public sector housing estates. *Public Health, 98*(6), 344-353.

Klepeis, N., Nelson, W., Ott, W., Robinson, J., Tsanh, A., Switzer, P., . . . Engelmann, W. (2001). The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants. *Journal of Exposure Analysis and Environmental Epidemiology, 11*, 231–252.

Lennock, J., & Ehrenpreis, D. (2003, May). Good health: a cornerstone of development. *OECD Observer, 237*.

Leventhal, T., & Brooks-Gunn, J. (2003). Moving to Opportunity: an Experimental Study of Neighborhood Effects of Mental Health. *American Journal of Public Health, 93*(9), 1576-1583.

Lewis, A. (1954). Economic Development with Unlimited Supplies of Labour. *The Manchester School, 22*(2), 139-191.

Lijzinga, J., & Boertien, D. (2016). *De rol van woningcorporaties op de woningmarkt - een WoOn 2015-verkenning*. Companen - advies voor woningmarkt en leefomgeving. Anrhem: Ministerie van Binnenlandse Zaken en Koninkrijksrelaties.

Lleras-Muney, A. (2005). The Relationship Between Education and Adult Mortality in the United States. *Review of Economic Studies, 72*, 189-221.

Low, C., Lai, P., Tse, W., Tsui, C., Lee, H., & Hui, P. (2013). Exploring tuberculosis by types of housing development. *Social Science & Medicine, 87*, 77-83.

Ludwig, J., Duncan, G., Gennetian, L., Katz, L., Kessler, R., Kling, . . . Sanbonmatsu, L. (2012). Neighbourhood Effects on the Long-term well-being of low income adults. *Science, 337*, 1505-1510.

Macintyre, S., Ellaway, A., Hiscock, R., Kearns, A., Der, G., & McKay, L. (2003). What features of the home and the area might help to explain observed relationships between housing tenure and health? Evidence from the west of Scotland. *Health & Place, 9*(3), 207-218.

Maisonneuve de la, C., & Martins, J. (2013). *Public spending on health and long-term care: a new set of projections*. Paris: OECD.

Maisonneuve de la, C., & Martins, J. (2015). The future of health and long-term care spending. *OECD Journal: Economic Studies*.

Marsh, A., Gordon, D., Heslop, P., & Pantazis, C. (2000). Housing Deprivation and Health: A Longitudinal Analysis. *Housing Studies, 15*(3), 411-428.

Mayer, N. S. (1981). Rehabilitation decisions in rental housing: An empirical analysis. *Journal of Urban Economics, 10*(1), 76-94.

McGregor, M. (1963). Housing and Health. *Public Health, 77*(2), 72-81.

Meijer, F., & Vijverberg, G. (2017). *Quality of social housing in the Netherlands and England*. Delft, the Netherlands: OTB Research Institute for Housing, Urban and Mobility Studies, Delft University of Technology.

Mendell, M., Mirer, A., Cheung, K., Tong, M., & Douwes, J. (2011). Respiratory and Allergic Health Effects of Dampness, Mold, and Dampness-Related Agents: A Review of the Epidemiologic Evidence. *Environmental Health Perspectives, 119*, 748-756.

Mincer, J. (1958). Investment in Human Capital and Personal Income Distribution. *Journal of Political Economy, 66*(4), 281-302.

Mincer, J. (1984). Human Capital and Economic Growth. *Economics of Education Review, 3*(3), 195-205.

Mirowsky, J., & Ross, C. (1998). Education, Personal Control, Lifestyle and Health: A Human Capital Hypothesis. *Research on Aging, 20*(4), 415-449.

Mladovsky, P., Allin, S., Masseria, C., Hernandez-Quevedo, C., McDaid, D., & Mossialos, E. (2009). *Health in the European Union: Trends and analysis*. Observatory Studies Series n. 19, European Observatory on Health Systems and Policies.

Morabito, M., Modesti, A., Cecchi, P., Crisci, L., Orlandini, A., Maracchi, S., . . . Gensini, G. (2005). Relationships between weather and myocardial infartion: a biometeorological approach. *International Journal of Cardiology, 105*(3), 288-293.

Mushkin, S. (1962). Health as an Investment. *J.P.E., 70*(2), 129-157.

Muurinen, J. (1982). Demand for Health: A Generalised Grossman Model. *Journal of Health Economics, 1*, 5-28.

Neidell, M. (2004). Air pollution, health, and socio-economic status: the effect of outdoor air quality on childhood asthma. *Journal of Health Economics, 23*(6), 1209-1236.

Nelson, R., & Phelps, E. (1966). Investments in Humans, Technological Diffusion, and Economic Growth. *The American Economic Review, 56*(1/2), 69-75.

Netherlands Enterprise Agency. (2012). *Building Decree 2012*. Retrieved from Building regulations: https://business.gov.nl/regulation/building-regulations/

Pega, F., & Wilson, N. (2016). A Systematic Review of Health Economic Analyses of Housing Improvement Interventions and Insecticide-Treated Bednets in the Home. *PLOS ONE*, pp. 1-29.

Pekkonen, M., Du, L., Skön, J., Raatikainen, M., & Haverinen-Shaughnessy, U. (2015). The influence of tenure status on housing satisfaction and indoor environmental quality in Finnish apartment buildings. *Building and Environment, 89*, 134-140.

Pollack, C., von dem Knesebeck, O., & Siegrist, J. (2004). Housing and health in Germany. *Epidemiol Community Health, 58*, 216-222.

Rauh, V., Landrigan, P., & Claudio, L. (2008). Housing and health: intersection of poverty and environmental exposures. *Annals of the New York Academy of Sciences, 1136*(1), 276-288.

Rijksoverheid. (2016). *Grote verschillen zoektijd sociale huurwoning*. Retrieved from https://www.rijksoverheid.nl/actueel/nieuws/2016/05/24/grote-verschillen-zoektijd-sociale-huurwoning

Rijksoverheid. (2017). *Staat van de Volkshuisvesting 2017*. Dutch Ministry of the Interior and Kingdom Affairs.

Rijksoverheid. (n.d.a). *Eerstelijnszorg*. Retrieved 1 1, 2018, from https://www.rijksoverheid.nl/onderwerpen/eerstelijnszorg

Rijksoverheid. (n.d.b). *Huurprijs en puntentelling*. Retrieved September 25, 2017, from https://www.rijksoverheid.nl/onderwerpen/huurprijs-en-puntentelling

Ross, C., Mirowsky, J., & Goldsteen, K. (1990). The Impact of the Family on Health: The Decade in Review. *Journal of Marriage and the Family, 52*(4), 1059-1078.

Roy, A. (1950). The Distribution of Earnings and Individual Outpu. *Economic Journal, 60*, 489-505.

Scherpenzeel, A. (2011). *Data Collection in a Probability-Based Internet Panel: How the LISS Panel Was Built and How It Can Be Used*. SAGE journals. Bulletin of Sociological Methodology.

Schlenker, W., & Walker, W. (2016). Airports, Air pollution, and COntemporeaneous Health. *Review of Economic Studies, 83*(2), 768-809.

Schultz, T. (1961). Investment in Human Capital. *The American Economic Review, 51*(1), 1-17.

Shaw, M. (2004). Housing and Public Health. *Annual Review of Public Health*, 397-418.

Shepherd, D., McBride, D., Welch, D., Dirks, K., & Hill, E. (2011). Evaluating the impact of wind turbine noise on health-related quality of life. *Noise and Health, 13*(54), 333-339.

Smith, A. (1776). An Inquiry into the Nature And Causes of the Wealth of Nations. Book 2: Of the Nature, Accumulation, and Employment of Stock. London.

Stiglitz, J., Sen, A., & Fitoussi, J. (2009). *The Measurement of Economic Performance and Social Progress*. OFCE. European Comission.

Strauss, J., & Thomas, D. (1998). Health, Nutrition, and Economic Development. *Journal of Economic Literature, 36*, 766-817.

The World Bank. (n.d.). *Health expenditure, public (% of GDP)*. Retrieved 9 1, 2017, from https://data.worldbank.org/indicator/SH.XPD.PUBL.ZS

Thunen von, H. (1875). Der isolierte Staat. reproduced by the Comp. Educ. Center, University of Chicago.

Turunen, M., Iso-Markku, K., Pekkonen, M., & Haverinen-Shaughnessy, U. (2017). Statistical associations between housing quality and health among Finnish households with children - Results from two (repeated) national surveys. *Science of the Total Environment, 574*, 1580-1587.

Warner, S., Dennis, S., & Stephen, C. (2002). Economic Outcomes in Later Life: Public Policy, Health and Cumulative Advantage. *Annual Review of Gerontology and Geriatrics, 22*.

Weinhold, D. (2015). *Sick of noise: the health effects of loud neighbours and urban din*. London: Grantham Research Institute on Climate Change and the Environment. Working Paper no. 213.

Wells, N. M., & Harris, J. D. (2007). Housing quality, psychological distress, and the mediating role of social withdrawal: A longtitudinal study of low-income women. *Journal of Environmental Psychology, 27*, 69-78.

Whitehead, C., Scanlon, K., Monk, S., Tang, C., Ha ner, M., Lunde, J., . . . Voigtländer, M. (2016). *Understanding the Role of Private Renting: A Four- country Case Study*. Copenhagen: Boligøkonomisk Videncente.

WHO. (2007). *Large analysis and review of European housing and health status (LARES)*. Copenhagen.

WHO. (2009). *Social inequalities and their influence on housing risk factors and health*. A data report based on the WHO LARES database, Copenhagen.

WHO. (2010). *Developing guidance for health protection in the built environment mitigation and adaptation responses*. Meeting Report, Geneva.

WHO. (2017a). *Health Impact Assessment (HIA): Health inequality and inequity*. Retrieved October 6, 2017, from http://www.who.int/hia/about/glos/en/index1.html

WHO. (2017b). *Health Impact Assessment (HIA): The determinants of health*. Retrieved September 10, 2017, from http://www.who.int/hia/evidence/doh/en/

Wilkinson, D. (1999). *Poor Housing and Ill Health*. Housing Research Branch, The Scottish Office: Central Research Unit.

Appendix

Table 2: Descriptive statistics for the entire sample

	N	Mean	SD
Health Measures			
General health perception (1-5)	52,134	3.12	0.77
Bad/Poor health (1=yes)	52,134	0.16	
Happiness (0-10)	36,557	7.57	1.28
Healthcare utilization (last year):	45,420	4.17	8.48
Hindrance of health status:	52,134	0.33	
Dwelling Condition			
Dwelling satisfaction (0-10)	24,919	7.95	1.49
Dwelling problems (1=yes)	25,209	0.23	
Comfort problems (1=yes)	25,209	0.08	
Hazard problems (1=yes)	25,209	0.09	
Noise problems (1=yes)	25,209	0.12	
Dwelling Characteristics			
Dwelling Typology:			
Detached (1=yes)	25,375	0.14	
Corner lot (1=yes)	25,375	0.14	
Duplex house (1=yes)	25,375	0.14	
Row house (1=yes)	25,375	0.29	
Apartment (1=yes)	25,375	0.23	
Other (1=yes)	25,375	0.07	
Number of rooms	25,318	4.36	1.45
Monthly rent (in euros)	6,966	508.30	210.81
Dwelling value (in euros)	12,017	303,654	1,032,987
External Characteristics			
Vicinity satisfaction (0-10)	25,053	7.76	1.53
Vicinity problems (1=yes)	25,209	0.33	

Table 2 (continued): Descriptive statistics for the entire sample

	N	Mean	SD
Household Characteristics			
Tenant (1=yes)	25,372	0.31	
Homeowner (1=yes)	25,372	0.67	
Monthly household income (euros)	16,529	2,944.79	5,259.35
Rent benefit (1=yes)	6,502	0.35	
Residency dwelling (years)	25,314	16.12	13.11
Respondent moved ever (1=yes)	38,610	0.24	
Regular absenteeism (1=yes)	25,247	0.02	
Household size	52,132	2.65	1.32
Household members per room	25,318	0.54	0.30
Household Typology			
Partner (1=yes)	37,662	0.77	
Living with partner (1=yes)	37,676	0.70	
Married (1=yes)	37,676	0.58	
Household with children (1=yes)	52,132	0.43	
Number of children	52,132	0.86	1.15
Respondent Characteristics			
Gender (1=male)	52,132	0.46	
Age of respondent	52,132	48.93	17.28
Health characteristics:			
Ever smoked (1=yes)	51,947	0.58	
Currently smokes (1=yes)	51,946	0.20	
Regular drinker (1=yes)	51,933	0.33	
Practices sports (1=yes)	43,007	0.53	
BMI	51,881	25.43	4.53
Individual is working (1=yes)	52,131	0.53	
Individual is studying (1=yes)	52,131	0.09	
Higher education degree (1=yes)	42,768	0.27	

Table 4: Household and dwelling characteristics per dwelling condition

Dwelling conditions	(1) No problem	(2) Problem
Dwelling typology		
Detached	0.92	0.08
Corner lot	0.79	0.21
Duplex house	0.87	0.13
Row house	0.77	0.23
Apartment	0.65	0.35
Other	0.71	0.29
Number of rooms	4.51	3.83
	(1.40)	(1.50)
Monthly rent (euros)	526.52	479.99
	(185.65)	(242.69)
Dwelling value (euros)	315,605	236,271
	(1,114,465)	(280,354)
Vicinity satisfaction	7.98	6.99
	(1.35)	(1.83)
Monthly household income (euros)	3,014.45	2,323.34
	(5,828.53)	(2,302.55)
Individual is an owner	0.73	0.45
Individual is a tenant	0.25	0.53
Tenant receives rent benefit	0.35	0.34
Age of respondent	55.03	47.90
	(15.29)	(15.09)

Notes: Standard deviation for continuous variables in parentheses.

Table 6: Dwelling condition and health status measures

Panel A: Reported general health perception for the entire sample by dwelling condition for different income-, age- and tenancy groups

	Net Household Income				Respondent Age				Tenancy Status	
	1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile	Rental dwelling	Owner occupied
No dwelling problems	2.93	3.05	3.14	3.28	3.40	3.18	3.05	2.94	2.96	3.13
Dwelling with problem	2.77	3.03	3.02	3.17	3.26	3.00	2.75	2.77	2.90	3.04

Panel B: Proportion of individuals of the entire sample reporting poor health status for different income-, age-, and tenancy groups

	Net Household Income				Respondent Age				Tenancy Status	
	1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile	Rental dwelling	Owner occupied
No dwelling problems	0.25	0.19	0.13	0.10	0.07	0.12	0.18	0.23	0.23	0.14
Dwelling with problem	0.36	0.19	0.18	0.18	0.13	0.19	0.34	0.33	0.28	0.19

Panel C: Reported happiness for the entire sample by dwelling condition for different income-, age- and tenancy groups

	Net Household Income				Respondent Age				Tenancy Status	
	1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile	Rental dwelling	Owner occupied
No dwelling problems	7.38	7.67	7.75	7.88	7.65	7.56	7.58	7.69	7.38	7.71
Dwelling with problem	6.78	7.28	7.35	7.56	7.37	7.09	6.88	7.23	6.97	7.33

Table 6 (continued): Dwelling condition and health status measures

Panel D: Proportion of individuals of the entire sample reporting poor hindrance as a result of health-related problems for different income-, age-, and tenancy groups

	Net Household Income				Respondent Age				Tenancy Status	
	1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile	Rental dwelling	Owner occupied
No dwelling problems	0.41	0.32	0.27	0.22	0.27	0.27	0.32	0.37	0.42	0.28
Dwelling with problem	0.55	0.36	0.36	0.32	0.36	0.40	0.51	0.49	0.50	0.36

Panel E: Total healthcare services utilization by individuals of the entire sample during the last year for different income-, age- and tenancy groups

	Net Household Income				Respondent Age				Tenancy Status	
	1st quartile	2nd quartile	3rd quartile	4th quartile	1st quartile	2nd quartile	3rd quartile	4th quartile	Rental dwelling	Owner occupied
No dwelling problems	4.65	4.11	3.67	3.18	3.47	3.30	3.86	5.30	5.84	3.61
Dwelling with problem	6.77	4.44	3.97	3.51	4.77	4.54	5.76	5.57	6.10	3.76

Table 7: Descriptive statistics for tenants

	N	Mean	SD
Health Measures			
General health perception (1-5)	7,851	2.93	0.80
Bad/Poor health (1=yes)	7,851	0.26	
Happiness (0-10)	6,376	7.22	1.52
Healthcare utilization (last year):			
Total health care utilization	7,621	5.95	12.95
General practitioner (visits)	7,762	3.04	6.35
Mental healthcare (visits)	7,635	1.09	8.49
Medical specialist (visits)	7,687	1.85	5.76
Hindrance of health status:			
Total hindrance	7,851	0.45	
Daily activity hindrance	7,841	0.34	
Social hindrance	7,841	0.29	
Work hindrance	7,840	0.34	
Dwelling Condition			
Dwelling satisfaction (0-10)	7,713	7.39	1.78
Dwelling problems (1=yes)	7,831	0.39	
Comfort problems (1=yes)	7,831	0.15	
Hazard problems (1=yes)	7,831	0.15	
Noise problems (1=yes)	7,831	0.24	
Dwelling problems:			
Too small (1=yes)	7,831	0.12	
Too dark (1=yes)	7,831	0.04	
Inadequate heating (1=yes)	7,831	0.06	
Leaking roof (1=yes)	7,831	0.02	
Damp walls or floors (1=yes)	7,831	0.07	
Rotten frames/floors (1=yes)	7,831	0.04	
Too noisy (1=yes)	7,831	0.24	
No problems at all (1=yes)	7,831	0.61	
Dwelling Characteristics			
Dwelling Typology:			
Detached (1=yes)	3,608	0.02	
Corner lot (1=yes)	3,443	0.27	
Duplex house (1=yes)	3,550	0.07	
Row house (1=yes)	7,279	0.32	
Apartment (1=yes)	5,785	0.64	
Other (1=yes)	1,707	0.33	
Number of rooms	7,847	3.47	1.21
Monthly rent (euros)	6,894	510.16	209.23

Table 7 (continued): Descriptive statistics for tenants

	N	Mean	SD
External Characteristics			
Vicinity satisfaction (0-10)	7,752	7.31	1.77
Vicinity problems (1=yes)	7,831	0.44	
Vicinity problems:			
Neighbour noise annoyance (1=yes)	7,831	0.32	
Street noise annoyance (1=yes)	7,831	0.14	
Stench, dust or dirt (1=yes)	7,831	0.07	
Vandalism or crime (1=yes)	7,831	0.12	
None of these (1=yes)	7,831	0.67	
Household Characteristics			
Monthly household income (euros)	3,141	2,142.65	7,385.67
Residency dwelling (years)	7,845	14.17	13.34
Respondent moved ever (1=yes)	7,851	0.34	
Regular absenteeism (1=yes)	7,818	0.03	
Household size	7,851	1.76	1.03
Household members per room	7,847	0.55	0.35
Household Typology			
Partner (1=yes)	6,521	0.54	
Living with partner (1=yes)	6,523	0.42	
Married (1=yes)	6,523	0.33	
Household with children (1=yes)	7,851	0.19	
Number of children	7,851	0.33	0.78
Respondent Characteristics			
Gender (1=male)	7,851	0.44	
Age of respondent	7,851	53.11	17.70
Health characteristics:			
Ever smoked (1=yes)	7,835	0.63	
Currently smokes (1=yes)	7,835	0.26	
Regular drinker (1=yes)	7,833	0.30	
Practices sports (1=yes)	7,524	0.44	
BMI	7,819	26.16	5.06
Individual is working (1=yes)	7,850	0.42	
Individual is studying (1=yes)	7,850	0.06	
Higher education degree (1=yes)	7,850	0.02	

Table 8: Household and dwelling characteristics per dwelling condition for tenants

Dwelling conditions	No problem		Problem		Comfort		Hazard		Noise	
	(1) Tenants	(2) Social tenants	(3) Tenants	(4) Social tenants	(5) Tenants	(6) Social tenants	(7) Tenants	(8) Social tenants	(9) Tenants	(10) Social tenants
Dwelling typology										
Detached	0.83	1.00	0.17		0.05		0.16		0.03	
Corner lot	0.62	0.60	0.38	0.40	0.08	0.08	0.16	0.17	0.24	0.26
Duplex home	0.60	0.65	0.40	0.35	0.08	0.10	0.24	0.25	0.25	0.25
Row house	0.67	0.66	0.33	0.34	0.09	0.10	0.13	0.15	0.22	0.23
Apartment	0.59	0.59	0.41	0.41	0.20	0.20	0.14	0.11	0.24	0.26
Other	0.52	0.58	0.48	0.43	0.26	0.24	0.22	0.19	0.27	0.25
Number of rooms	3.57	3.43	3.31	3.32	2.75	2.69	3.50	3.65	3.44	3.42
	(1.09)	(0.99)	(1.36)	(1.17)	(1.32)	(1.05)	(1.40)	(1.17)	(1.40)	(1.16)
Monthly rent (euros)	528.83	473.46	481.21	443.65	460.59	424.72	483.83	441.04	476.37	442.35
	(182.52)	(113.35)	(242.66)	(120.79)	(205.33)	(124.02)	(316.34)	(114.92)	(270.56)	(119.85)
Vicinity satisfaction	7.69	7.69	6.70	6.46	6.40	6.24	6.71	6.32	6.52	6.26
	(1.54)	(1.70)	(1.94)	(2.03)	(1.97)	(2.07)	(2.03)	(2.06)	(2.07)	(2.15)
Monthly household income (euros)	2,353.48	1,771.17	1,783.09	1,097.60	1,730.20	970.42	1,813.50	1,033.26	1,771.55	1,150.44
	(9,193.00)	(8,108.05)	(1,749.40)	(1,005.24)	(1,727.31)	(648.55)	(1,584.92)	(881.37)	(1,879.77)	(1,152.55)
Age of respondent	56.72	58.58	47.40	48.88	43.57	45.94	47.39	49.42	47.22	48.56
	(17.61)	(17.47)	(16.26)	(15.39)	(15.87)	(16.42)	(16.12)	(13.86)	(15.64)	(14.77)

Notes: Standard deviation for continuous variables in parentheses.

Table 9: Dwelling condition and health status measures for all tenants

Panel A: Subjective health measures for different dwelling problems by tenants in general and social tenants

Dwelling conditions	No problem		Problem		Comfort		Hazard		Noise	
	(1) Tenants	(2) Social tenants	(3) Tenants	(4) Social tenants	(5) Tenants	(6) Social tenants	(7) Tenants	(8) Social tenants	(9) Tenants	(10) Social tenants
General health perception	2.96	2.80	2.90	2.72	2.96	2.80	2.89	2.64	2.84	2.69
Poor health status	0.23	0.32	0.28	0.38	0.26	0.34	0.28	0.43	0.30	0.41
Happiness	7.38	7.18	6.97	6.55	6.91	6.56	6.94	6.33	6.90	6.45
Total hindrance	0.42	0.51	0.50	0.64	0.47	0.61	0.48	0.66	0.51	0.63
Daily activity hindrance	0.32	0.40	0.35	0.48	0.32	0.43	0.33	0.51	0.32	0.49
Social hindrance	0.25	0.34	0.35	0.46	0.34	0.44	0.34	0.51	0.37	0.46
Work hindrance	0.31	0.40	0.40	0.52	0.38	0.48	0.40	0.55	0.41	0.52

Panel B: Healthcare services utilization during the last year for different dwelling problems by tenants in general and social tenants

Dwelling conditions	No problem		Problem		Comfort		Hazard		Noise	
	(1) Tenants	(2) Social tenants	(3) Tenants	(4) Social tenants	(5) Tenants	(6) Social tenants	(7) Tenants	(8) Social tenants	(9) Tenants	(10) Social tenants
Total health care utilization	5.84	7.84	6.10	8.82	5.99	8.12	5.85	8.20	6.52	9.36
General practitioner	3.09	4.05	2.98	3.86	2.84	3.23	3.08	4.20	3.02	3.77
Mental healthcare	0.81	1.27	1.51	2.94	1.65	3.06	1.11	2.10	1.82	3.59
Medical specialist	1.97	2.56	1.64	2.00	1.53	1.78	1.68	1.89	1.70	2.00

Table 10: Descriptive statistics for social tenants

	N	Mean	SD
Health Measures			
General health perception (1-5)	2,259	2.77	0.80
Bad/Poor health (1=yes)	2,259	0.34	0.47
Happiness (0-10)	1,808	6.94	1.71
Healthcare utilization (last year):			
Total health care utilization	2,207	8.22	17.99
General practitioner (visits)	2,240	3.97	7.59
Mental healthcare (visits)	2,213	1.92	12.74
Medical specialist (visits)	2,221	2.34	8.80
Hindrance of health status:			
Total hindrance	2,259	0.56	
Daily activity hindrance	2,259	0.43	
Social hindrance	2,259	0.39	
Work hindrance	2,259	0.44	
Dwelling Condition			
Dwelling satisfaction (0-10)	2,217	7.42	1.75
Dwelling problems (1=yes)	2,252	0.39	
Comfort problems (1=yes)	2,252	0.15	
Hazard problems (1=yes)	2,252	0.14	
Noise problems (1=yes)	2,252	0.25	
Dwelling problems:			
Too small (1=yes)	2,252	0.12	
Too dark (1=yes)	2,252	0.05	
Inadequate heating (1=yes)	2,252	0.05	
Leaking roof (1=yes)	2,252	0.02	
Damp walls or floors (1=yes)	2,252	0.08	
Rotten frames/floors (1=yes)	2,252	0.03	
Too noisy (1=yes)	2,252	0.25	
No problems at all (1=yes)	2,252	0.61	
Dwelling Characteristics			
Dwelling Typology:			
Detached (1=yes)	70	0.09	
Corner lot (1=yes)	817	0.41	
Duplex house (1=yes)	215	0.24	
Row house (1=yes)	2,003	0.35	
Apartment (1=yes)	2,958	0.35	
Other (1=yes)	439	0.31	
Number of rooms	2,259	3.39	1.06
Monthly rent (euros)	2,102	461.71	117.12

Table 10 (continued): Descriptive statistics for social tenants

	N	Mean	SD
External Characteristics			
Vicinity satisfaction (0-10)	2,233	7.21	1.93
Vicinity problems (1=yes)	2,252	0.44	
Vicinity problems:			
Neighbour noise annoyance (1=yes)	2,252	0.33	
Street noise annoyance (1=yes)	2,252	0.15	
Stench, dust or dirt (1=yes)	2,252	0.07	
Vandalism or crime (1=yes)	2,252	0.13	
None of these (1=yes)	2,252	0.56	
Household Characteristics			
Monthly household income (euros)	1,002	1,524.12	6,494.47
Residency dwelling (years)	2,259	13.53	12.31
Respondent moved ever (1=yes)	2,259	0.33	
Regular absenteeism (1=yes)	2,258	0.02	
Household size	2,259	1.67	0.97
Household members per room	2,259	0.52	0.31
Household Typology			
Partner (1=yes)	1,870	0.40	
Living with partner (1=yes)	1,870	0.28	
Married (1=yes)	1,870	0.23	
Household with children (1=yes)	2,259	0.20	
Number of children	2,259	0.36	0.81
Respondent Characteristics			
Gender (1=male)	2,259	0.33	
Age of respondent	2,259	54.79	17.33
Health characteristics:			
Ever smoked (1=yes)	2,257	0.65	
Currently smokes (1=yes)	2,257	0.33	
Regular drinker (1=yes)	2,257	0.25	
Practices sports (1=yes)	2,170	0.39	
BMI	2,249	26.11	5.38
Individual is working (1=yes)	2,259	0.27	
Individual is studying (1=yes)	2,259	0.05	
Higher education degree (1=yes)	2,186	0.13	

Table 11 (full version): Estimation results of dwelling problems on health status for tenants

	(3) General health	(6) Poor health	(9) Happiness	(12) Hindrance	(15) Work hindrance
Dwelling problems:					
Too small	-0.082	0.086*	-0.578***	-0.009	-0.028
	(0.337)	(0.096)	(0.000)	(0.872)	(0.601)
Too dark	-0.055	-0.050	-0.196	0.003	-0.034
	(0.593)	(0.416)	(0.309)	(0.965)	(0.606)
Inadequate heating	-0.130	0.107*	-0.232	0.036	-0.007
	(0.151)	(0.052)	(0.176)	(0.556)	(0.908)
Leaking roof	-0.252	0.196	0.008	-0.085	-0.074
	(0.252)	(0.140)	(0.985)	(0.566)	(0.596)
Damp walls/ floors	-0.017	0.002	-0.048	0.070	0.131**
	(0.834)	(0.972)	(0.758)	(0.211)	(0.013)
Rotten frames/floors	0.223*	-0.185**	0.001	-0.086	-0.077
	(0.064)	(0.011)	(0.996)	(0.293)	(0.319)
Too noisy	-0.196***	0.141***	-0.350***	0.100***	0.100***
	(0.000)	(0.000)	(0.001)	(0.006)	(0.004)
Number of rooms	0.017	0.028	0.180*	-0.030	-0.035
	(0.736)	(0.346)	(0.050)	(0.369)	(0.271)
Log monthly rent	0.072	-0.037	0.232*	-0.097*	-0.047
	(0.327)	(0.409)	(0.093)	(0.052)	(0.316)
Vicinity problems (1=yes)	-0.114***	0.062**	-0.389***	0.077***	0.087***
	(0.007)	(0.016)	(0.000)	(0.008)	(0.001)
Log monthly household income	0.087***	-0.056***	0.023	-0.064***	-0.040***
	(0.000)	(0.000)	(0.554)	(0.000)	(0.002)
Residency dwelling (years)	0.005***	-0.002*	0.006	-0.005***	-0.003**
	(0.008)	(0.066)	(0.107)	(0.001)	(0.017)
Household size	-0.054	-0.048	-0.675***	0.074	0.044
	(0.651)	(0.501)	(0.002)	(0.359)	(0.562)
Household members per room	0.342	-0.008	1.018*	-0.252	-0.261
	(0.281)	(0.967)	(0.088)	(0.241)	(0.198)
Partner (1=yes)	-0.014	0.021	0.324**	-0.026	0.020
	(0.851)	(0.640)	(0.020)	(0.601)	(0.665)
Living with partner (1=yes)	-0.016	0.053	0.562**	-0.029	-0.010
	(0.899)	(0.489)	(0.017)	(0.738)	(0.898)
Married (1=yes)	0.064	-0.080	0.249	0.026	-0.052
	(0.528)	(0.195)	(0.186)	(0.706)	(0.425)
Household with children (1=yes)	-0.008	-0.035	-0.423	-0.062	0.019
	(0.958)	(0.694)	(0.120)	(0.530)	(0.841)
Number of children	-0.028	0.058	0.570***	-0.013	0.015
	(0.806)	(0.401)	(0.008)	(0.865)	(0.840)
Age of respondent	0.005**	-0.003**	0.020***	-0.003*	-0.005***
	(0.041)	(0.039)	(0.000)	(0.093)	(0.001)
Health characteristics:					
Ever smoked (1=yes)	-0.183***	0.088***	-0.322***	0.036	0.028
	(0.000)	(0.002)	(0.000)	(0.261)	(0.351)
Currently smokes (1=yes)	-0.017	-0.016	0.162	-0.029	-0.054
	(0.743)	(0.607)	(0.103)	(0.416)	(0.112)
Regular drinker (1=yes)	0.015	-0.028	-0.023	-0.110***	-0.074***
	(0.727)	(0.283)	(0.780)	(0.000)	(0.008)
Practices sports (1=yes)	0.137***	-0.101***	0.195**	-0.089***	-0.070**
	(0.001)	(0.000)	(0.015)	(0.002)	(0.010)
BMI	-0.027***	0.017***	-0.012	0.013***	0.008***
	(0.000)	(0.000)	(0.124)	(0.000)	(0.004)
Individual is working (1=yes)	0.340***	-0.214***	0.590***	-0.191***	-0.184***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Individual is studying (1=yes)	0.469**	-0.406***	0.834*	-0.210	-0.509***
	(0.045)	(0.004)	(0.054)	(0.184)	(0.001)
Higher education degree (1=yes)	0.192***	-0.035	0.205**	-0.107***	-0.103***
	(0.000)	(0.287)	(0.044)	(0.004)	(0.003)
Observations	5,019	5,019	5,019	5,019	5,019
R-squared	0.159	0.158	0.209	0.143	0.124
Number of individuals	1,225	1,225	1,225	1,225	1,225
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Movers and frequent absence excluded	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 12 (full version): Estimation results of dwelling problems on health status for social tenants

	(3) General health	(6) Poor health	(9) Happiness	(12) Hindrance	(15) Work hindrance
Dwelling problems:					
Too small	-0.039	0.084	-0.145	0.069	0.031
	(0.791)	(0.378)	(0.650)	(0.503)	(0.763)
Too dark	-0.229	0.053	-0.678	0.175	-0.048
	(0.224)	(0.663)	(0.100)	(0.181)	(0.710)
Inadequate heating	-0.199	0.014	-0.239	0.017	-0.061
	(0.273)	(0.907)	(0.536)	(0.894)	(0.626)
Leaking roof	0.013	-0.019	-2.470	-0.349	-0.145
	(0.980)	(0.956)	(0.129)	(0.343)	(0.688)
Damp walls/ floors	0.194	-0.005	0.168	0.035	0.072
	(0.168)	(0.953)	(0.573)	(0.720)	(0.454)
Rotten frames/floors	-0.218	0.045	-0.659	0.335**	0.401**
	(0.354)	(0.767)	(0.195)	(0.041)	(0.013)
Too noisy	-0.223**	0.213***	-0.527**	0.105	0.049
	(0.028)	(0.001)	(0.016)	(0.135)	(0.484)
Number of rooms	0.063	0.010	-0.039	-0.029	-0.050
	(0.469)	(0.861)	(0.835)	(0.630)	(0.398)
Log monthly rent	0.059	0.027	0.300	-0.174*	-0.119
	(0.672)	(0.763)	(0.316)	(0.075)	(0.215)
Vicinity problems (1=yes)	-0.248***	0.182***	-0.787***	0.193***	0.224***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Log monthly household income	0.071**	-0.037	0.011	-0.014	-0.020
	(0.046)	(0.110)	(0.882)	(0.560)	(0.420)
Residency dwelling (years)	0.001	-0.002	0.004	-0.001	0.001
	(0.728)	(0.385)	(0.569)	(0.736)	(0.765)
Household size	0.047	-0.105	-0.673	-0.081	-0.052
	(0.807)	(0.392)	(0.102)	(0.545)	(0.693)
Household members per room	0.401	0.072	0.198	-0.109	-0.329
	(0.420)	(0.823)	(0.854)	(0.752)	(0.335)
Partner (1=yes)	-0.084	0.027	0.012	-0.055	0.008
	(0.519)	(0.749)	(0.964)	(0.545)	(0.929)
Living with partner (1=yes)	0.007	-0.024	2.019***	-0.205	-0.167
	(0.977)	(0.882)	(0.000)	(0.247)	(0.338)
Married (1=yes)	0.234	-0.028	-0.416	0.239	0.153
	(0.303)	(0.849)	(0.390)	(0.130)	(0.326)
Household with children (1=yes)	-0.197	0.171	-0.499	0.201	0.367**
	(0.461)	(0.317)	(0.390)	(0.278)	(0.045)
Number of children	-0.182	0.043	0.739*	0.042	0.061
	(0.332)	(0.722)	(0.076)	(0.745)	(0.637)
Age of respondent	0.002	-0.001	0.021***	-0.001	-0.003
	(0.548)	(0.661)	(0.009)	(0.765)	(0.255)
Health characteristics:					
Ever smoked (1=yes)	-0.403***	0.176***	-0.636***	0.029	0.014
	(0.000)	(0.001)	(0.001)	(0.621)	(0.816)
Currently smokes (1=yes)	0.138	-0.129**	0.319	-0.004	-0.028
	(0.136)	(0.030)	(0.111)	(0.956)	(0.665)
Regular drinker (1=yes)	0.045	-0.023	0.007	-0.142***	-0.083
	(0.558)	(0.636)	(0.966)	(0.008)	(0.116)
Practices sports (1=yes)	0.180**	-0.135***	0.243	-0.064	-0.090*
	(0.020)	(0.007)	(0.145)	(0.229)	(0.087)
BMI	-0.031***	0.021***	-0.014	0.010*	0.001
	(0.000)	(0.000)	(0.362)	(0.057)	(0.898)
Individual is working (1=yes)	0.475***	-0.230***	1.009***	-0.189**	-0.150**
	(0.000)	(0.001)	(0.000)	(0.012)	(0.044)
Individual is studying (1=yes)	0.419	-0.328	0.582	-0.050	-0.412*
	(0.181)	(0.103)	(0.381)	(0.818)	(0.055)
Higher education degree (1=yes)	-0.162	0.114	0.365	0.005	-0.056
	(0.181)	(0.146)	(0.159)	(0.955)	(0.502)
Observations	1,490	1,490	1,190	1,490	1,490
R-squared	0.248	0.223	0.305	0.170	0.183
Number of individuals	416	416	407	416	416
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Movers and frequent absence excluded	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 13 (full version): Estimation results of dwelling problems on demand for health for tenants

	(3) Total healthcare	(6) General practitioner	(9) Mental healthcare	(12) Medical specialist
Dwelling problems:				
Too small	-0.451	-0.759	-0.033	0.316
	(0.729)	(0.393)	(0.958)	(0.536)
Too dark	-2.800*	-1.752	-0.515	-0.590
	(0.076)	(0.102)	(0.501)	(0.337)
Inadequate heating	-0.351	0.280	-0.527	-0.118
	(0.801)	(0.768)	(0.434)	(0.829)
Leaking roof	-0.151	0.325	0.323	-0.730
	(0.964)	(0.888)	(0.843)	(0.580)
Damp walls/ floors	0.336	0.761	-0.346	-0.065
	(0.790)	(0.378)	(0.572)	(0.896)
Rotten frames/floors	0.480	-0.922	-0.133	1.537**
	(0.794)	(0.465)	(0.882)	(0.034)
Too noisy	-1.027	-0.535	-0.482	-0.051
	(0.215)	(0.344)	(0.231)	(0.876)
Number of rooms	-0.945	-0.016	-0.774**	-0.125
	(0.209)	(0.975)	(0.034)	(0.673)
Log monthly rent	-2.514**	-2.695***	-0.502	0.562
	(0.027)	(0.000)	(0.362)	(0.205)
Vicinity problems (1=yes)	1.328**	0.797*	0.338	0.286
	(0.043)	(0.074)	(0.287)	(0.264)
Log monthly household income	-0.695**	-0.384*	-0.127	-0.165
	(0.028)	(0.074)	(0.406)	(0.181)
Residency dwelling (years)	-0.033	-0.047**	0.012	0.003
	(0.283)	(0.023)	(0.414)	(0.801)
Household size	0.087	0.266	0.055	-0.415
	(0.962)	(0.830)	(0.951)	(0.561)
Household members per room	-4.326	-2.451	-1.257	-0.478
	(0.373)	(0.460)	(0.594)	(0.802)
Partner (1=yes)	-3.382***	-1.769**	-1.200**	-0.439
	(0.003)	(0.023)	(0.031)	(0.326)
Living with partner (1=yes)	1.521	1.323	0.049	0.264
	(0.438)	(0.319)	(0.959)	(0.730)
Married (1=yes)	1.307	0.251	0.829	0.252
	(0.404)	(0.813)	(0.276)	(0.679)
Household with children (1=yes)	-0.113	-0.046	0.645	-0.688
	(0.959)	(0.976)	(0.551)	(0.431)
Number of children	1.608	0.195	0.266	1.289*
	(0.365)	(0.871)	(0.758)	(0.062)
Age of respondent	-0.028	0.049**	-0.111***	0.036***
	(0.416)	(0.038)	(0.000)	(0.007)
Health characteristics:				
Ever smoked (1=yes)	-0.285	0.334	-1.152***	0.487*
	(0.696)	(0.501)	(0.001)	(0.088)
Currently smokes (1=yes)	-0.304	0.625	-0.597	-0.385
	(0.709)	(0.260)	(0.132)	(0.228)
Regular drinker (1=yes)	-2.051***	-1.110**	-0.048	-0.876***
	(0.002)	(0.015)	(0.884)	(0.001)
Practices sports (1=yes)	1.153*	0.674	-0.038	0.558**
	(0.079)	(0.131)	(0.906)	(0.030)
BMI	0.118*	0.109**	-0.067**	0.082***
	(0.064)	(0.012)	(0.030)	(0.001)
Individual is working (1=yes)	-3.446***	-0.642	-2.118***	-0.701**
	(0.000)	(0.270)	(0.000)	(0.036)
Individual is studying (1=yes)	-3.906	-0.986	-2.737	-0.168
	(0.275)	(0.687)	(0.115)	(0.905)
Higher education degree (1=yes)	-1.510*	-0.545	-0.478	-0.516
	(0.071)	(0.337)	(0.239)	(0.115)
Observations	4,873	4,973	4,879	4,920
R-squared	0.082	0.054	0.102	0.067
Number of individuals	1,239	1,251	1,241	1,250
Year fixed effects	Yes	Yes	Yes	Yes
Movers and frequent absence excluded	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 14 (full version): Estimation results of dwelling problems on demand for health for social tenants

	(3) Total healthcare	(6) General practitioner	(9) Mental healthcare	(12) Medical specialist
Dwelling problems:				
Too small	-1.676	-1.122	-1.630	1.057
	(0.600)	(0.638)	(0.292)	(0.378)
Too dark	-2.050	-3.463	1.277	0.108
	(0.612)	(0.252)	(0.514)	(0.943)
Inadequate heating	-2.223	-0.518	-0.666	-0.987
	(0.568)	(0.859)	(0.724)	(0.499)
Leaking roof	3.486	5.475	2.449	-4.424
	(0.759)	(0.518)	(0.656)	(0.299)
Damp walls/ floors	-0.471	0.688	-0.285	-0.801
	(0.876)	(0.759)	(0.845)	(0.478)
Rotten frames/floors	1.852	-2.655	-1.164	5.641***
	(0.714)	(0.481)	(0.634)	(0.003)
Too noisy	-3.796*	-2.235	-1.010	-0.603
	(0.082)	(0.169)	(0.338)	(0.460)
Number of rooms	-1.983	0.550	-2.152**	-0.375
	(0.289)	(0.693)	(0.018)	(0.593)
Log monthly rent	-8.256***	-7.879***	-2.916**	2.350**
	(0.007)	(0.001)	(0.047)	(0.039)
Vicinity problems (1=yes)	3.155*	2.101*	0.663	0.554
	(0.060)	(0.091)	(0.410)	(0.374)
Log monthly household income	-0.269	-0.406	-0.070	0.222
	(0.724)	(0.476)	(0.850)	(0.437)
Residency dwelling (years)	-0.059	-0.075	0.027	-0.013
	(0.454)	(0.201)	(0.470)	(0.671)
Household size	0.641	-1.210	1.681	0.174
	(0.876)	(0.694)	(0.399)	(0.910)
Household members per room	-9.194	-1.628	-5.137	-2.495
	(0.389)	(0.838)	(0.320)	(0.533)
Partner (1=yes)	-5.841**	-2.942	-2.429*	-0.466
	(0.038)	(0.159)	(0.075)	(0.658)
Living with partner (1=yes)	2.250	3.366	-1.484	0.462
	(0.681)	(0.410)	(0.575)	(0.822)
Married (1=yes)	2.347	-0.673	3.378	-0.418
	(0.630)	(0.853)	(0.152)	(0.819)
Household with children (1=yes)	1.240	1.565	-0.534	0.195
	(0.830)	(0.714)	(0.848)	(0.928)
Number of children	2.819	0.755	0.930	1.084
	(0.488)	(0.802)	(0.636)	(0.477)
Age of respondent	-0.080	0.086	-0.230***	0.069**
	(0.321)	(0.152)	(0.000)	(0.022)
Health characteristics:				
Ever smoked (1=yes)	-2.512	-0.446	-2.257**	0.217
	(0.174)	(0.746)	(0.011)	(0.752)
Currently smokes (1=yes)	1.690	2.555*	-1.069	0.150
	(0.397)	(0.086)	(0.267)	(0.840)
Regular drinker (1=yes)	-3.494**	-1.019	-1.101	-1.402**
	(0.036)	(0.410)	(0.172)	(0.025)
Practices sports (1=yes)	1.073	1.031	-1.121	1.204*
	(0.519)	(0.404)	(0.164)	(0.054)
BMI	0.049	0.176	-0.202***	0.089
	(0.754)	(0.129)	(0.007)	(0.126)
Individual is working (1=yes)	-5.932**	-1.547	-3.297***	-1.119
	(0.011)	(0.373)	(0.004)	(0.200)
Individual is studying (1=yes)	-3.716	-1.972	-2.419	0.697
	(0.580)	(0.694)	(0.457)	(0.782)
Higher education degree (1=yes)	-0.781	0.231	-1.729	0.699
	(0.767)	(0.906)	(0.176)	(0.480)
Observations	1,456	1,478	1,460	1,465
R-squared	0.128	0.096	0.210	0.107
Number of individuals	412	414	414	414
Year fixed effects	Yes	Yes	Yes	Yes
Movers and frequent absence excluded	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 15 (full version): Estimation results of dwelling problems on demand for health for tenants by gender

	Total healthcare		General practitioner		Mental healthcare		Medical specialist	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Male	Female	Male	Female	Male	Female	Male	Female
Dwelling problems:								
Too small	1.828	-1.739	-0.569	-0.162	1.996***	-2.195*	0.410	0.584
	(0.295)	(0.395)	(0.676)	(0.895)	(0.000)	(0.076)	(0.524)	(0.487)
Too dark	-3.946*	-2.026	-1.921	-1.774	-0.926	-0.630	-1.116	0.320
	(0.070)	(0.380)	(0.254)	(0.200)	(0.107)	(0.652)	(0.161)	(0.736)
Inadequate heating	-2.404	1.364	-1.203	1.799	-0.968*	-0.299	-0.282	-0.087
	(0.227)	(0.505)	(0.440)	(0.142)	(0.065)	(0.809)	(0.702)	(0.917)
Leaking roof	-3.115	1.910	-0.039	0.924	-3.039**	2.103	0.092	-1.046
	(0.576)	(0.660)	(0.993)	(0.722)	(0.039)	(0.423)	(0.965)	(0.558)
Damp walls/ floors	0.993	0.816	1.128	0.703	0.200	-0.469	-0.341	0.609
	(0.624)	(0.632)	(0.478)	(0.491)	(0.708)	(0.649)	(0.650)	(0.384)
Rotten frames/floors	-0.525	1.775	-0.751	-1.397	-0.723	0.962	0.979	2.189**
	(0.873)	(0.451)	(0.770)	(0.322)	(0.402)	(0.500)	(0.420)	(0.024)
Too noisy	0.042	-2.167*	-0.410	-0.791	-0.315	-0.676	0.735*	-0.746
	(0.971)	(0.068)	(0.659)	(0.265)	(0.314)	(0.346)	(0.095)	(0.126)
Number of rooms	-1.503	-0.268	-0.864	0.647	-0.117	-1.259*	-0.492	0.337
	(0.164)	(0.809)	(0.307)	(0.332)	(0.681)	(0.062)	(0.219)	(0.461)
Log monthly rent	1.406	-5.738***	0.104	-4.783***	0.563	-1.827*	0.858	0.556
	(0.388)	(0.001)	(0.935)	(0.000)	(0.190)	(0.068)	(0.153)	(0.411)
Vicinity problems (1=yes)	1.572*	1.551	1.426**	0.678	0.191	0.506	-0.004	0.539
	(0.090)	(0.104)	(0.049)	(0.233)	(0.435)	(0.379)	(0.991)	(0.166)
Log monthly household income	-0.218	-0.699*	-0.152	-0.340	0.034	-0.178	-0.095	-0.144
	(0.702)	(0.084)	(0.733)	(0.158)	(0.822)	(0.468)	(0.653)	(0.384)
Residency dwelling (years)	0.010	-0.076*	-0.028	-0.064**	0.017	0.001	0.024	-0.016
	(0.813)	(0.088)	(0.413)	(0.017)	(0.148)	(0.971)	(0.133)	(0.395)
Household size	-0.549	-0.892	-0.112	-0.256	-0.133	0.395	-0.758	-1.006
	(0.839)	(0.731)	(0.957)	(0.868)	(0.852)	(0.801)	(0.443)	(0.341)
Household members per room	-5.035	-1.540	-3.347	-1.272	0.329	-2.033	-1.723	1.624
	(0.478)	(0.824)	(0.547)	(0.760)	(0.861)	(0.629)	(0.512)	(0.570)
Partner (1=yes)	-1.534	-4.764***	-1.827	-1.436	-0.366	-2.094**	0.626	-1.202*
	(0.364)	(0.003)	(0.162)	(0.133)	(0.411)	(0.031)	(0.314)	(0.068)
Living with partner (1=yes)	2.021	1.276	2.132	1.836	0.015	-1.003	0.167	0.556
	(0.461)	(0.677)	(0.315)	(0.316)	(0.983)	(0.589)	(0.868)	(0.658)
Married (1=yes)	-0.036	2.524	0.187	-0.578	-0.003	2.554	-0.106	0.408
	(0.986)	(0.331)	(0.904)	(0.710)	(0.995)	(0.105)	(0.885)	(0.702)
Household with children (1=yes)	-3.223	2.272	0.012	0.348	-1.428	0.990	-1.801	1.017
	(0.411)	(0.425)	(0.997)	(0.837)	(0.167)	(0.565)	(0.216)	(0.385)
Number of children	5.649*	-0.948	1.602	-0.355	0.849	-0.244	3.605***	-0.371
	(0.056)	(0.680)	(0.485)	(0.794)	(0.275)	(0.861)	(0.001)	(0.692)
Age of respondent	-0.002	-0.096*	0.007	0.065**	-0.043***	-0.185***	0.033*	0.032
	(0.966)	(0.067)	(0.856)	(0.038)	(0.001)	(0.000)	(0.067)	(0.130)
Health characteristics:								
Ever smoked (1=yes)	2.572**	-1.915*	1.624*	-0.488	-0.523*	-1.239**	1.507***	-0.246
	(0.024)	(0.059)	(0.067)	(0.421)	(0.081)	(0.043)	(0.000)	(0.555)
Currently smokes (1=yes)	-1.889	0.516	-0.676	1.109	-0.248	-0.906	-1.015**	0.217
	(0.104)	(0.663)	(0.456)	(0.119)	(0.417)	(0.207)	(0.018)	(0.656)
Regular drinker (1=yes)	-1.498	-2.184**	-0.873	-1.056*	0.141	-0.093	-0.725**	-1.052**
	(0.117)	(0.033)	(0.244)	(0.084)	(0.575)	(0.880)	(0.041)	(0.012)
Practices sports (1=yes)	0.800	0.784	0.255	0.911	0.314	-0.668	0.248	0.632
	(0.402)	(0.404)	(0.732)	(0.105)	(0.213)	(0.240)	(0.483)	(0.101)
BMI	0.036	0.151*	-0.035	0.185***	-0.012	-0.093*	0.082**	0.071**
	(0.729)	(0.071)	(0.666)	(0.000)	(0.665)	(0.067)	(0.032)	(0.038)
Individual is working (1=yes)	-1.587	-5.014***	-0.755	-0.627	-0.443	-3.378***	-0.374	-1.000**
	(0.233)	(0.000)	(0.469)	(0.372)	(0.207)	(0.000)	(0.448)	(0.038)
Individual is studying (1=yes)	-1.416	-4.678	-3.115	-0.396	2.735**	-4.831	-1.061	0.560
	(0.785)	(0.364)	(0.444)	(0.898)	(0.046)	(0.122)	(0.581)	(0.792)
Higher education degree (1=yes)	-2.417*	-1.440	-1.336	-0.369	-0.599*	-0.385	-0.552	-0.673
	(0.050)	(0.232)	(0.164)	(0.608)	(0.065)	(0.597)	(0.225)	(0.174)
Observations	2,124	2,749	2,181	2,792	2,125	2,754	2,151	2,769
R-squared	0.073	0.153	0.047	0.120	0.118	0.160	0.129	0.093
Number of individuals	593	646	601	650	593	648	600	650
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Movers and freq. absence excl.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 16 (full version): Estimation results of dwelling problems on demand for health for social tenants by gender

	Total healthcare		General practitioner		Mental healthcare		Medical specialist	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Male	Female	Male	Female	Male	Female	Male	Female
Dwelling problems:								
Too small	1.796	2.318	-0.550	1.267	1.339	-2.115	1.007	3.121*
	(0.790)	(0.595)	(0.932)	(0.646)	(0.130)	(0.401)	(0.541)	(0.089)
Too dark	0.909	-2.975	3.600	-4.854	-1.215	0.751	-1.475	1.136
	(0.917)	(0.535)	(0.665)	(0.111)	(0.287)	(0.786)	(0.489)	(0.573)
Inadequate heating	3.295	2.348	5.289	1.573	-0.932	1.211	-1.061	-0.387
	(0.671)	(0.678)	(0.475)	(0.661)	(0.358)	(0.711)	(0.576)	(0.870)
Leaking roof		4.272		9.166		2.339		-7.492
		(0.727)		(0.238)		(0.741)		(0.146)
Damp walls/ floors	-1.009	4.055	-0.284	2.705	0.892	1.110	-1.617	0.224
	(0.865)	(0.317)	(0.960)	(0.290)	(0.250)	(0.635)	(0.265)	(0.895)
Rotten frames/floors	-3.378	8.367	-2.045	-4.466	-1.214	1.007	-0.119	11.842***
	(0.657)	(0.267)	(0.778)	(0.349)	(0.223)	(0.817)	(0.949)	(0.000)
Too noisy	-5.179	-6.393**	-4.170	-2.921*	-0.604	-2.646	-0.405	-0.833
	(0.225)	(0.022)	(0.305)	(0.098)	(0.278)	(0.101)	(0.697)	(0.476)
Number of rooms	-0.106	-1.558	-0.824	1.465	1.572***	-3.658**	-0.854	0.672
	(0.979)	(0.523)	(0.827)	(0.344)	(0.003)	(0.010)	(0.377)	(0.511)
Log monthly rent	-2.255	-12.249**	-2.531	-10.483***	-0.042	-4.520**	0.318	2.525
	(0.703)	(0.002)	(0.653)	(0.000)	(0.957)	(0.049)	(0.826)	(0.128)
Vicinity problems (1=yes)	7.810**	0.754	7.082**	0.434	1.243***	0.024	-0.515	0.557
	(0.020)	(0.726)	(0.027)	(0.748)	(0.005)	(0.985)	(0.526)	(0.533)
Log monthly household income	0.663	-0.732	0.205	-0.879	-0.032	-0.141	0.490	0.328
	(0.661)	(0.458)	(0.887)	(0.159)	(0.870)	(0.804)	(0.187)	(0.427)
Residency dwelling (years)	0.106	-0.140	0.037	-0.129**	0.041**	0.049	0.029	-0.065
	(0.448)	(0.173)	(0.783)	(0.047)	(0.027)	(0.407)	(0.402)	(0.127)
Household size	4.210	1.207	7.964	-1.936	-3.771***	4.527	0.016	-1.449
	(0.698)	(0.807)	(0.441)	(0.537)	(0.009)	(0.114)	(0.995)	(0.485)
Household members per room	10.015	-11.438	1.144	-0.916	13.738***	-13.278**	-4.867	3.021
	(0.692)	(0.389)	(0.962)	(0.913)	(0.000)	(0.084)	(0.431)	(0.587)
Partner (1=yes)	-6.822	-8.718**	-8.112	-2.878	-0.249	-4.384**	1.540	-1.369
	(0.241)	(0.017)	(0.144)	(0.208)	(0.742)	(0.038)	(0.279)	(0.370)
Living with partner (1=yes)	1.003	6.749	0.304	5.420	1.160	0.808	-0.462	0.478
	(0.937)	(0.331)	(0.980)	(0.218)	(0.481)	(0.840)	(0.881)	(0.870)
Married (1=yes)	-6.950	1.679	-4.769	-1.971	-1.890	2.965	-0.290	0.848
	(0.458)	(0.793)	(0.593)	(0.627)	(0.123)	(0.423)	(0.899)	(0.752)
Household with children (1=yes)	7.615	9.349	-13.093	4.385	7.100*	-0.200	13.607*	5.159*
	(0.795)	(0.159)	(0.640)	(0.290)	(0.066)	(0.958)	(0.060)	(0.064)
Number of children		-6.170		-2.233		-1.249		-2.653
		(0.222)		(0.479)		(0.668)		(0.211)
Age of respondent	0.040	-0.273**	0.075	0.051	-0.066***	-0.380***	0.031	0.070
	(0.788)	(0.015)	(0.595)	(0.468)	(0.001)	(0.000)	(0.392)	(0.133)
Health characteristics:								
Ever smoked (1=yes)	0.348	-4.558**	1.139	-1.068	-0.683	-3.183**	-0.108	-0.145
	(0.931)	(0.063)	(0.766)	(0.490)	(0.195)	(0.023)	(0.912)	(0.886)
Currently smokes (1=yes)	2.919	1.994	2.408	2.009	0.499	-0.709	0.012	0.533
	(0.433)	(0.457)	(0.498)	(0.236)	(0.306)	(0.646)	(0.989)	(0.634)
Regular drinker (1=yes)	-2.014	-4.687**	-1.746	-1.732	0.061	-1.237	-0.329	-1.785*
	(0.565)	(0.039)	(0.600)	(0.225)	(0.894)	(0.344)	(0.701)	(0.061)
Practices sports (1=yes)	-2.101	1.762	-2.039	1.867	0.262	-1.541	-0.324	1.437*
	(0.567)	(0.390)	(0.560)	(0.148)	(0.585)	(0.192)	(0.718)	(0.094)
BMI	-0.349	0.136	-0.488	0.334***	0.040	-0.248**	0.100	0.069
	(0.314)	(0.457)	(0.140)	(0.004)	(0.379)	(0.019)	(0.239)	(0.362)
Individual is working (1=yes)	-7.966	-8.396***	-6.043	-1.459	-1.599**	-4.262**	-0.324	-2.609**
	(0.139)	(0.005)	(0.238)	(0.435)	(0.024)	(0.013)	(0.805)	(0.036)
Individual is studying (1=yes)	-2.631	-10.855	-5.683	-4.106	4.540***	-8.508*	-1.487	1.814
	(0.823)	(0.222)	(0.612)	(0.466)	(0.004)	(0.099)	(0.604)	(0.627)
Higher education degree (1=yes)	-2.915	-2.047	-0.133	0.031	-3.595***	-2.094	0.813	-0.041
	(0.660)	(0.505)	(0.983)	(0.987)	(0.000)	(0.239)	(0.616)	(0.975)
Observations	455	1,001	460	1,018	455	1,005	458	1,007
R-squared	0.182	0.211	0.144	0.190	0.511	0.281	0.326	0.176
Number of individuals	141	271	141	273	141	273	141	273
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Movers and freq. absence excl.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 17 (full version): Estimation results of dwelling problems on demand for health for tenants who moved during the period

	(3) Total healthcare	(6) General practitioner	(9) Mental healthcare	(12) Medical specialist
Dwelling problems:				
Too small	1.913	0.522	-0.058	1.439
	(0.189)	(0.222)	(0.872)	(0.256)
Too dark	0.802	0.024	1.652**	-0.851
	(0.767)	(0.976)	(0.015)	(0.718)
Inadequate heating	0.288	0.397	-0.155	0.028
	(0.886)	(0.506)	(0.760)	(0.987)
Leaking roof	-2.105	-0.975	-0.951	-0.142
	(0.523)	(0.319)	(0.251)	(0.961)
Damp walls/ floors	1.033	0.197	-0.439	1.266
	(0.651)	(0.771)	(0.445)	(0.525)
Rotten frames/floors	1.085	1.794*	1.553**	-2.266
	(0.726)	(0.051)	(0.046)	(0.401)
Too noisy	0.272	0.791**	0.305	-0.788
	(0.834)	(0.040)	(0.348)	(0.484)
Number of rooms	0.303	-0.089	0.130	0.298
	(0.713)	(0.715)	(0.527)	(0.676)
Log monthly rent	-0.946	-1.009**	-0.153	0.217
	(0.546)	(0.029)	(0.696)	(0.873)
Vicinity problems (1=yes)	2.378**	0.111	0.476*	1.729*
	(0.023)	(0.717)	(0.069)	(0.057)
Log monthly household income	0.446	0.118	0.170	0.111
	(0.389)	(0.439)	(0.190)	(0.805)
Residency dwelling (years)	-0.036	-0.023**	-0.002	-0.011
	(0.359)	(0.048)	(0.870)	(0.756)
Household size	0.054	0.481	-0.227	-0.206
	(0.980)	(0.442)	(0.668)	(0.911)
Household members per room	-1.486	-1.160	0.036	-0.300
	(0.683)	(0.282)	(0.969)	(0.924)
Partner (1=yes)	0.262	0.499	0.009	-0.204
	(0.856)	(0.244)	(0.980)	(0.871)
Living with partner (1=yes)	0.456	-0.108	0.379	0.133
	(0.822)	(0.857)	(0.455)	(0.939)
Married (1=yes)	-0.683	-0.108	-0.373	-0.112
	(0.717)	(0.845)	(0.430)	(0.945)
Household with children (1=yes)	-1.914	0.409	-0.728	-1.629
	(0.507)	(0.633)	(0.316)	(0.517)
Number of children	0.101	-0.600	0.614	0.045
	(0.964)	(0.361)	(0.272)	(0.981)
Age of respondent	0.013	0.025*	-0.042***	0.030
	(0.779)	(0.077)	(0.000)	(0.457)
Health characteristics:				
Ever smoked (1=yes)	-0.089	0.346	0.250	-0.767
	(0.942)	(0.338)	(0.416)	(0.471)
Currently smokes (1=yes)	2.452*	-0.048	-0.320	2.849**
	(0.075)	(0.906)	(0.354)	(0.018)
Regular drinker (1=yes)	-3.210***	-1.181***	-0.158	-1.893**
	(0.002)	(0.000)	(0.533)	(0.031)
Practices sports (1=yes)	-0.071	0.284	0.095	-0.507
	(0.943)	(0.338)	(0.705)	(0.561)
BMI	0.306***	0.025	-0.036	0.324***
	(0.008)	(0.468)	(0.216)	(0.001)
Individual is working (1=yes)	-5.137***	-1.497***	-0.888**	-2.738**
	(0.000)	(0.000)	(0.014)	(0.029)
Individual is studying (1=yes)	-4.606	-1.332	-1.640**	-1.658
	(0.102)	(0.111)	(0.021)	(0.498)
Higher education degree (1=yes)	-1.819	-0.613*	-1.053***	-0.159
	(0.137)	(0.091)	(0.001)	(0.881)
Observations	2,612	2,652	2,619	2,629
R-squared	0.138	0.169	0.125	0.099
Number of individuals	559	564	560	561
Year fixed effects	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who did not move during the sample period. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 18 (full version): Estimation results of dwelling problems on demand for health for social tenants who moved during the period

	(3) Total healthcare	(6) General practitioner	(9) Mental healthcare	(12) Medical specialist
Dwelling problems:				
Too small	0.517	-0.302	0.782	0.037
	(0.908)	(0.795)	(0.330)	(0.993)
Too dark	-1.014	-1.046	0.954	-0.922
	(0.903)	(0.628)	(0.522)	(0.907)
Inadequate heating	-0.978	0.223	0.890	-2.091
	(0.892)	(0.905)	(0.490)	(0.760)
Leaking roof	14.446	2.242	0.456	11.748
	(0.292)	(0.526)	(0.852)	(0.366)
Damp walls/ floors	-5.564	-0.797	-1.741	-3.025
	(0.389)	(0.632)	(0.132)	(0.621)
Rotten frames/floors	-2.196	4.784**	4.119**	-11.099
	(0.811)	(0.045)	(0.013)	(0.203)
Too noisy	-0.440	0.647	0.695	-1.782
	(0.899)	(0.470)	(0.262)	(0.587)
Number of rooms	3.598	0.371	0.204	3.023
	(0.142)	(0.557)	(0.640)	(0.193)
Log monthly rent	-0.388	-2.703*	-0.584	2.899
	(0.946)	(0.068)	(0.567)	(0.592)
Vicinity problems (1=yes)	3.341	-0.109	0.251	3.199
	(0.248)	(0.884)	(0.626)	(0.243)
Log monthly household income	-0.903	-0.364	0.174	-0.713
	(0.573)	(0.380)	(0.543)	(0.639)
Residency dwelling (years)	-0.201	-0.082**	-0.021	-0.098
	(0.104)	(0.011)	(0.334)	(0.402)
Household size	-1.109	0.759	0.586	-2.453
	(0.870)	(0.665)	(0.628)	(0.702)
Household members per room	4.715	-0.470	0.035	5.151
	(0.636)	(0.855)	(0.985)	(0.585)
Partner (1=yes)	0.059	0.640	0.490	-1.070
	(0.990)	(0.590)	(0.550)	(0.806)
Living with partner (1=yes)	1.130	-1.083	-0.322	2.535
	(0.861)	(0.518)	(0.780)	(0.680)
Married (1=yes)	-5.073	0.623	-1.844*	-3.851
	(0.378)	(0.675)	(0.074)	(0.479)
Household with children (1=yes)	3.790	1.688	-0.738	2.840
	(0.633)	(0.411)	(0.603)	(0.706)
Number of children	-4.101	-1.673	-0.586	-1.842
	(0.545)	(0.339)	(0.628)	(0.774)
Age of respondent	0.061	0.038	-0.039*	0.063
	(0.616)	(0.237)	(0.076)	(0.588)
Health characteristics:				
Ever smoked (1=yes)	-2.708	0.413	-0.372	-2.749
	(0.484)	(0.679)	(0.590)	(0.453)
Currently smokes (1=yes)	5.221	-0.355	-0.361	5.938*
	(0.152)	(0.705)	(0.578)	(0.086)
Regular drinker (1=yes)	-5.063*	-1.355*	-0.470	-3.238
	(0.096)	(0.085)	(0.385)	(0.260)
Practices sports (1=yes)	-1.776	0.662	0.612	-3.051
	(0.518)	(0.352)	(0.213)	(0.243)
BMI	1.048***	0.037	0.031	0.981***
	(0.001)	(0.659)	(0.597)	(0.002)
Individual is working (1=yes)	-7.394*	-2.012*	-1.332*	-4.050
	(0.073)	(0.059)	(0.071)	(0.299)
Individual is studying (1=yes)	-4.541	-1.769	-2.342*	-0.430
	(0.512)	(0.323)	(0.059)	(0.948)
Higher education degree (1=yes)	1.936	-0.648	-1.257	3.841
	(0.688)	(0.603)	(0.146)	(0.401)
Observations	737	748	739	742
R-squared	0.229	0.245	0.262	0.186
Number of individuals	182	183	182	183
Year fixed effects	Yes	Yes	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who did not move during the sample period. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 20: Estimation results of dwelling problems on health status for female social tenants

	(1) General health	(2) Poor health
Dwelling problems:		
Too small	-0.066	0.144
	(0.719)	(0.259)
Too dark	-0.379*	0.073
	(0.061)	(0.605)
Inadequate heating	-0.208	0.004
	(0.381)	(0.981)
Leaking roof	-0.130	0.146
	(0.801)	(0.683)
Damp walls/ floors	0.012	0.032
	(0.942)	(0.784)
Rotten frames/floors	-0.044	0.048
	(0.889)	(0.827)
Too noisy	-0.144	0.178**
	(0.218)	(0.030)
Number of rooms	0.165	-0.048
	(0.109)	(0.503)
Log monthly rent	-0.045	0.092
	(0.784)	(0.420)
Vicinity problems (1=yes)	-0.272***	0.226***
	(0.002)	(0.000)
Log monthly household income	0.064	-0.052*
	(0.123)	(0.071)
Residency dwelling (years)	-0.000	-0.002
	(0.993)	(0.613)
Household size	-0.040	-0.046
	(0.849)	(0.750)
Household members per room	0.612	0.035
	(0.273)	(0.928)
Partner (1=yes)	-0.047	-0.034
	(0.754)	(0.747)
Living with partner (1=yes)	0.052	-0.071
	(0.859)	(0.727)
Married (1=yes)	0.063	0.076
	(0.814)	(0.685)
Household with children (1=yes)	-0.647**	0.553***
	(0.019)	(0.004)
Number of children	0.152	-0.217
	(0.466)	(0.137)
Age of respondent	-0.000	0.002
	(0.858)	(0.532)
Health characteristics:		
Ever smoked (1=yes)	-0.074	0.040
	(0.467)	(0.571)
Currently smokes (1=yes)	0.081	-0.092
	(0.467)	(0.236)
Regular drinker (1=yes)	0.135	-0.160**
	(0.154)	(0.016)
Practices sports (1=yes)	0.131	-0.094
	(0.125)	(0.112)
BMI	-0.028***	0.020***
	(0.000)	(0.000)
Individual is working (1=yes)	0.350***	-0.192**
	(0.005)	(0.027)
Individual is studying (1=yes)	0.360	-0.177
	(0.335)	(0.496)
Higher education degree (1=yes)	-0.181	0.121
	(0.156)	(0.174)
Observations	1,027	1,027
R-squared	0.272	0.292
Number of individuals	275	275
Year fixed effects	Yes	Yes

Notes: P-values at individual level in parentheses. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 21: Estimation results of dwelling problems conditional on self-reported health status on demand for health for female social tenants

	(1) Total healthcare	(2) General practitioner
Dwelling problems:		
Too small	1.149	0.786
	(0.788)	(0.776)
Too dark	-3.527	-5.069*
	(0.450)	(0.094)
Inadequate heating	2.340	1.515
	(0.674)	(0.673)
Leaking roof	2.840	8.674
	(0.812)	(0.261)
Damp walls/ floors	3.806	2.579
	(0.340)	(0.316)
Rotten frames/floors	7.974	-4.591
	(0.278)	(0.333)
Too noisy	0.340	-0.265
	(0.929)	(0.914)
*Too noisy * Poor health*	8.481***	3.048**
	(0.000)	(0.045)
Observations	1,001	1,018
R-squared	0.259	0.207
Number of individuals	271	273
Year fixed effects	Yes	Yes
Dwelling characteristic control	Yes	Yes
External environment control	Yes	Yes
Socio-economic control	Yes	Yes
Health behaviour control	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are available upon request. Estimation results exclude individuals who moved during the sample period and are frequently absent from the home environment. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Table 23: Estimation results of dwelling problems on the probability to change residency

	(1) Tenants	(2) Social tenants
Dwelling problems:		
Too small	0.082**	0.104
	(0.033)	(0.147)
Too dark	0.537**	-0.124
	(0.012)	(0.229)
*Too dark * Mental healthcare*	0.325**	
	(0.049)	
Inadequate heating	0.019	-0.190**
	(0.682)	(0.041)
Leaking roof	0.135	0.080
	(0.142)	(0.734)
Damp walls/floors	-0.093**	-0.206***
	(0.033)	(0.004)
Rotten frames/floors	0.038	0.312
	(0.646)	(0.122)
*Rotten frames/floors * General practitioner*	0.122**	-0.004
	(0.022)	(0.942)
*Rotten frames/floors * Mental healthcare*	-0.383**	-0.043
	(0.024)	(0.456)
Too noisy	-0.079	0.120**
	(0.134)	(0.016)
*Too noisy * General practitioner*	-0.126**	
	(0.034)	
Observations	7,851	2,259
R-squared	0.157	0.175
Number of individuals	1,822	595
Year fixed effects	Yes	Yes
Dwelling characteristic control	Yes	Yes
External environment control	Yes	Yes
Socio-economic control	Yes	Yes
Health behaviour control	Yes	Yes

Notes: P-values at individual level in parentheses. Coefficients from dwelling characteristics, external environmental, socio-demographic and health behaviour controls are available upon request. Dummy variables have been generated for general practitioner visits and mental healthcare services; the value of one is taken if at least one visit has been paid during the last year. *** Significantly different from 0 at 1 percent level. ** Significantly different from 0 at 5 percent level. * Significantly different from 0 at 10 percent level.

Appendix 2:

Official statement of original paper/report/thesis

By signing this statement, I hereby acknowledge the submitted paper/report/thesis*, titled:

Health in homes: an investigation of the Dutch rental housing market

to be produced independently by me, without external help.

Wherever I paraphrase or cite literally, a reference to the original source (journal, book, report, internet, etc.) is given.

By signing this statement, I explicitly declare that I am aware of the fraud sanctions as stated in the Education and Examination Regulations (EERs) of the SBE.

Place: Utrecht, the Netherlands

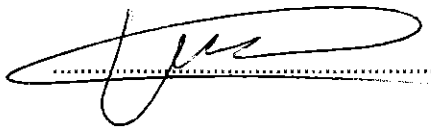
Date: January 22nd, 2018

First and last name: Maaike Vranckaerts

Study programme: MSc International Business - Sustainable Finance

Course/skill: MSc thesis

ID number: 1604584

Signature: 

*strikethrough the subjects that are not applicable.