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Is Owning your Home Good for your Health? Evidence from exogenous variations in subsidies in England

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Abstract

Little is known about the causal effects of home ownership on health. We exploit the "Right to Buy" policy in England as a source of exogenous variation in the ownership decision. The policy gave secure long-term tenants of publicly rented housing a discount in order to encourage them to buy their home. We assess the health and well-being impacts of this ownership decision by considering a macro and micro level analysis. In both analyses, home ownership is associated with higher levels of health and well-being. At the macro-level, local authorities with higher ownership rates had lower rates of people reporting having a longstanding health condition and also lower average counts of the number of health conditions reported by individuals. At the micro-level, becoming a homeowner reduced the number of self-reported health conditions by 0.65, increased self-assessed health by 0.19 points on a five-point scale, and increased General Health Questionnaire scores by 1.46 points on a 37-point scale. These results are robust to a number of assumptions. Further models suggest that the mechanisms through which home ownership affects health may operate via the labour markets with new job opportunities, extra time saved travelling and resources available for healthy leisure activities.

Key words: Home ownership; Health and Well-being; Right to Buy

JEL codes: H70, I10, I31, I38

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1 Introduction

Home ownership is a sizable component of wealth in Western economies. In the United States the rate of home ownership reached 60% of the population in the late 1990s, peaking to 70% in the early 2000s, after which it declined to approximately 65% at the beginning of the Great Recession (U.S. Census Bureau, 2017). Home ownership is thought to be an essential ingredient of the "American Dream" with several initiatives supporting ownerships including the federal tax code, Federal Housing Administration (FHA) programs, the Clinton Administration's National Homeownership Strategy and, more recently, the Moving to Opportunity for Fair Housing program. The United Kingdom has seen similar changes to the structure of home ownership: from 1953 ownership started to increase at a faster rate than in previous years reaching an equal percentage of households owning and renting by 1971. In Figure 1 we show that home ownership rates have reached 72% in the late 1990s, but they have then declined after the Great Recession. Like the U.S., the U.K. implemented several initiatives to support home ownership such as the "Housing Act" in the 1980s, the "Affordable Homes Programme", "Help to Buy" and Lifetime ISAs and, more recently, the "Right to Buy" scheme .

Home ownership is an important component of wealth, but does it affect health? Whilst there is some evidence that housing is correlated with health (Parliamentary Office of Science and Technology, 2011; Buck et al., 2016; Marmot et al., 2010), there is little causal evidence about the effect of home ownership on health (Dietz and Haurin, 2003). In addition to home ownership rates, in Figure 1 we also plot the unemployment rate and the average number of health conditions for the English population between 1998 and 2014. Figure 1 suggests that health is pro-cyclical, with a deterioration of health as employment and ownership rates decline. However, a causal relation between health and home ownership is difficult to establish because healthier individuals might select into home ownership and because home ownership rates might simply capture area-level factors, such as unemployment rates and possibly other omitted factors, affecting both health and ownership.

<Figure 1 about here>

Our contribution in this paper is to examine whether and why home ownership affects health.

We do so by exploiting variations in housing subsidies, through the Right to Buy scheme, introduced in British Local Authorities[1] to allow purchase of affordable homes. The Right to Buy scheme allowed long-term tenants of publicly owned properties to buy the home they lived in at a discount that varied across Local Authorities. The discount value could reach £50,000 in some years and localities. This constituted a substantial incentive to buy the home which was previously rented, representing 76% more than an average U.K. yearly wage. This internationally unique policy increased home ownership as a share of housing tenure by 15 percentage points and generated the largest public privatisation revenue in the U.K. Nonetheless, it has not been analysed by economists with the exception of one paper examining its effects on the quality and quantity of publicly-provided houses (Disney and Luo, 2017).

We examine the effect of home ownership on health in two ways. We estimate fixed-effect (FE) models using longitudinal data for the 2004-2010 period. Health is measured by a count of the number of health conditions. The units of observation are the 326 English Local Authorities and most of the analyses investigate *within*-localities changes in home ownership and health controlling for a rich set of local characteristics. The advantage of this macro-data is that we can mitigate concerns over endogeneity of home ownership to health by using the size of the discount and the Right to Buy sales data as instruments for home ownership.

In addition, we use micro-data in a large longitudinal sample of individuals from the British Household Panel Survey (BHPS; 2000-2008) to validate our macro findings and examine the mechanisms through which health and home ownership are related. Linking the BHPS to data containing geographical information on the respondents, and local-level house prices from administrative data relating to commercial sales, we use hedonic regressions to estimate the potential Right to Buy discount to which public renters would be entitled. We then use this potential discount as an exogenous predictor of home ownership rates and estimate the effect of home ownership on health. Our identifying assumption is that conditional on a range of individual characteristics, local level house prices and house characteristics, the size

[1] Although there were variants of the scheme in England, Scotland, and Wales, we focus only on England in this paper.

of the potential discount is as good as random and does not affect health directly other than through home ownership. Therefore, after controlling for a range of individual and house characteristics, as well as time invariant and time varying locality factors, home ownership is *conditionally* exogenous to health.

We find that home ownership improves physical and psychological health with an increase in the General Health Questionnaire Score by 1.46 points (on a 0 to 36 scale), self-assessed health by 0.19 points (on a 1 to 5 scale) and a reduction of 0.65 in the number of health conditions reported. This is consistent with related national and international evidence: Fichera and Gathergood (2016) find that changes in housing wealth in the U.K. lower the likelihood of home owners exhibiting a range of non-chronic conditions and improve self-assessed health; and Kling et al. (2007) find that the U.S. Moving to Opportunity program substantially improved mental health and some measures of physical health. Our results are robust to a battery of sensitivity analyses that involve using a placebo group of private renters similar to home owners but not eligible for the scheme, and different methods to estimate the hedonic regressions. We explore potential mechanisms and find that the health effects of home ownership operate through the labour markets, where home owners are more likely to become employed and spend less time travelling to work. Home owners spend more money on leisure, and they are less likely to smoke and to suffer from lifestyle-related diseases such as diabetes and blood pressure problems.

Our paper is structured as follows. In the next section, we outline some related literature. In section 3 we describe the Right to Buy Policy. Section 4 describes the data and section 5 the empirical strategy. Section 6 provides summary statistics, section 7 provides the results and a discussion. Section 8 concludes.

2 Literature Review

Our paper is closely related to two existing themes of literature: (1) the ways in which housing more generally affects health and (2) the effects of exogenous variations in wealth on health. We summarise each in turn below.

2.1 Channels through which home ownership could affect health

How does home ownership affect health? In economic models, health is produced by human capital investments, lifestyle behaviours and other random shocks, and it can be influenced by socioeconomic factors such as income and wealth (Grossman, 1972). Assume that individuals maximise a utility function with health and consumption of other goods subject to time and budget constraints. In this case individuals will allocate time and resources for health investments to equalize the marginal utility to the marginal cost. In such a model, wealth gains behave like permanent income shocks shifting the budget constraint out and affecting health. However, there are at least five reasons why the direction of this relation is ambiguous.

First, there is a direct effect of home ownership on health through housing conditions. Disney and Luo (2017) showed that the Right to Buy lowered housing quality for residual public renters who did not partake in the scheme. There is evidence of a detrimental effect of poor housing conditions on health (Marmot et al., 2008; Shaw, 2004). Shaw (2004) provides a review of potential direct and indirect effects of housing on health looking at historical and current evidence. She points out that respiratory health is the main health outcome to be affected by temperature and humidity in the house. As home owners are able to make structural adjustments to their dwellings, home ownership could improve housing quality and, therefore, health (Haurin et al., 2002; Chapman, 2013).

Home ownership could also have a direct effect on health by providing people with a sense of physical and emotional security, control over their life and safety (Elsinga et al., 2008). This might reflect social comparisons with those who did not make it onto the housing ladder or it might be related to home owners' ability to make changes to their houses. These non-financial effects may affect psychological health favourably.

Third, home ownership could have an indirect effect on health through a housing wealth effect. Housing wealth represents 60% of British households' financial wealth (Banks et al., 2003). The U.K. housing market is one of the most volatile in the world (Ferrari and Rae, 2011). Equity extraction from unsold homes is quite large in the U.K., reaching 6-8% of total household income in the mid-2000s (Reinold, 2011). Such wealth gains have an ambiguous

effect on health depending on the relative size of the substitution and wealth effects. Fichera and Gathergood (2016) find that house price gains improve physical health. They find no statistically significant effect of housing wealth gains on risky health behaviours such as smoking and drinking. But they find that housing wealth increases the likelihood of private medical coverage for home owners. However, this wealth effect could have detrimental effects on health inducing anxiety if home owners struggle to keep up with mortgage payments (Nettleton and Burrows, 2000; Evans et al., 2003).

Another potential indirect effect of home ownership on health is via labour markets (Blanchflower and Oswald, 2013; Laamanen, 2017; Oswald, 1996). Blanchflower and Oswald (2013) find that the housing market can create dampening externalities on the labour market and the economy. Using historic state-level data in the United States, they show that states with higher rates of home ownership have longer commute times and higher levels of joblesseness. There is indeed evidence that longer commuting times reduce well-being, have detrimental effects on self-assessed health and reduce health-related quality of life (Munford et al., 2015). The effect found by Blanchflower and Oswald (2013) is quite large, as a doubling of the home ownership rate is associated with more than a doubling of the long-run unemployment rate. These results are confirmed by micro-level data on two million individuals from the March Current Population Surveys (1992-2011). Laamanen (2017) find similar results using Finnish individual level data exploiting a rental housing market deregulation reform in the early 1990s. However, when looking at the effect of house price gains in the U.K., Fichera and Gathergood (2016) find a reduction of working hours by women suggesting a substitution of working hours with the additional wealth.

A final indirect effect of home ownership is via the production of social capital. Some studies find that home owners are more likely to belong to church and community organisations (Homenuck, 1973); they are involved in neighbourhood and block associations (Rohe and Stegman, 1994); they are more socially communicative with neighbours (Fischer, 1982) and politically active (Glaeser and Sacerdote, 2000). This social activity effect could favourably impact psychological health.

2.2 Effects of other exogenous variations in wealth on health

Our paper also relates to a more general literature, the relationship between economic resources and health. One strand of this literature uses exogenous changes in economic resources exploiting lottery wins (Apouey and Clark, 2015; Lindahl, 2005; Gardner and Oswald, 2007), inheritance (Meer et al., 2003; Kim and Ruhm, 2012), cohort-level income shocks (Adda et al., 2009), weather shocks (Fichera and Savage, 2015) and spousal wealth (Michaud and Van Soest, 2008). Apouey and Clark (2015) use a sample of lottery winners from the British Household Panel Survey (BHPS) between 1997 and 2005 and find that greater lottery winnings produce better mental health, but induce riskier lifestyle choices such as smoking and social drinking. Meer et al. (2003) use the 1984, 1989, 1994 and 1999 waves of the Panel Study of Income Dynamics and an instrumental variable approach where inheritance is an instrument for wealth. They find that in the short-run there is no statistically significant evidence of the health-wealth nexus.

There has been considerable interest in the relationship between unemployment and health. The seminal work of Ruhm (2000) suggests that unemployment rates and health are pro-cyclical, but later work (Ruhm, 2015) showed that this was true only after accounting for time periods, with different effects in the periods 1976-1995 compared to 1991-2010. It has also been argued that the level of analysis (micro vs. macro) is important, but van den Berg et al. (2017) find consistent results when they use the same data at both levels.

A second strand of this literature exploits changes in public policies as source of exogenous variation in income or wealth (Snyder and Evans, 2006; Frijters et al., 2005; Case, 2004; Schmeiser, 2009). For instance, Frijters et al. (2005) compare health satisfaction between East and West Germany using post-unification income changes. Using data from the German Socio-Economic Panel Survey between 1984 and 2002, they find positive effects of income changes on health satisfaction. Schmeiser (2009) exploits state-level differences in the Earned Income Tax Credit supplement to examine the impact of income on body mass index (BMI). Using the U.S. National Longitudinal Survey of Youth 1979 cohort and instrumental variable methods, he finds that an additional $1,000 of family income raises BMI by 0.07 units for men and by 0.24 units for women.

Finally, our paper contributes to a growing number of studies that exploits the timing and spatial variations of a policy (Hoynes and Schanzenbach, 2009; Ludwig and Miller, 2007; Cascio et al., 2010). For instance, Hoynes and Schanzenbach (2009) use the variation in the introduction of the food stamps program across U.S. counties to examine its impact on spending. In our paper we exploit the timing and variation in the intensity of the discount across geographical areas in England.

3 The Right to Buy Policy

The Right to Buy scheme is a policy in the United Kingdom which gives long-term tenants of publicly owned properties the legal right to buy, at a large discount, the home they are living in. A public sector tenant is someone whose landlord is a public body such as a council, housing association or government department. Around 1.5 million homes in the UK have been sold under the Right to Buy scheme since 1980. The rationale for the Right to Buy scheme was to give households a tangible asset, secure their finances and improve public finances as well.

The Right to Buy legislation was passed in The Housing Act 1980. Initially, the sale price of a council house was based on its market valuation[2] but it was discounted by 33% to 50% depending on length of tenancy and the market valuation to encourage take-up. The uptake was initially high but dropped during the mid-1980s because of high unemployment, inflation and the recession of the early 1990s. Because of the shortage of new homes, the Labour government implemented a series of measures between 1998 and 2004; the aims of which were to tighten eligibility, reduce discounts and restrict the re-selling of properties by Right to Buy within a short period of time. Most notably, the maximum size of the discount to tenants was reduced from £50,000 to a maximum of £38,000 in February 1999, with discounts varying across regions (in some areas it could be as low as £22,000), and

[2]These valuations were set by the landlord, based on the value of the property at the time the Right to Buy application was submitted. However, the valuation was verified by a District Valuer (an independent adjudicator) in cases where the tenant thought the valuation was too high. The District Valuer would then independently value the property, and their valuation would be the one that was used as the value of the property in cases of dispute.

eligibility was based on at least two years of tenancy. In March 2003 discounts were further reduced differentially by area to reflect pressure on available public housing. In nine Local Authorities (LAs) in the South East, and all but two London boroughs, the maximum discount was reduced to £16,000 (see Figure 2, Panel (i)). In other areas, the maximum discount remained up to £38,000.

<Figure 2 about here>

The discounts were calculated as 32% of the value of the property plus 1% for each year of tenancy above the length-of-tenancy eligibility criteria if the property was a house, and 44% of the value of the property plus 2% for each year of tenancy above the eligibility criteria if the property was a flat. For example, consider two identical individuals, A and B, living in houses valued at £100,000. Both have been public renters in their respective homes for 7 years. Individual A lives in the south-east and individual B lives in the north-east. Without caps, they would both be entitled to a Right to Buy discount of 0.32*(100,000)+0.01*(7-2)*(100,000) = £37,000. However, as individual B lives in the north-east their discount is capped at £22,000, whereas individual A can have the full £37,000 discount (as this is just below the south-east cap of £38,000).

The Right to Buy rules changed again for new public sector tenants taking up their tenancy after 18 January 2005. The discounts were 35% of the value of the property plus 1% for each year above the eligibility criteria if a house, and 50% of the value of the property plus 2% for each year above the eligibility criteria if a flat. Also, the eligibility period was increased from two years to a minimum of five years of tenancy. However, these new rules only applied to new tenants who took up residency after January, 2005. Therefore, the new five year eligibility criteria did not take effect until (at the earliest) January 2010, i.e. 5 years after the amendment of the policy. Tenants who were already in a publicly rented house before January 2005 were still eligible under the two year tenancy criterion.

No discounts were available in any period if the property was rented privately. That is, only renters of publicly owned properties were eligible for the Right to Buy discounts.

In Panel (ii) of Figure 2 we show that the local authority homeownership rates are higher in areas where the discount were higher (correlation = 0.05). This is particularly true within

the East of England and the South East regions. However, when the discounts were reduced in 2003, the correlation with ownership rates fell as well (correlation = 0.03).

4 Datasets

4.1 Local Authority Data

We start by considering the local authority district (LAD) as the level of analysis. These LADs are administrative geographies that usually encompass one city or some larger rural area. They are roughly comparable to US counties. England is made up of a total of 326 LADs. We collect a range of information relating to home ownership rates, Right to Buy sales, and measures of population health reported at the LAD level. This assembled dataset includes information on home ownership, including: (i) the LAD home ownership rate, defined as the proportion of individuals living within a LAD who own (either outright or through a mortgage) their home; (ii) the number of recorded Right to Buy sales in each LAD in each year; and (iii) the maximum available Right to Buy discount cap in each LAD in each year. The dataset also contains information on measures of population health, including: (i) the proportion of individuals within a LAD who report that they have a longstanding health condition (defined as lasting at least 12 months); and (ii) the average count of the number of self- reported health conditions each individual has (individuals who report they have a health condition are asked to indicate which condition(s) they have from a pre-specified list). Finally, the dataset contains information on other LAD characteristics which could correlate with health, including: (i) the proportion of people in the LAD who are economically active; (ii) the median hours worked per-week; the median weekly pay; the population size; and the proportion of the population who are aged 65 years and older. Further information of these variables, and their sources, are reported in Table 1.

<Table 1 about here>

The wide variation in home ownership rates across Local Authorities illustrated in Panel (ii) of Figure 2 suggests a fruitful approach might be to compare home ownership rates and health over time at the Local Authority level. We do so in Figure 3, which shows scatter

plots of the average annual change in home ownership rates in each Local Authority against the average change in the number of health conditions. These changes have been predicted from a first difference regression controlling for a rich set of Local Authority characteristics such as unemployment, the proportion of economically active people, the total population, and median wages. We show that changes in the number of health conditions are negatively related to home ownerships changes. However, there are few outliers in some localities in the North, such as Manchester and Birmingham, and the South, such as West Devon and South Buckinghamshire. We will investigate this further in the empirical analyses.

<Figure 3 about here>

This macro, or LAD analysis, can uncover the local average treatment effect (LATE) of the Right to Buy policy on health. However, it may well mask a lot of important variation occurring *within* a LAD (the so-called *aggregation bias* or *ecological fallacy* argument). Aggregate levels of analysis also suffer from a lack of detailed individual-level measures of health and well-being, as well as not containing much information on the potential mechanisms by which home ownership can affect health. With these concerns in mind, we further construct a detailed dataset at the individual level, and this is outlined in the following subsections.

4.2 Individual level data: The British Household Panel Survey

We use data from waves 10 to 18 (2000-2008) of the British Household Panel Survey (BHPS) due to the availability of our outcome variables. The BHPS is a nationally representative annual longitudinal survey of households in the UK. Each member (aged 16+) of the household is asked a series of questions on a wide range of topics, including health and well-being. Information is also collected at the household level (household size and composition, council tax band[3], etc.). One attraction of the BHPS is that it asks respondents about a broad range of health conditions (as well as containing self-assessed health measures) and also contains detailed information on housing, geographic location and a broad range of socio-economic

[3]Council tax is a local taxation system used in England (as well as Scotland and Wales, but we focus on England here). Introduced in 1993, it is a tax on domestic property. Every property in the country in placed into one of eight bands, depending on the assumed capital value of the property as of 1st April, 1991. Properties constructed after 1991 are assigned a nominal assumed capital value, based on 1991 prices.

characteristics such as income and labour market status. It also has the attraction of being a panel survey which employs a 'following rule', so that it remains representative of the UK population as a whole throughout the 18 waves.

We use a special license version of the data for which we know the location (at local authority district level) of each household. Using this information, we match local level house price data derived from house price sales into the BHPS. We use the Halifax local authority-level house price index for 326 local authorities in England provided by Halifax Bank of Scotland (now part of the Lloyds banking group), the UK's largest mortgage lender (Fichera and Gathergood, 2016).

4.2.1 Health and well-being outcomes

We consider a range of measures of well-being and health. To measure subjective well-being we use the General Health Questionnaire (GHQ). The GHQ is a list of 12 questions designed to identify minor psychiatric disorders and measure psychosocial health, and has been used as a proxy for well-being in several economic analyses (Clark and Oswald, 1994; Clark, 2003; Roberts et al., 2011). Each of the 12 questions is answered on a 0-3 scale, thus giving a 37 point summary scale. For ease of interpretation, we recode GHQ such that higher scores correspond to a 'better' level of psychological health.

We use self-assessed health (SAH) as a proxy for subjective health (Contoyannis et al., 2004). Individuals are asked "Please think back over the last 12 months about how your health has been. Compared to people of your own age, would you say that your health has on the whole been ...", and are given options (1) 'Excellent' through to (5) 'Very Poor'. As with GHQ, we reverse code this so that higher responses correspond to higher levels of subjective health. Although self-assessed health is used as a general measure of health, there is evidence that it is subject to measurement error (Crossley and Kennedy, 2002).

For a more objective measure of health, we consider the count of the number of health conditions each individual has. Each respondent is shown a card with a list of 13 conditions which prior to 2001 did not contain conditions such as cancer and stroke. We focus on the 13 conditions that were consistent throughout the sample and include cancer and stroke

in the "other" category that was recorded in every wave. In the additional analyses, we investigate each of these conditions separately. We do so by generating five dummy variables for each category: (a) musculoskeletal problems, comprising arthritic/rheumatic conditions; (b) cardiovascular diseases (CVD), comprising diabetes and heart/blood pressure problems; (c) skin, allergy, hearing and sight problems; (d) respiratory problems, comprising bronchial and asthmatic conditions; and (e) other chronic problems, comprising cancer, stroke and epilepsy.

We measure health-seeking behaviours with five variables: (a) presence of private health insurance, (b) number of General Practitioner visits, (c) if a smoker, (d) number of cigarettes smoked, and (e) whether or not a person is active. Private health insurance is equal to one if the individual has paid personally for supplementary private insurance. In the BHPS individuals are asked how many times they visited the doctor in the last 12 months with the possible answers being: none; one or two times; three to five times; six to ten times; and more than ten times. We recode this variable to the midpoint value of each interval of reported number of visits. The number of cigarettes indicates the number of cigarettes smoked per day by the smokers. Smoker is an indicator variable that equals one if the BHPS respondent is currently a smoker. Active is a dummy variable that equals one if in the past 12 months the BHPS has been gardening or she had done yoga or sport several times a year or more.

4.2.2 Information on housing tenure, characteristics and eligibility for Right to Buy

The BHPS asks people to report their housing tenure from a seven point list. We use this information to classify people into three groups: (1) owners (including outright and with a mortgage); (2) public renters; and (3) private renters.

If a house is owned, the owner is asked to report the value of their property and the council tax band. We generate dummy variables for each of the eight bands of the council tax. These are: "A" for house values up to £40K, "B" for house values greater than £40K and lower than or equal to £52K, "C" for house values greater than £52K and lower than or equal to £68K, "D" for house values greater than £58K and lower than or equal to £88K, "E" for

house values greater than £88K and lower than or equal to £120K, "F" for house values greater than £120K and lower than or equal to £160K, "G" for house values greater than £160K and lower than or equal to £320K, and "G" for house values greater than £320K. Non-owners are not asked to report the value of the property, but are still asked to report the council tax band, as this is payable by everyone – regardless of tenure type.

As well as recording the date of the interview, the BHPS asks individuals what date (day, month, and year) they moved into their current house. From these two pieces of information, we can calculate how long an individual has lived at their current address. However, as day is often set to the first of the month (or missing), we focus only on the month and year, meaning we have duration at current address in months and years. We then use this information on duration to establish which public renters are eligible for the Right to Buy discount, as well as size of discount they are eligible for (equation 7).

Characteristics of the house are reported, including number of rooms, property type (detached, semi-detached, terrace, end-terrace purpose built flat, converted flat, contains business premises, and other), whether there is central heating (and if so, what fuel), whether there is a garden or terrace ("*Does this accommodation have the following facilities? A place to seat outside e.g. a terrace or garden*"), if there is a separate kitchen, and if there is a separate toilet. Individuals are also asked to report if there is a problem with pollution and crime/vandalism in their local area.

4.2.3 Socioeconomic and demographic variables

As well as detailed housing information, the BHPS contains a wealth of information about the demographic characteristics and socioeconomic position of each respondent, including gender, age, marital status, highest educational qualification attained, number of people who live in the household, and equivalised monthly household income. We use age in years (and its squared value). Gender is self-reported, and we include a dummy variable equal to one if the respondent replies they are male, zero otherwise. We use information on present legal marital status ("*What is your current legal marital status, are you...*" and list of nine options is given), creating a dummy variable equal to one if the response is either married (including cohabiting) or in a civil partnership, zero otherwise. For education, we

use a question which asks about highest academic qualification, and we create three dummy variables: one for university level education (including undergraduate and postgraduate), one for college level qualifications (including A-levels), and one for school level qualifications. The omitted category is 'no qualifications'.

There is consistent international evidence that amongst the dimensions of socioeconomic status education is the key determinant of health (Cutler et al., 2008; Cutler and Lleras-Muney, 2010). We consider the highest educational attainment because it appears to be the strongest predictor of mortality rather than years of schooling which might capture individuals repeating school (Clark and Roayer, 2013).

For income, we use a measure of total household weekly net income, which has been equivalised (using the OECD equivalence scale) and deflated for inflation. This is a derived variable (*hhnetde2*) available in the BHPS Derived Current and Net Household Income Variables dataset. To generate monthly income data, we multiply the value by 52 and then divide by 12. We additionally use information on the number of people who live in the household, which we include as a continuous variable.

The relationship between family size and health is ambiguous. On the one hand, according to the quantity-quality model an increase in family size is associated with unhealthier children because family size is an input in the health production function and the cost of investing and increasing the health of children increases with the size of the family (Becker and Lewis, 1973). On the other hand, empirical evidence finds the opposite, suggesting that in smaller families children are less exposed to diseases and this in turn weakens the development of their immune system (Karmaus and Botezan, 2002; Bevier et al., 2011). The spousal health literature suggests an ambiguous relation between individual health and that of her partner. On the one hand, "social contagion" implies that individual outcomes change the marginal utility of the partner's actions. Social comparisons between spouses, for example, attenuate the negative impact of unhealthy outcomes (i.e. weight). However, the healthcare needs that these outcomes require might incentivise the partner to improve her health. Using German panel data Clark and Etilé (2011) find evidence supporting the social contagion hypothesis. However, this is not to be interpreted as causal evidence because of the lack of exogenous variation in spousal health. We consider the total number of people in the

household comprising both adults and children.

4.2.4 Labour, leisure and housing costs

In the mechanisms analyses, we consider several labour market and leisure outcomes. We define "employed" as a dummy variable equal to one if the respondent is employed or self-employed, zero otherwise, including unemployed and retired. For those respondents who are in work, we consider working time which indicates the number of hours worked per week and commuting time which is the number of minutes spent travelling to work, one-way per day. BHPS respondents are asked the amount (in pound sterling) of expenditure on leisure activities per month from an eleven point-interval list of values ranging from under £10 to £160 or over. We take the midpoint value of each interval and treat this variable as continuous. We also consider the housing costs that a BHPS respondent incurs for either mortgage or renting. We make use of the BHPS derived variable '*xphsn*' which is defined as "*net monthly mortgage or rent costs. For renters who receive housing benefit, either partial or complete, includes the rent after the rebate. Variable is zero for houses rent free or owned outright*". As a robustness check, we compute similar variables ourselves, based on reported rent and mortgage payments, and the results were very similar.

4.2.5 Social capital

For the analysis of social mechanisms, we take a broad definition of social capital and consider measures of political and social participation, and of satisfaction. Although the BHPS is rich in measures of social activity and political participation, our choice of variables is restricted to those that were available across many years and that displayed sufficient variation in our sample of interest. We define "*vote*" as a dummy variable equal to one if the respondent supports a particular party. The variable "*Talk to neighbours*" is a dummy that equals one if the respondent talks to neighbours at least once or twice a week. "*Satisfaction with home*" is a score that indicates how satisfied the respondent is with her home and it goes from one (not satisfied at all) to seven (completely satisfied).

4.2.6 Our estimation sample at the individual level

As we are interested in the transition from renting to owning, our estimation sample is comprised of people who were public renters when we first observe them in the data. We only include individuals with more than one observation (i.e. be in the BHPS for at least two waves, which need not be consecutive). Our estimation sample contains 1,204 individuals and 6,430 observations, around 12% of the whole BHPS sample.

5 Empirical Strategy

5.1 Macro analysis

Our starting point is a macroeconomic level analysis where we consider a LAD fixed-effects (FEs) specification. The basic model is:

$$H_{lt} = \beta_1 owner_{lt} + \beta_2 X_{lt} + \mu_l + u_t + \varepsilon_{lt} \tag{1}$$

where H is a measure of LAD health, *owner* is the home ownership rate, X is a vector of LAD specific time varying characteristics (see Table 1), μ is a LAD fixed-effect, u is a time fixed-effect, and ε is an error term. Subscript l refers to LAD and t to time.

However, the above simple specification ignores reverse causality (it could simply be the LADs that experience greater increases in health also experience great increases in home ownership rates). To overcome this issue, we implement a fixed-effects instrumental variable (FE-IV) specification, where the first stage is specified as:

$$owner_{lt} = \pi_1 RtBDiscountCap_{lt} + \pi_2 X_{lt} + \mu_l^1 + u_t^1 + \varepsilon_{lt}^1 \tag{2}$$

where the first-stage instrument, *RtBDiscountCap*, is the maximum discount (or the discount cap) in a specific LAD in a given year. The identifying assumption is that at the LAD level, the RtB discount should only affect the health of the LADs population through the fact that it encourages home ownership.

This macro-level analysis will uncover the LATE, but cannot provide information on the *within* LAD variability, nor can it explain potential mechanisms. To answer these questions, we turn to an individual-level analysis.

5.2 Micro analysis

To motivate our micro-level analysis over-and-above the macro-level analysis, we plot the average level of GHQ by local authorities. By comparing panel (ii) of Figure 2 with Figure 4, we show that in local authorities where home ownership is higher there are better levels of psychological health (correlation = 0.27).

<Figure 4 about here.

However, this correlation between health and home ownership might reflect the fact that healthy individuals are more likely to become home owners. It might also be that wealthier local authorities, where ownership rates are higher, are also healthier, so that the relationship between home ownership and health is confounded by area-level factors.

We overcome some of these issues by exploiting the longitudinal nature of our individual-level data and by controlling for a wide range of factors that might affect both home ownership and health:

$$H_{ilt} = \beta_1 owner_{ilt} + \beta_2 X_{ilt} + \beta_3 HC_{ilt} + \mu_{(l \times t)} + \varepsilon_{ilt} \tag{3}$$

where subscript i indicates the individual, l is the region where i lives[4], and t is year. H is a measure of health or well-being, owner is a binary variable $=1$ if an individual owns the house they live in; 0 otherwise. The vector X contains socioeconomic and demographic information

[4]We initially wanted to use Local Authority District (LAD) level fixed effects. However, as our identification is based on the transition from public renting to owning, we did not have enough variation to include fixed-effects at this smaller geographic level. We have approximately 320 LADs in each year, but only 207 individuals go onto become owners. Therefore, for the majority of the sample LAD fixed effects and the ownership dummy are collinear. We therefore include regions as the locality effect. Whilst regions are large areas, we feel that these fixed-effects can still account for differences in England. For example, the north-east and south-east are very different. We additionally pick up LAD variation in the house price calculation by including LAD average house prices, and the first stage models (see below).

known to correlate with health and well-being (section 4.2.3). HC contains selected house characteristics that might have a direct effect on health other than through housing wealth (central heating fuel type, if there is a garden, if there are issues with pollution or if there are issues with crime/vandalism). $\mu_{(l\times t)}$ is the interaction of region (see footnote 4) and time fixed effects and ε_{ilt} is a stochastic error term whose distribution depends on the econometric model considered (see below).

The coefficient β_1 is our main coefficient of interest indicating the relationship between home ownership and health. By exploiting the longitudinal nature of our data, we estimate within region changes in health rather than health differences between regions. As we cannot control for all the geographic factors that correlate both with home ownership and health, we follow Lovenheim and Mumford (2013) and include region-by-time fixed effects. These allow us to control for factors such as the quality of healthcare or of schooling which might change over time and affect health and the propensity to become a home owner.

However, β_1 is still likely to be biased as unobserved factors that affect health also affect home ownership. For instance, individuals' time preferences, preferences over the trade-off between present and future outcomes, influence how individuals make intertemporal choices such as investing in a house, becoming a home owner and investing in prevention to increase life expectancy.

To overcome these issues, we modify equation (3) as follows:

$$H_{ilt} = \beta_1 owner_{ilt} + \beta_2 X_{ilt} + \beta_3 HC_{ilt} + \beta_4 \widehat{\varphi}_{ilt} + \mu_{(l\times t)} + \varepsilon_{ilt} \tag{4}$$

where the predicted residual ($\widehat{\varphi}_{ilt}$) is obtained from the following hedonic regression

$$owner_{ilt} = \alpha_1 RtBDiscount_{ilt} + \alpha_2 C_{ilt} + \alpha_3 X_{ilt} + \varphi_{ilt} \tag{5}$$

such that the probability of becoming a home owner is explained by the potential Right to Buy discount that this individual could receive if they bought the property they currently publicly rent. As stated above, this discount varies by individual (and house), by LAD, and over time. We outline the hedonic regressions associated with this discount in the next subsection. The vector C contains other factors that could influence the choice to buy a house, including the duration at the current property and the average local area house price,

taken from Land Registry data. We use a logit model to estimate Eq. (5), as this accounts for the binary nature of the ownership variable. Our identifying assumption here is that after controlling for a range of individual and house characteristics, as well as time invariant and time varying local authority factors (picked up by the time-varying average LAD house prices), home ownership is conditionally exogenous to health. Under this assumption, β_1 in equation (4) measures the effect of home ownership on health through changes in the value of the discount they would be entitled to.

This approach is known as two-stage residual inclusion (Terza et al., 2008). Traditional instrumental variable approaches use a similar setup, only they include the predicted value of the first stage outcome in the second stage, whereas this approach includes the predicted residual. See Terza et al. (2008) for further details of the approach.

5.2.1 Functional form for the second stage equation

Given that we consider three different health and well-being outcomes, each with different distributions, we use the two-stage residual inclusion (2SRI) procedure described above. 2SRI is more flexible than traditional instrumental variable approaches as it allows different functional forms in the first and the second stage. As mentioned above, we use a logit model for the first stage ownership equation.

We use ordinary least squares for self-assessed health. In an appendix we account for the ordinal nature of SAH by applying the ordered logit model, and the results are qualitatively very similar. For the GHQ we use OLS. It has been argued that GHQ is technically speaking ordinal, but as there are 37 response categories it is preferable to use OLS (as ordinal models do not cope well with many response categories; Greene and Hensher (2010)). Finally, for the count of conditions, we use a negative binomial count data model. This is preferred over a Poisson model due to over dispersion in the data (alpha = 63.59; $p < 0.0001$).

Given that we used ordered choice models (in the appendix) and count data models, we present marginal effects estimated at the mean of the independent variables. As self-assessed health is ordinal, we report the probabilities of reporting each of the five possible answers (see above) in an appendix. As we use OLS for SAH (in the main analysis) and GHQ, we

simply report the coefficient.

5.2.2 Calculating the size of the potential Right to Buy discount

As the Right to Buy discount varies across both time and place, we first calculate the potential discount renters could be entitled to. To do this, we use a number of hedonic regressions.

Step 1: Calculate the estimated value of a rented property

The value of the property an individual currently lives in is only reported by owners. We therefore need to calculate an estimate of the value of the properties for renters. To do this, we implicitly assume that rental properties have the same values as owned properties, *ceteris paribus*. There may be some unobservable factors (such as potential stigmas associated with ex-council housing). Given that we condition on a rich set of information (see below), we feel we mitigate somewhat against this issue. However, we return to this issue in a robustness check.

To calculate the estimated value of a property, we run a regression on owners only, where we regress reported house price (HP) as a function of house characteristics (HC^*) and average local house prices (from the land registry; $\overline{HP}$).

$$HP_{ilt} = \gamma_1 HC^*_{ilt} + \gamma_2 \overline{HP}_{lt} + u_{ilt} \tag{6}$$

where u_{ilt} is a stochastic error term. The elements of the vector HC^* include: the number of rooms in the property, the house type, the council tax band of the property, the central heating fuel type, if there is a separate toilet/bathroom, if the kitchen is open-plan, if there is a garden/terrace, if there is an indoor toilet, if there are neighbourhood problems with either crime/vandalism and/or pollution/the environment. We additionally interact the number of rooms with property type, as a five room house and a five room flat, say, may have other unobserved differences. We do not include time or local authority fixed-effects, as this variation should be captured in the average local house price ($\overline{HP}$).

We then apply these predicted coefficients $(\widehat{\gamma}_1, \widehat{\gamma}_2)$ to the same house characteristics for renters, to obtain an imputed value of a rented property, $(\widehat{HP})$.

Step 2: Calculate the potential Right to Buy discount

Once we have the estimated value of a rented property $(\widehat{HP})$, we can use this to calculate the potential Right to Buy discount that this individual could receive if they bought this property. These discounts are:

$$RtBDiscount = \begin{cases} \min\{M, (0.32HP + 0.01(T-2)HP)\} & \text{if a house} \\ \min\{M, (0.44HP + 0.02(T-2)HP)\} & \text{if a flat} \end{cases} \tag{7}$$

Where M is a local-authority level maximum threshold (which we discuss above in section 3), and T is the total time (in years) in the current property. The value of the variable M in Eq. (7) varies over time and space to reflect changes in the Right to Buy policy.

5.2.3 Bootstrapping

As we use estimated (or predicted) values in a number of steps, we bootstrap the whole procedure, using 2,000 replications. We do this to provide more confidence in the point estimates reported.

5.3 Robustness checks

A possible limitation to our macro-level analysis is that there appears to be a number of outliers in Figure 3 which may be determining the results. To test for the robustness of the results, we repeat the macro-level analysis without these outliers[5].

One limitation to our micro-level empirical strategy is that we identify changes in health off *within* region changes in home ownership. However, there might be other *within* region factors that affect home ownership and coincide with the changes in the Right to Buy subsidies. If that is so, β_1 in equation (4) would at best indicate the correlation between

[5]We remove Birmingham, Manchester Tower Hamlets, Brent, and Harrow from the 'bottom' of the figure and Tamworth, Forest Heath, Havering, Rossendale and the Isle of Wight from the 'top' of the figure.

the changes in local level characteristics and health. This could be particularly problematic because regions are large geographical entities and it is likely there to be other policy changes within a region. In order to mitigate these concerns, we estimate equation (4) on a "placebo" group that we expect not to be affected by the Right to Buy. The Right to Buy scheme was only applicable to individuals who rented public housing – it was not available for private renters. If we therefore repeat our analysis, but only consider private renters, we would not expect β_1 to be statistically different from zero. We do so by using propensity score matching with caliper and no replacement to construct a sample of private renters which is similar to public renters on a set of characteristics such as age, marital status, education, income and household size (and the interactions of these socio-economic characteristics with age), house characteristics and region and time interactions.

A second potential source of concern relates to the hedonic regression in equation (6) where we use both household characteristics and the local average property value to predict housing value. There may be a correlation between health and the misreporting of house characteristics. This could generate a form of measurement error in the predicted house value that is correlated with health thus yielding a biased estimate of β_1 in equation (4). Therefore, we re-estimate equation (6) without house characteristics – that is we simply regress reported house price on average local house prices.

A third concern may arise from the inclusion of income. Whilst this might be key to capture the socioeconomic condition of the household, it could also constitute an outcome of home ownership. In an additional robustness check we don't control for this as it may be a "bad control" (Angrist and Pischke, 2008).

Fourth, a potential source of concern is the level of analysis at the individual level. Models estimated by equation (4) consider both the health of the household and her partner. However, within the same locality the size of the discount would only vary between different houses and not individuals. Admittedly, if people sort themselves into marriage according to some unobserved preferences over health, then our instrumental variables approach would not produce an unbiased effect of home ownership on health. Additionally, we do not have information as to what share of the mortgage is paid within the household, meaning that home ownership could have a differential effect between different owners within

the household and between partners if only one is the home owner. In order to examine this, we investigate the health effects of home ownership on different individuals within the household: heads and non-heads.

Finally, one might argue that the Right to Buy scheme was more appealing to people who are in employment as opposed to those who are not. For simplicity we group full and part time employment into one category, and compare to all other statuses (including unemployed, retired, and not in the labour market). Additionally, to account for possible endogeneity, we define someone as employed if they were employed the first time they were observed in the survey. We re-estimate equation (4) on this sample of people.

5.4 Mechanisms

Investigating the mechanisms through which home ownership affects health is important for the design of policies that can influence these pathways. In the BHPS there is limited availability of specific inputs of the health production function. For instance, we have no information on food expenditure, or the time spent on leisure activities. Nevertheless, using the limited data available we explore some potential mechanisms.

First, we follow Apouey and Clark (2015) and examine the effect of home ownership on different components of health. The purpose of this exercise is twofold. Firstly, the temporal dimension of health and its measurement (Mullahy, 2016) has implications as to whether housing policies could have long-lasting or shortly-lived health effects. In the Grossman (1972) human capital model there is a distinction between health capital (i.e. a stock measure of health) and health status (i.e. "healthy time" or flow measure of health). For instance, in the BHPS the self-assessed health variable is anchored to a time dimension asking respondents to rate their health in the past 12 months. As such, it can be considered a flow measure. Instead, specific categories of health are not attached to any time dimensions and are therefore measures of the stock of health[6]. Secondly, the type of condition might inform us of the potential pathways between home ownership and health. For instance, if

[6]Although we can expect chronic conditions to be less transitory than conditions such as back problems, we have no information on the time-span they occur in.

diabetes[7] is affected by home ownership, we might expect potential pathways to be through lifestyle behaviours as being overweight, unhealthy diet and physical inactivity are three of the major risk factors for type 2 diabetes (World Health Organization, 2016). Therefore, we modify equation (4) where H indicates each of the six dummies of health conditions. We estimate six logit models separately.

Second, we directly observe some of the inputs of the health production function such as risky health behaviours, number of visits to the doctor and the purchase of private medical insurance. We expect home ownership to have an ambiguous effect on these. On the one hand, there is a wealth effect, meaning those who become home owners might be able to extract equity from their house and spend it on goods such as alcohol or cigarettes. If these are normal goods, home ownership might have detrimental effects on health. However, the wealth effect might allow individuals to purchase private medical care and have quicker access to treatment thereby improving health. On the other hand, there might be a time effect. Individuals might reduce their working hours by substituting wages for the equity extracted from the house. This extra time might be spent on preventive activities or on leisure activities (healthy or unhealthy). The extent to which individuals invest in healthier lifestyle behaviours might depend on their time preferences. Home ownership might change the intertemporal trade-off between current and future outcomes shifting individual preferences towards the future when the house can be fully owned or more equity can be extracted. In this case, individuals have more incentive to invest in their health. Or else more forward-looking individuals become home owners and invest more in their health. We explore these factors by modifying equation (4) and estimating a series of logit models of private health insurance, the probability to become a smoker and being active[8], and linear models for the number of visits to the doctor and number of cigarettes smoked by smokers.

A third potential channel is via labour market activities. We investigate whether home ownership is positively associated with the likelihood of becoming employed and whether employed people change their working hours in response to the policy. We do so, by using a two-part model for equation (4). First, we use a logit model where the dependent variable

[7]However, we note that we do not have information on the type of reported diabetes.

[8]The BHPS contains information on alcohol drinking and frequency of physical exercise, but as these were only available in every other wave, we have not used them here.

indicates whether individual i is employed. Then we use a linear model where the dependent variable is working time measured with hours per week (if individual i is employed). These labour market consequences of the policy might have ambiguous effects on health depending on the relative size of the substitution and income effects.

A fourth channel is via non-market time activities and economic resources. If home ownership and commuting times are negatively related, then individuals might spend this extra time in the production of health. However, it is worth noting here that individuals who exploit the Right to Buy policy by definition cannot move their home location. Therefore any change to commuting distance must be brought about by changes in workplace location, travel mode, or transport infrastructure (Munford et al., 2015). We estimate equation (4) with a linear model of commuting time (for those in employment). There is also a wealth effect as home owners can extract equity from their house or have more resources if their mortgage is lower than their rent, or if they were able to buy outright and are now rent-free. These extra resources could be used on leisure activities which we capture by estimating equation (4) with a linear model on expenditure on leisure activities measured in pound sterling per month. The BHPS records information on housing costs either in the form of monthly rental or mortgage payments. We modify equation (4) to be a linear model of housing costs.

A fifth channel, Disney and Luo (2017) suggest that although the Right to Buy increased home ownership, this came at the expense of housing quality. The supply of accommodations eligible for the Right to Buy, although cheaper, tended to be of poor quality. There is evidence of a detrimental effect of poor house quality on health (Shaw, 2004; Marmot et al., 2008). We do not have detailed information on the quality of the house in the BHPS. However, we have some information on the characteristics of the house that might directly impact on health. We modify equation (4) to separately estimate four logit models where the dependent variable is equal to one if the house where individual i lives has central heating, if it has garden, if there are issues with pollution or if there are issues with crime/vandalism. Note that because an individual who becomes an owner as a result of the Right to Buy scheme cannot move, we infer that they have redeveloped some land to create a garden (changing a yard to a garden, say) and their perceptions of their local area have changed,

rather than actual observable changes to their local area. One individual becoming a home owner is unlikely to reduce area level pollution, say, but could impact on that individual's perceptions.

Finally, the social capital channel may operate via increased political participation, the building of social ties with neighbours and increased satisfaction with the home which home owners can improve (Fischer, 1982; Glaeser and Sacerdote, 2000). Therefore, we estimate equation (4) with linear models of voting behaviour, of a variable indicating whether the BHPS respondent talks to their neighbours, and their satisfaction with their home.

6 Descriptive Statistics

Our micro-level estimation sample contains 6,430 observations on 1,204 individuals. Of these 1,204 individuals, 207 (17%) go on to become home owners. Of the 207 people who become owners, only 25 (12%) then go back to renting at some point in the future. We therefore infer that we can classify owning as an absorbent state here.

Table 2 provides descriptive statistics for our estimation sample. In Panel (a) we report descriptive statistics of our main variables of interest. From this, we can see that our sample have average levels of self-reported health and well-being that are towards the higher end of the respective ranges (average SAH is 3.45/5; GHQ is 23.74/36; and the average number of conditions reported is 1.69). 42% of our sample is male, with an average age of 50.45 years. Approximately 42% are married or cohabiting, and the modal level of qualification is 'no qualifications' (the omitted category). Average household equivalised monthly income is £898 (=exp(6.80)), with the average household containing just over 2 and a half people. The final column of Table 2 shows the same values for the whole BHPS 2000-2008 sample. Health and well-being is slightly higher than in our estimation sample, average age is younger and there are more males. Consistent with Disney and Luo (2017), in our sample of public renters there are: fewer married/cohabiting individuals, on average lower levels of education, and a lower average income.

The average calculated house value in our sample is just over £120,000 and the predicted Right to Buy discount is £24,250.

In Panel (b) of Table 2 we report selected descriptive statistics of the mechanisms. As in Fichera and Gathergood (2016) the proportion of people paying for private insurance is only about 5% and is very similar to the full BHPS sample. On average, those who were initial public renters go to the doctor about three times a year and this is similar to the full sample of BHPS respondents. Approximately 43% are smokers and the smokers smoke an average of 16 cigarettes per day. About 43% of our estimation sample are employed, work about 34 hours a week and spend about 20 minutes per day travelling to work. About 96% of our sample live in a house with gas and electricity which is only slightly higher than the 93% in the full BHPS sample. Compared to the full BHPS sample, our sample of initial public renters were less likely to have a garden, more likely to live in polluted areas and in areas with vandalism problems.

In Table 3, we report average health and well-being by tenancy type. We report the health and well-being for both subgroups, individuals who: (i) are always public renters (column (1)); and (ii) switch from public renting to owning (column (2)). We can see that people who are always public renters have lower SAH and GHQ scores, and more chronic conditions than those who go on to become owners. When considering the transition to ownership, we observe that there are small increases in SAH and GHQ after individuals become owners, but no change in the number of conditions reported.

<Tables 2 and 3 about here>

6.1 How good are our predictions of house values?

The R-squared in the house price prediction model (Eq. 6) is just under 65%. In Table A.1 (in the appendix) we present selected coefficients to demonstrate that they behave as expected. For example, we can see that property value increases as the number of rooms within the property increases, and that all property types are less expensive than detached properties. Also, the predicted value increases with the council-tax band. These coefficients allow us to be confident in our house price imputation equation. (Full coefficients are available on request.)

In Figure 5 we plot the predicted house values (panel a) and the actual values reported

by owners (panel b). The distributions of predicted and real values are similar, and this is confirmed in Figure A.1 (in the appendix) where we plot the predicted residuals. These residuals are normally distributed, with mean close to zero. The actual values display some clumping at £5,000 intervals..

In Figure 6 we present a scatter plot of land registry reported average house prices in LADs (x-axis) against our within-sample predicted averages (y-axis). If our predictions were perfect , we would expect all of the observations to lie on the 45 degree (grey, dashed) line. However, we can see that the actual relationship (black, solid line) is slightly above this, but that on the whole our approximations are quite good. The relationship is: average predicted values = constant + 1.07*(land registry averages), and the t-value on the 1.07 is 71.70, indicating it is strongly significant. However, we can also reject the hypothesis that the estimated coefficient is equal to one (t-value 4.94), implying whilst the relationship is close to unity, it is not equal to it.

Note Figure 6 is based on our estimation sample, whereas Figures 4 and A.1 are based on owners only (i.e. out-of-sample). Figure 5 can be thought of as a test of whether predicted values of rented houses are the same as sold houses.

<Figures 5 and 6 about here>

7 Results and Discussion

7.1 Macro level results

At the LAD level, we observe that higher Right to Buy discounts are associated with higher levels of home ownership (column (1); Table 4). Also, LADs with higher home ownership (instrumented by Right to Buy discounts) have lower rates of people with longstanding health conditions; a 10 percentage point increase in the home ownership rate reduces the rate of people with longstanding health conditions by about 2 percentage points. Similarly, higher home ownership is associated with lower average counts of the number of health problems individuals have; a 10 percentage point increase in the home ownership rate reduces the average number of health problems by around 5.

<Table 4 about here>

7.2 Individual level results

First Stage Results: How Right to Buy discounts affect the probability of home ownership

We start by considering equation 5. These results are presented in column (1) of Table 5. However, given the binary nature of the ownership outcome, we present marginal effects in column (2). We can see that the Right to Buy discount is a statistically significant predictor of homeownership uptake; a £10,000 increase in the Right to Buy discount increases the probability of ownership by 2 (=0.002*100*10) percentage points. The first-stage Likelihood-Ratio (LR)-statistic is 1036.67, meaning that the Right to Buy discount is a very strong predictor of ownership and hence our instrument is relevant. This is higher than the critical values described by Stock and Yogo (2005) and the conventional minimum value of $F = 10$ (Stock et al., 2002). The longer an individual has lived in their publicly rented property, the less likely they are to buy it; every additional year in the property reduces the probability of ownership by 0.1 percentage points. Also, people who live in areas with expensive average house prices, ceteris paribus, are less likely to buy; a 10% increase in average local property prices reduced the probability that an individual becomes an owner by 0.8 percentage points (=0.081*10).

<Table 5 about here>

Second Stage Results: How home ownership affects health and well-being

We report the second stage results along with one stage model estimates in Table 6. Home-ownership is associated with higher self-assessed health in both the one and two stage models. The significance of the first stage residual indicates it is necessary to account for endogeneity. Becoming an owner increases self-assessed health by 0.19 points on a five-point scale.

<Table 6 about here>

When we consider GHQ as an outcome, we can see there is no effect of homeownership in a one-stage OLS model (column (3)). However, when we consider a two-stage model (column (4)), we see that the effect of predicted homeownership on GHQ is large in magnitude

($\beta = 1.46$) and statistically significant. As the endogeneity test (first stage residual) rejects the null hypothesis that home ownership is exogenous, we prefer the two-stage model results.

Home ownership is associated with a reduction in the number of chronic conditions in both the one-stage and two-stage models. The reduction is larger in the two stage model (0.65 compared to 0.44), and our preferred model is the two-stage model, due to the significance of the first stage residual.

To put the magnitude of our effects into context, we compare them to estimated associations with becoming unemployed. Böckerman and Ilmakunnas (2009) use data from the European Community Household Panel for Finland and show that, becoming unemployed reduces self-assessed health (measured on a five-point scale) by 0.23 points, after controlling for socioeconomic information and random-effects. This reduction is comparable to the results we present here; it would appear that becoming unemployed is at least as 'bad' for health as becoming a home owner is 'good'.

Clark (2003) found that unemployment reduced GHQ by around 0.83. These figures are comparable in magnitude with our estimate. However, some caution must be observed – Clark (2003) used the 12-point version of the GHQ (whereas we use the 36-point version). He also dichotomised the data, such that he compared the top score (12) to all others (0-11) and used a fixed-effects logit model. A similar result was found by Booker and Sacker (2012), who considered the effects of unemployment spells. They showed that the first spell reduced GHQ by 1.33, but again they used the GHQ12. Wildman and Jones (2002) consider the effects of unemployment on GHQ using BHPS data, only they use the 36-point version of GHQ. They show that unemployment reduced GHQ by 1.98 points, but that this reduces in magnitude (to about 1.00) when you control for financial satisfaction and expectations of future financial position. Flint et al. (2013) also consider unemployment using the BHPS, but condition on local area employment characteristics, and find that being unemployed reduces GHQ by 2.2 (on the 0-36 GHQ scale). Based on these papers, we feel our result is plausible – becoming a home owner is in the same range (but opposite sign) to becoming unemployed.

From the results presented above, we observe that for both (self-assessed) heath and subjective well-being, measured by the GHQ36, the effects of becoming a home owner are of a

similar magnitude, but opposite sign, to the effects of becoming unemployed.

7.2.1 Function form of second stage

Given that self-assessed health is technically an ordinal variable, we estimate marginal effects following an ordered logit regression (Table A.2, in the appendix), where we observe for both the one- and two-stage models, that ownership increases the probability of being in the top two responses (excellent and very good) and reduces the probability of being in the bottom three classes (good, fair, and poor). We prefer the two-stage results, due to the significance of the first-stage residual in the second stage outcome model.

7.3 Leads and Lags

In the main results presented above, we have shown that the average health of those individuals who become a home owner is higher than those individuals who do not become an owner. However, we do not know if there were anticipation effects, nor do we know if this result is due to increasing health of new owners or deteriorating health of non-owners. For example, Disney and Luo (2017) argue that the non-bought housing stock is of lower quality, so it may not be unreasonable to assume that those houses which are not bought are worse, and hence the people who continue to rent them experience worse health relative to those who buy their (better) homes. To descriptively examine these two potential explanations, we plot the average health status of those who do go on to become a home owner against years to and from becoming an owner in Figure 7. For graphical clarity, we normalise all health measures to one at the year ownership occurs. For reasons of statistical accuracy, we focus on four years prior and six years post ownership to ensure all cells contain at least 35 observations.

<Figure 7 about here>

From Figure 7, we can see there does not appear to be any anticipation effects. In the four years leading up to ownership all three health measures appear pretty constant (with some small deviations). However, after becoming an ownership there are marked improvements in all three health measures. GHQ and SAH increase and there is a reduction in the number

of health problems reported. This Figure would suggest that we are observing the results we report due to improvements in the health of owners, and not deteriorating health in the non-owners/constant renters.

If we look at the relationship between years post-ownership and health for those who do become an owner (Table A.3, in the appendix) we can see that health does improve as time passes. This is true when we consider health as a linear trend (columns (1), (3), and (5)), but also when we include years post ownership as a series of binary variables (columns (2), (4), and (6)).

7.4 Robustness checks

In this sub-section we present the results from these robustness checks we outline in Section 5.3. For reasons of brevity, we only present the second stage results.

7.4.1 Excluding outliers

When we remove outliers such as Manchester and Birmingham, West Devon and South Buckinghamshire from our macro-level analysis, we observe that the results are qualitatively and quantitatively very similar, and hence are robust to the exclusion of these potential outlier LADs (results available on request).

7.4.2 Placebo test: Use initial private renters

The results from this placebo test are reported in Table 7, and as hypothesised above, we observe no statistical relationship between ownership and health and well-being outcomes. The coefficients maintain the expected direction, but are much smaller than for public renters (Table 6). It is worth noting here that the private renters were chosen to be as similar as possible to public renters to make these results more interpretable. As a result, the 2SRI residual is no longer statistically significant indicating that selection into treatment was a source of endogeneity. We note that results for the one stage OLS are quite similar (available from the authors on request).

<Table 7 about here>

7.4.3 Other robustness checks

How to calculate the estimated value of a rented property

In the reduced specification of the house price equation, the coefficient on local average house prices is 1.25 (standard error = 0.011; t-statistic = 115.66). This is larger than the corresponding coefficient in the full model (0.94; first row of Table A.1). The adjusted R-squared of the model with only local average house prices is 24%, compared to the adjusted R-squared in the full model of 65%.

In Figure A.2 (appendix) we show the relationship between the two predictions, and we see this is upward sloping and close to the 45 degree line. However there is some variability, and in Figure A.3 (appendix) we plot the distribution of the predicted values from the full model (grey bars with no lines) and the reduced model (clear bars with black lines). For graphical quality, we have censored the upper tail at £1,000,000. This figure shows that the two distributions are quite similar, with the reduced model's predictions being slightly to the right of the full model's, on average.

When turning to the results of the second stage equation, in panel (a) of Table 8 we observe that how we predict house prices for public renters makes very little qualitative difference in that the sign and significance is the same. The magnitude of the coefficients is also quite similar.

<Table 8 about here>

Exclude income

When we remove income from the set of control variables (panel (b), Table 8), we observe that the main result holds true; home ownership is good for health. However, the magnitude of the relationship is slightly smaller for all three health measures when we exclude income.

Consider the head of household and non-head of household separately

In our data, we have 4,185 observations on 858 individuals who are classified as being the

head of household (as defined in the BHPS[9]). The results for GHQ and the number of conditions are qualitatively the same as the main results (columns (2) and (3), panel (b) of Table 8). However, when we consider self-assessed health as the outcome, we observe no statistically significant effect.

We additionally have 2,245 observations on 598 individuals[10] who are classified as not being the head of household. For the non-heads (panel (c) of Table 8) we observe consistently larger health benefits than reported in the main results (Table 6) and for the subsample of heads of household. We attribute this to the fact that the decision to become a home owner may have been exogenously imposed upon the non-heads by the head. It is also possible to imagine that non-heads face less financial pressure, and hence enjoy living in an owned home more.

Consider only people who are employed when first observed

We have information on 527 individuals (2,790 observations) who meet our definition of being initially employed (Section 5.3). The results based on this sample are qualitatively similar to the main results (panel (d) of Table 8); we observe the same sign and statistical significance. The effects on self-assessed health and the number of conditions are slightly smaller, but larger for GHQ in this sub-sample. We therefore conclude that our main results are not being driven by the policy being taken up more by individuals in employment compared to individuals who are unemployed or retired.

7.5 Mechanisms

In Panel (a) of Table 9 we investigate which type of health conditions are affected by home ownership. We find that those who become home owners are 14 percentage points less likely to report cardiovascular conditions such as diabetes. This might suggest that one

[9]The BHPS definition of the head of household is defined as the principal owner or renter of the property, and (where there is more than one), the eldest taking precedence.

[10]Note that the number of observations between the two subsample (4185+2245) sums to the full sample (6430). However, the number of individuals in the two subsamples (858+598=1456) is larger than the overall number of observations (1204). This is due to the fact that head of household is not stable over time; for example an individual maybe the head of household in one wave, but not the next.

of the pathways through which we observe health improvements is via lifestyle behaviours. Indeed, we find that those who become home owners are 11 percentage points less likely to smoke (column 4b).

<Table 9 about here>

We also find that those who become home owners are 13 percentage points less likely to report respiratory problems. If, as Shaw (2004) suggests, those living in poor quality accommodations are more likely to exhibit respiratory conditions, then our results suggest that the Right to Buy did not lower housing quality to the point that the health of the new home owners deteriorated. Actually, we find that those who become home owners are seven percentage points more likely to have a garden. As noted above, as household location is fixed for people who bought under the policy, this suggests that people redeveloped existing land into a usable garden space. We explore the possibility of excluding potential movers in section 7.5.1. to further strengthen this claim.

With regards to health-seeking behaviours (panel (b) of Table 9), those who become home owners are four percentage points more likely to buy private health insurance and go to the doctor about two times less per year than renters. This might be because those who become home owners are relatively healthier.

We hypothesised that one potential pathway from home ownership to health was via the labour markets. We find that those who become home owners are 11 percentage points more likely to be employed. Whilst this result would appear contradictory to that of Blanchflower and Oswald (2013), we emphasise a number of important differences; their analysis used state level data whereas we use individual level data. They also consider all individuals, whereas we only focus on initial public renters. Further, although we find no evidence of a reduction in working time (Fichera and Gathergood, 2016), we find they spend about 5 minutes less travelling to work than renters. Our results suggest that they spend the extra resources (from working or saving on rent) and, to some extent, the extra time available to spend about six extra pounds on leisure activities. When we consider total monthly household costs, we find that those who own their home spend approximately £200 more a month on their home that those who rent.

Finally, our results suggest that owners are less likely to talk to their neighbours and are much more satisfied with their home than renters. There is no difference in voting behaviour between renters are owners.

All in all, our models suggest that the mechanisms through which home ownership affects health may operate via the labour markets with new job opportunities (conditional on a fixed household location), extra time saved travelling and resources available for (healthy) leisure activities.

7.5.1 Robustness check for mechanisms

Some of the potential mechanisms we explore above could be interpreted as an individual owning a different house to the one they previously rented (e.g. the garden mechanism and changes in commuting time). In order to attempt to establish if the individual bought the house they were renting (and hence more likely to exploit the Right to Buy scheme), we perform a final robustness check. Through a special license version of the BHPS, we are able to obtain the Lower Super Output Area (LSOA) of each respondent. LSOAs are small levels of administrative geography based on the 2001 Census. Each LSOA contains approximately 1,500 individuals. For the purpose of this robustness check, we assume that if an individual does not change their LSOA throughout their time in the sample, then they have not moved house. Moves within an LSOA are uncommon due to their small size. Based on this constant LSOA assumption, our sample reduces for $N = 1204$ $[NT = 6430]$ to $N = 983$ (82%) $[NT = 3908; 61\%]$. We then repeat the analysis on this subsample, and the results are reported in Table A.4 (appendix). We observe that the results are essentially the same in terms of direction and statistical significance. We have additionally performed robustness checks on variables we infer could also be proxies for constant household location and the results remain robust (available from the authors on request). We therefore conclude that our results are not impacted upon by people moving to (and buying) houses other than the ones they were previously renting; that is, we can make stronger clams regarding the likely impact of the Right to Buy scheme.

8 Conclusion

Our results indicate that the Right to Buy scheme did lead to increased levels of home ownership, and that that this home ownership is associated with better levels of health, both at the macro (LAD) and micro (individual) level. At the macro level, LADs with higher Right to Buy discounts have higher levels of home ownership, and LADs with higher home ownership rates have fewer people with longstanding health conditions and also smaller numbers of health conditions reported.

At the individual level, we find that becoming a home owner, from the initial position of being a public renter, led to higher levels of health and well-being. The variations in the size of discounts available under the Right to Buy policy are a good predictor of home ownership. The results are consistent across both subjective and more objective measures of health. The Right to Buy policy has been shown to be a success in that it encourages individuals who otherwise would not have been able to buy their home, but to our knowledge this is the first study that quantifies the effect it has had on health and well-being. However, we acknowledge here that we have not performed a full population evaluation – we have only looked at the benefits to the people who were eligible, and so the results must be interpreted with some caution.

By considering only people who were eligible for the Right to Buy discount (those individuals who were public renters) and exploiting exogenous variation in the size of the discount offered, we assert that our estimated effects of the health and well-being gains of home ownership can be considered as causal.

Our main results hold for our estimation sample, and as expected they do not hold true when we consider a falsification test – a 'placebo'-policy where we apply the discounts to the ineligible private renters. Further, our results are robust to the relaxation of a number of assumptions we make.

When considering the mechanisms behind our results, we find evidence to suggest that those who go onto become owners are less likely to have unhealthy behaviours (such as smoking) and less likely to suffer from cardiovascular and respiratory conditions. Those who become owners are also more likely to buy health insurance and make fewer visits to their GP.

The results we present above are plausible, both in terms of direction and magnitude. However, there are a number of possible limitations, which we discuss below. First, we do not know whether those individuals who were eligible for the Right to Buy scheme and then went onto become an owner actually took advantage of the scheme. There are no variables in the BHPS that specifically indicate if the scheme was taken advantage of. We therefore rely on the hypothesis that (at least in the majority of cases) this is likely to be the case. If a rational individual was going to buy their property and a discount was available, then we assume that rationality implies that this discount was exploited. Further on this point, when we compare the effects of home ownership on the number of conditions reported, we observe that the macro analysis, instrumented with the actual Right to Buy discount, has a coefficient of 0.5 and the micro analysis, instrumented with the potential Right to Buy discount, has a coefficient of 0.6. These two estimated effects are similar in magnitude, and this further strengthens our assumption that our sample of BHPS respondents did indeed take advantaged of the scheme.[11]

Second, whilst we have bootstrapped our estimates using 2,000 replications, we have not explicitly accounted for the nested (or multilevel) nature of the full BHPS data. That is, the BHPS has information on individuals nested within households nested within local authorities. Our current bootstrapping procedure ignores this nesting.

Third, we have considered home ownership as the main effect of the Right to Buy policy. This can be thought of as the 'extensive' margin. It may well be interesting to consider the 'intensive' margin and look at wealth (and/or income) effects alongside home ownership. That is, examine how an individual's health and well-being responds to a wealth shock brought about by the policy. However, the BHPS only contains detailed wealth information in three years (1995, 2000, and 2005), and hence we will lose a lot of information from the years in between.

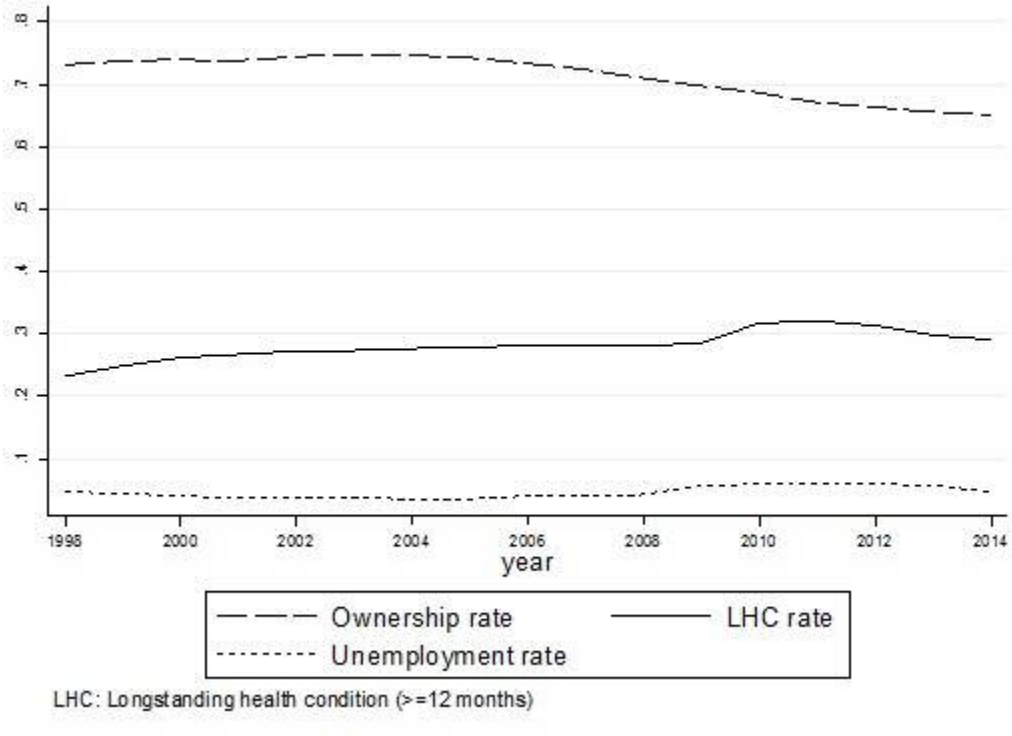
All in all, our findings, that home ownership has a positive impact on health, might support initiatives such as the Affordable Homes Programme being implemented in the UK. Our results support Buck et al. (2016) suggesting that population health cannot be improved

[11] We cannot perform similar checks on other outcome variables, as they are not consistently in both macro and micro level datasets.

by the National Health Service (NHS) alone and that appropriate housing policies, such as affordable housing, can support health policies (NHS England, 2014). Also, because we find that some mechanisms operate via reduced travelling time and extra time spent on healthy leisure activities, improvements in the infrastructure and transport system that reduce travelling time might also be beneficial to health. More widely, our findings support the idea that as health is determined by wider socio-economic factors, non-health policies can impact on health.

Figures and Tables (to be inserted into the body of text)

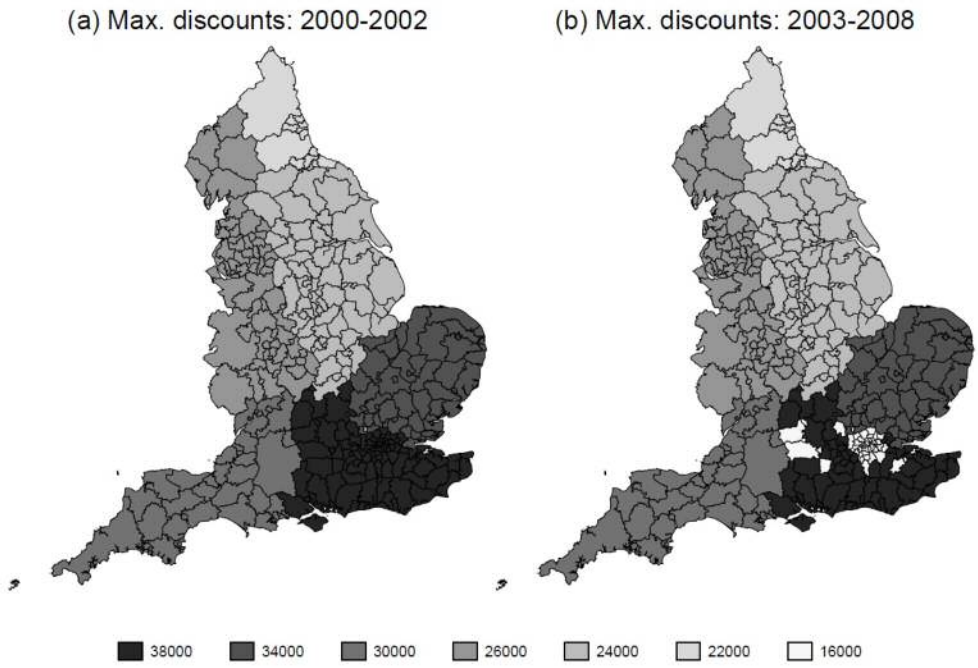
Figure 1: Time trends of health, home ownership and unemployment



Source: Authors' calculations from the U.K. Labour Force Survey.

Figure 2: Map of geographic variation in subsidies and ownership rates in England

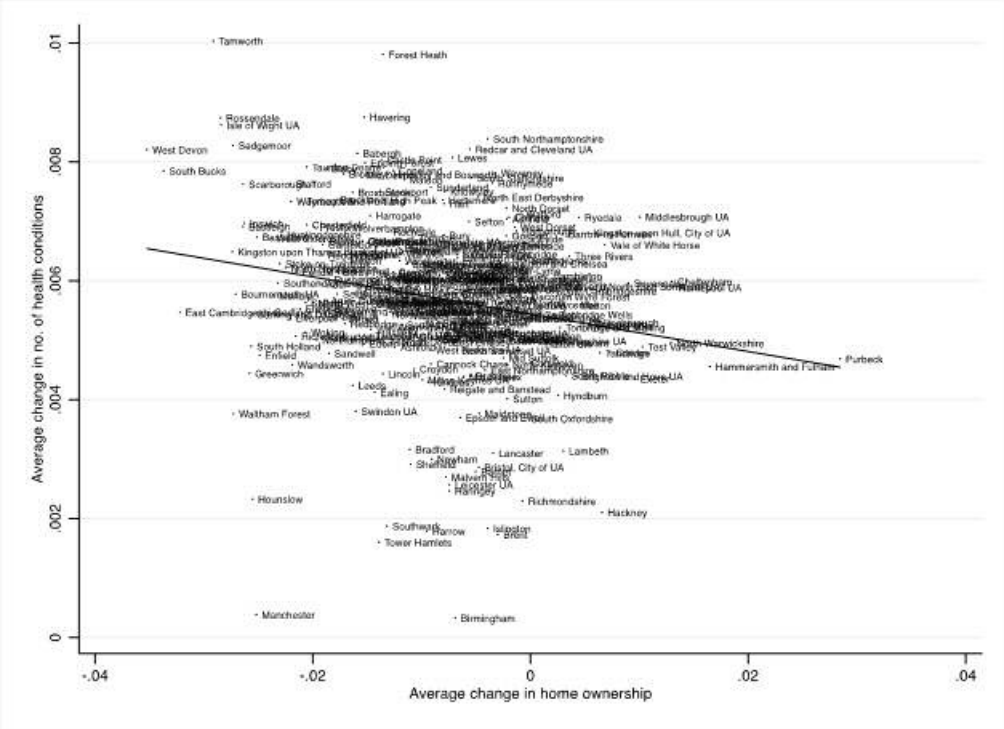
Panel (i): Right to Buy maximum discount caps by local authorities



Panel (ii): Average annual ownership rates by local authorities

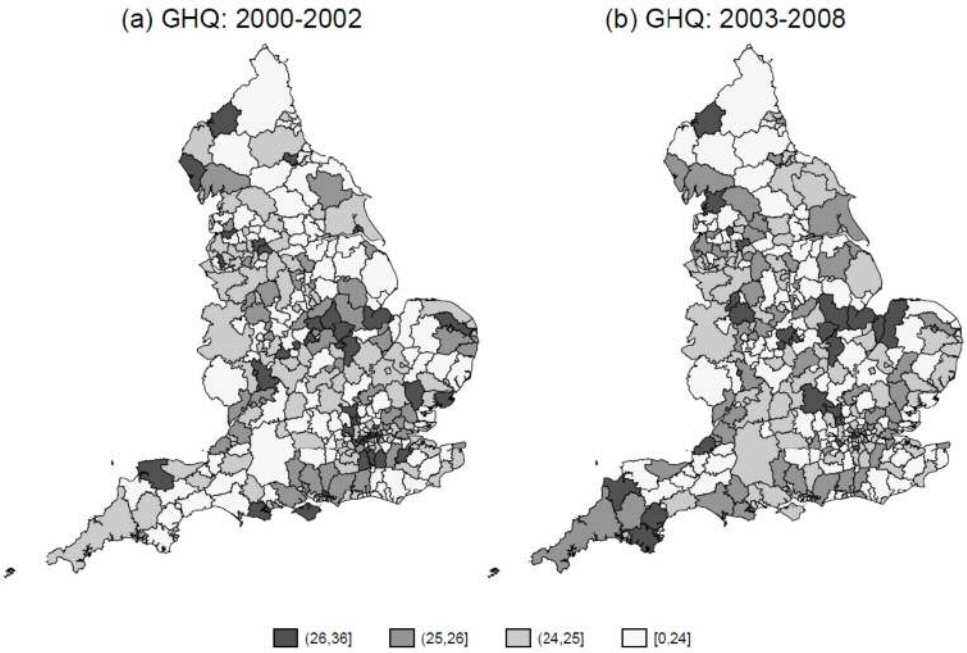
Source: Authors' representation. Data for the top two graphs has been obtained from the Department of Communities and Local Government. The bottom two graphs use BHPS data 1999-2008, to show the local authority average of the ownership variable. As this variable is binary, we multiply by 100 to obtain percentages.

Figure 3: Scatter Plot of average change in home ownership and average annualized change in number of health conditions



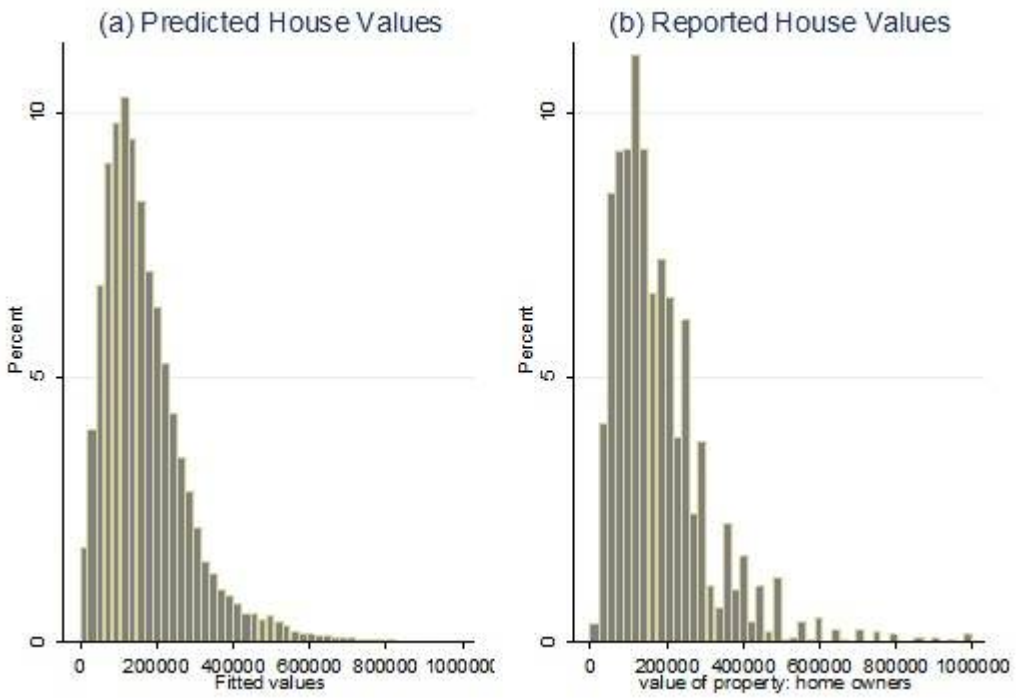
Source: Local authority data 2003-2010.

Figure 4: Map of geographic variation of GHQ score for initial public renters



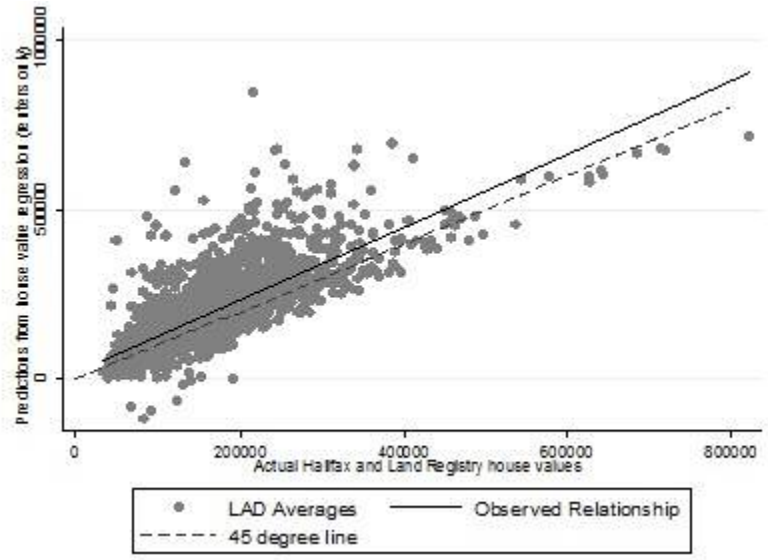
Source: Authors' representation from BHPS data 1999-2008. GHQ scores are averaged across local authority districts.

Figure 5: Predicted and reported house values



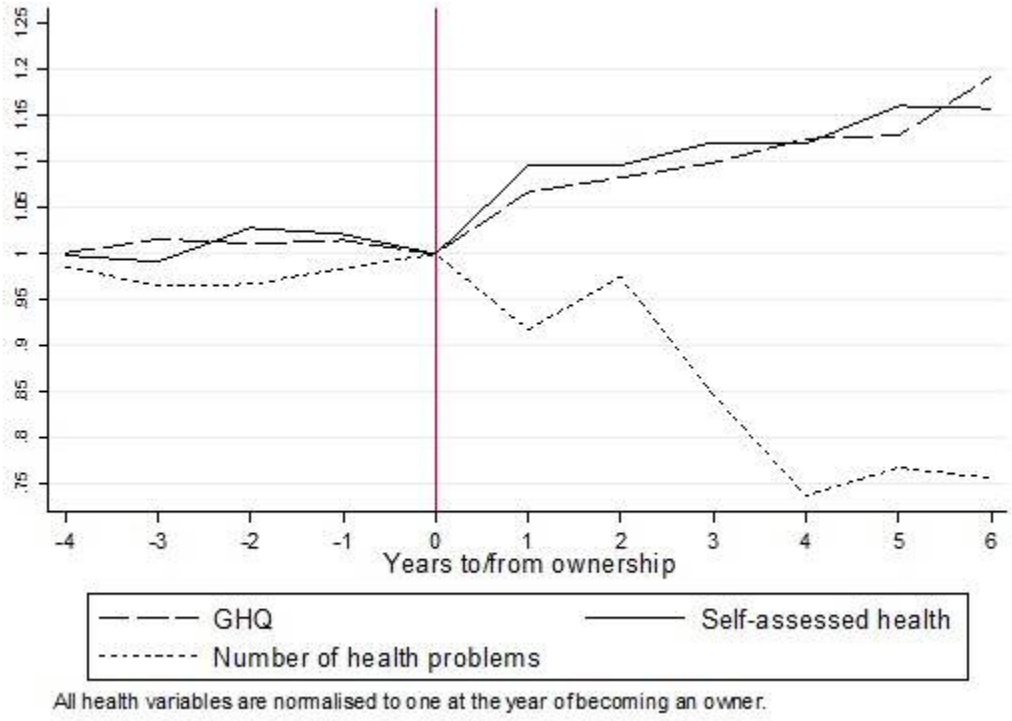
Source: Authors' representation from BHPS data 1999-2008. For graphical clarity, we censor the observations at £1,000,000.

Figure 6: Examining the goodness of predicted house values: local authority district average prices



Source: Authors' representation from BHPS data 1999-2008 (y-axis) and Halifax and Land Registry data (x-axis). For graphical clarity, we censor the observations at £1,000,000.

Figure 7: Average health for those who become an owner by years to/from ownership



Source: Authors' representation from BHPS data 1999-2008.

Table 1: Second Stage models of physical and psychological health outcomes for remaining robustness checks

Variable	Definition	Source
Home ownership rate	The proportion of people in a LAD who report that they own (outright or through a mortgage) their home	Authors derivations from LFS data. The variable we use is 'TEN1'[a].
RtB sales	The number of houses sold through the RtB scheme in each LAD	Department for Communities and Local Government (DCLG). Table 685, available online at https://www.gov.uk/government/statistical-data-sets/live-tables-on-social-housing-sales
RtB maximum discount	The maximum available RtB discount in each LAD	Email communication from DCLG.
% who report having a longstanding health condition	The average number of people who report having a longstanding health condition (LHC) in a LAD. A LHC is defined as lasting more than 12 months.	Authors derivations from LFS data. The variable we use is 'LNGLIM'[b].
Average number of (self-reported) health conditions	The average number of self-reported health conditions individuals in a LAD have.	Authors derivations from LFS data.
% who are economically active	The percentage of the LAD population who report they are economically active (including the employed and the unemployed who are actively seeking work).	NOMIS[c]
Median hours worked per week	The median number of hours worked by an individual per week in a LAD.	NOMIS[c]
Median weekly pay	The median weekly salary received by an individual in a LAD (deflated using the RPI with 2008 as the base year).	NOMIS[c]
Population size	The total size of the LAD population.	NOMIS[c]
% of population aged 65 years and older	The proportion of individuals in an LAD who are aged 65 years and above.	NOMIS[c]

a: we define owners as responses (1) owned outright and (2) being bought with a mortgage or loan.
b: we are aware that this variable changed in Spring 2000 (in that it was asked to more individuals; previous to this it was limited to individuals of working age only, whereas after spring 2000 it was asked to all respondents of working age or those aged 75 and under and first contact or those aged 75 and over and are not too ill/distressed to continue) and again in Spring 2013 (being replaced with 'LNGLST'). However, these changes do not affect our time frame of consideration (2003 – 2010).
c: NOMIS is the Office for national Statistics (ONS) official labour market statistics portal – see https://www.nomisweb.co.uk/

Table 2: Summary statistics from the individual-level data

	Estimation Sample				Full BHPS Sample
	Mean	Std. Dev.	Min.	max.	Mean (Std. Dev)
Panel (a): Main analysis					
Health and well-being					
Self-assessed health	3.45	1.02	1	5	3.81 (0.92)
General Health Questionnaire score	23.74	6.04	0	36	24.82 (5.38)
Number of health conditions reported	1.69	1.59	0	9	1.18 (1.32)
Individual characteristics					
Male	0.42		0	1	0.47
Age	50.45	19.93	16	99	47.41 (18.27)
Age squared	2942.11	2145.52	256	9801	2581.73 (1880.20)
Married	0.42		0	1	0.57
School qualifications	0.33		0	1	0.32
College qualifications	0.1		0	1	0.19
University qualifications	0.05		0	1	0.22
House characteristics					
Equivalised log Household income	6.8	0.47	1.58	9.76	7.11 (0.62)
Number of people in household	2.68	1.5	1	8	2.69 (1.30)
Estimated House Price (£'000s)	120.05	78.5	0.23	717.1	N/A
Calculated RtB discount (£'000s)	24.25	9.89	0	38	N/A
LAD average house prices (£'000s)	142.98	73.51	43.27	823.18	N/A
Transition to ownership					
Becomes a home owner	0.17	0.35	0	1	N/A
Panel (b): Mechanisms					
Private Health Insurance	0.02		0	1	0.06
Number of visits to the doctor in last year	3.82	3.52	0	10	2.93 (3.06)
Number of cigarettes smoked per day	16.16	8.99	0	80	14.30 (8.39)
Current smoker	0.43		0	1	0.24
Active	0.36		0	1	0.37
Employed	0.43		0	1	0.62
Working time (hours per week)	33.78	12.74	1	97	34.64 (12.23)
Commuting time (one way; minutes)	20.57	18.55	1	240	24.86 (22.02)
Expenditure on leisure (£ per week)	28.39	36.72	0	160	41.30 (43.18)
Housing costs (net monthly £)	188.89	184.69	0	1,716	266.97 (315.98)
Gas/electricity	0.96		0	1	0.93

Garden	0.91		0	1	0.94
Pollution in area	0.08		0	1	0.07
Vandalism in area	0.27		0	1	0.16
Vote	0.35		0	1	0.39
Talk to neighbours	0.81		0	1	0.78
Satisfaction with home	5.13	1.62	1	7	5.40 (1.38)
Individuals (N)		1,204			20,294
Observations (NT)		6,430			56,607

These values are based on the original sample(s), and not on the bootstrapped data. For the full sample, we report mean and standard deviation values only for reasons of space. In Panel (b) the sample size for each variable is the same as the estimation samples in Table 7 which we do not report for reasons of space. The full sample for the mechanisms is lower than the one reported for the labour market variables referring to those in work ($NT = 34,700$), and for the cigarettes smoked by smokers ($NT = 12,986$).

Table 3: Average health by changes in tenancy

	Always Public renter	Public renter to owner		
		Pooled	Before	After
	(1)	(2)	(3)	(4)
Self-assessed health	3.39	3.78	3.77	3.78
	(1.03)	(0.91)	(0.90)	(0.94)
GHQ	23.59	24.58	24.39	24.86
	(6.06)	(5.83)	(5.76)	(5.93)
Number of Health Conditions	1.82	0.99	0.99	0.99
	(1.62)	(1.20)	(1.22)	(1.18)
Individuals	999		205	
Observations	5,454	976	390	586

Standard deviations in parentheses.

'Before' refers to the health/well-being of those individuals who went on to become an owner when they were still a public renter. 'After' refers to their health/well-being once they have become an owner.

Table 4: Local Authority District level fixed-effects instrumental variables analysis of home ownership on health

	(1)	(2)	(3)
	(First stage)	(Second stage)	(Second stage)
	LAD ownership rate	Rate with LHC	Average# of health probs.
LAD ownership rates		-0.198***	-0.493***
(*Instrumented*)		(0.053)	(0.151)
Maximum RtB disc. (£'000s)	0.00240***		
(*Instrument*)	(0.000)		
% of population aged 65+	-0.0124***	0.00931***	0.0181***
	(0.002)	(0.002)	(0.006)
Median weekly pay (deflated)	0.00000146	-0.0000250	-0.0000140
	(0.000)	(0.000)	(0.000)
Median hours worked per week	0.00308	-0.00310*	-0.00650
	(0.002)	(0.002)	(0.005)
% in LAD economically active	0.00164***	-0.00185***	-0.00620***
	(0.000)	(0.000)	(0.001)
Year dummies	Yes	Yes	Yes
Observations (N*T)	2161	2161	2161

Sample includes initial public renters only, 2003 – 2010. We have information on N=311 LADs.

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

LHC=longstanding health condition (lasting at least 12 months).

Table 5: First Stage model of predicted Right to Buy discount on ownership

	(1)	(2)
	Coefficient	Marginal Effect#
Calculated RtB disc. (£'000s)	0.0266	0.002
	(0.005)***	(0.0003)***
	[0.006]***	[0.0004]***
Time lived at property (years)	-0.0184	-0.001
	(0.006)***	(0.0004)***
	[0.008]***	[0.0005]***
Log(average LAD house price)	-1.139	-0.081
	(0.121)***	(0.0088)***
	[0.164]***	[0.010]***
Socioeconomic Characteristics [a]	Yes	Yes
Year dummies	Yes	Yes
Observations (N*T)	6430	6430

Sample includes initial public renters only, 2000 – 2008. We have information on N=1204 individuals.

Standard errors in parentheses. Bootstrapped standard errors, based on 2,000 replications, in brackets.

* p<0.10, ** p<0.05, *** p<0.01.

a: additional controls include: sex, age, age squared, log of monthly household income, marital status, and educational attainment.

#: Marginal effects calculated at the means of independent variables.

Table 6: Single-stage and Second-stage models of physical and psychological health outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome:	SAH	SAH	GHQ	GHQ	#Probs	#Probs
Model:	OLS	2SRI OLS	OLS	2SRI OLS	Nbreg	2SRI Nbreg
Becomes a	0.248	0.185	0.455	1.458	-0.441	-0.651
home owner	(0.039)***	(0.082)**	(0.234)*	(0.492)***	(0.059)***	(0.115)***
	[0.048]***	[0.104]*	[0.287]	[0.587]**	[0.088]***	[0.149]***
First Stage		0.023		-0.365		0.074
Residual		(0.003)***		(0.158)**		(0.034)**
		[0.003]***		[0.151]**		[0.035]**
Socioeconomic Characteristics[a]	Yes	Yes	Yes	Yes	Yes	Yes
Housing Characteristics[b]	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Region dummies[c]	Yes	Yes	Yes	Yes	Yes	Yes
Year × Region Interactions	Yes	Yes	Yes	Yes	Yes	Yes
Observation (NT)	6430					

Sample includes initial public renters only, 2000 – 2008. We have information on N=1204 individuals.

Standard errors in parentheses. Bootstrapped standard errors, based on 2,000 replications, in brackets.

* p<0.10, ** p<0.05, *** p<0.01

The estimates presented in columns (1) - (4) are coefficients. The estimates presented in columns (5) and (6) are marginal effects, calculated at the means of independent variables.

a: additional controls include: sex, age, age squared, log of monthly household income, marital status, and educational attainment.

b: housing characteristics included are: heating type, problems with vandalism or crime, problems with pollution, whether there is a garden

c: England is broken down into 16 regions. We include regions as opposed to lad dummies as using lower levels of geography encountered problems with collinearity (see footnote 4).

Table 7: Second Stage models of physical and psychological health outcomes for first robustness check (placebo policy of private renters)

	(1)	(2)	(3)
Outcome:	SAH	GHQ	#Probs
Model:	2SRI OLS	2SRI OLS	2SRI Nbreg
Becomes a home owner	0.099	0.458	-0.277
	(0.125)	(0.458)	(0.173)
First stage residual	-0.003	-0.079	0.033
	(0.044)	(0.263)	(0.059)
Observation (NT)		1413	

Sample includes initial private renters only, 2000 - 2008. Initial private renters are matched to similar initial public renters using propensity score matching. We have information on N=545 individuals.

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Marginal effects, from second stage models, calculated at the means of independent variables. The models contain all additional variables as reported in Table 6.

Table 8: Second Stage models of physical and psychological health outcomes for remaining robustness checks

	(1)	(2)	(3)
Outcome:	SAH	GHQ	#Probs
Model:	2SRI OLS	2SRI OLS	2SRI Nbreg
Panel (a): Only LAD averages in house price prediction			
	$(NT = 6430; N = 1204)$		
Becomes a home owner	0.194	1.429	-0.658
	(0.082)**	(0.489)***	(0.114)***
First stage residual	0.019	-0.353	0.076
	(0.003)***	(0.156)**	(0.034)**
Panel (b): Exclude income as a covariate			
	$(NT = 6430; N = 1204)$		
Becomes a home owner	0.159	1.26	-0.543
	(0.095)*	(0.565)**	(0.086)***
First stage residual	0.032	-0.274	0.092
	(0.032)	(0.191)	(0.026)***
Panel (c): Head of households only			
	$(NT = 4185; N = 858)$		
Becomes a home owner	0.095	1.931	-0.664
	(0.102)	(0.604)***	(0.147)***
First stage residual	0.022	-0.56	0.081
	(0.031)	(0.185)***	(0.040)**
Panel (d): Non-head of households only			
	$(NT = 2245; N = 598)$		
Becomes a home owner	0.36	2.595	-0.704
	(0.153)**	(0.934)***	(0.178)***
First stage residual	-0.012	-0.806	0.122
	(0.005)**	(0.339)**	(0.061)**
Panel (e): Initial employees			
	$(NT = 2790; N = 527)$		
Becomes a home owner	0.083	2.955	-0.34
	(0.015)***	(0.939)***	(0.179)*
First stage residual	0.044	-1.096	0.047
	(0.006)***	(0.387)***	(0.074)

Each panel contains a separate second stage model.

Sample includes initial public renters only, 2000 – 2008. Number of observations (N*T) and individuals (N) is shown in each panel.

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Marginal effects, from second stage models, calculated at the means of independent variables. The models contain all additional variables as reported in Table 6.

Table 9: Second Stage models of physical and psychological health outcomes for remaining robustness checks

Panel (a): Specific health conditions						
	(1a)	(2a)	(3a)	(4a)	(5a)	(6a)
	Musculoskeletal	CVD	Skin problems	Respiratory problems	Depression	Other chronic
Becomes a home owner	0.0311	-0.1365	-0.1485	-0.1289	-0.0166	-0.0357
	(0.0526)	(0.0393)***	(0.0391)***	(0.0362)***	(0.0327)	(0.0335)
First stage residual	-0.0421	0.0072	0.0315	0.0187	-0.0017	0.006
	(0.0175)**	(0.0111)	(0.0615)***	(0.0109)*	(0.0103)	(0.0101)
Observations (NT)	6,430	6,430	6,430	6,430	6,430	6,430
Panel (b): Health-seeking behaviours						
	(1b)	(2b)	(3b)	(4b)	(5b)	
	Private health ins.	No. visits to GP	No. cigarettes	Smoker	Active	
Becomes a home owner	0.0414	-1.6989	-0.4391	-0.1075	0.0622	
	(0.0194)**	(0.2872)***	(1.2602)	(0.0466)**	(0.0625)	
First stage residual	-0.0011	0.2078	0.2377	0.0105	-0.0109	
	(0.0067)	(0.0922)**	(0.4235)	(0.0155)	(0.0188)	
Observations (NT)	3,903	6,419	2,751	6,430	2,954	
	(1c)	(2c)	(3c)	(4c)	(5c)	
	Employed	Working time	Commuting time	Expenditure on leisure	Housing costs	
Becomes a home owner	0.1114	-2.5493	-5.4086	6.5273	200.846	
	(0.0535)**	(1.5348)	(2.6990)**	(2.7736)**	(12.7978)***	
First stage residual	0.0484	1.5743	1.7619	1.2641	-24.4117	
	(0.0162)***	(0.5582)***	(1.7619)*	(0.8905)	(4.1067)**	
Observations (NT)	6,414	2,707	2,511	6,401	6,404	

Table 9: *continued from previous page*

Panel (c): Labour markets and economic resources				
Panel (d): Housing quality				
	Gas/electricity	Garden	Pollution	Vandalism
	(1d)	(2d)	(3d)	(4d)
Becomes a home owner	-0.0254	0.0632	-0.086	0.0249
	(0.0254)	(0.0335)**	(0.0327)	(0.0397)
First stage residual	-0.0004	0.0034	0.0024	-0.0196
	(0.0079)	(0.0112)	(0.0114)	(0.0132)
Observations (NT)	6,424	5,834	5,879	6,424
Panel (e): Social capital				
	(1e)	(2e)	(3e)	
	Vote	Talk to neighbours	Sat. with home	
Becomes a home owner	-0.0024	-0.7482	0.3808	
	-0.0382	(0.2461)***	(0.1311)**	
First stage residual	-0.0012	0.1157	0.0009	
	(0.0123)	(0.0861)	(0.0428)	
Observations (NT)	6,426	6,399	5,564	

Each panel contains a separate second stage model. Sample includes initial public renters only, 2000 – 2008.

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Marginal effects, from second stage models, calculated at the means of independent variables. The models contain all additional variables as reported in Table 6.

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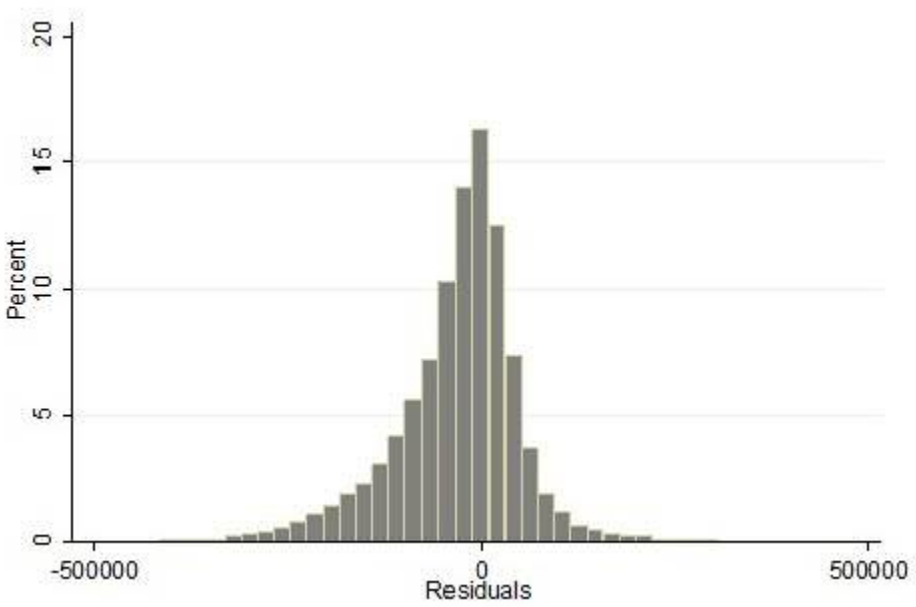
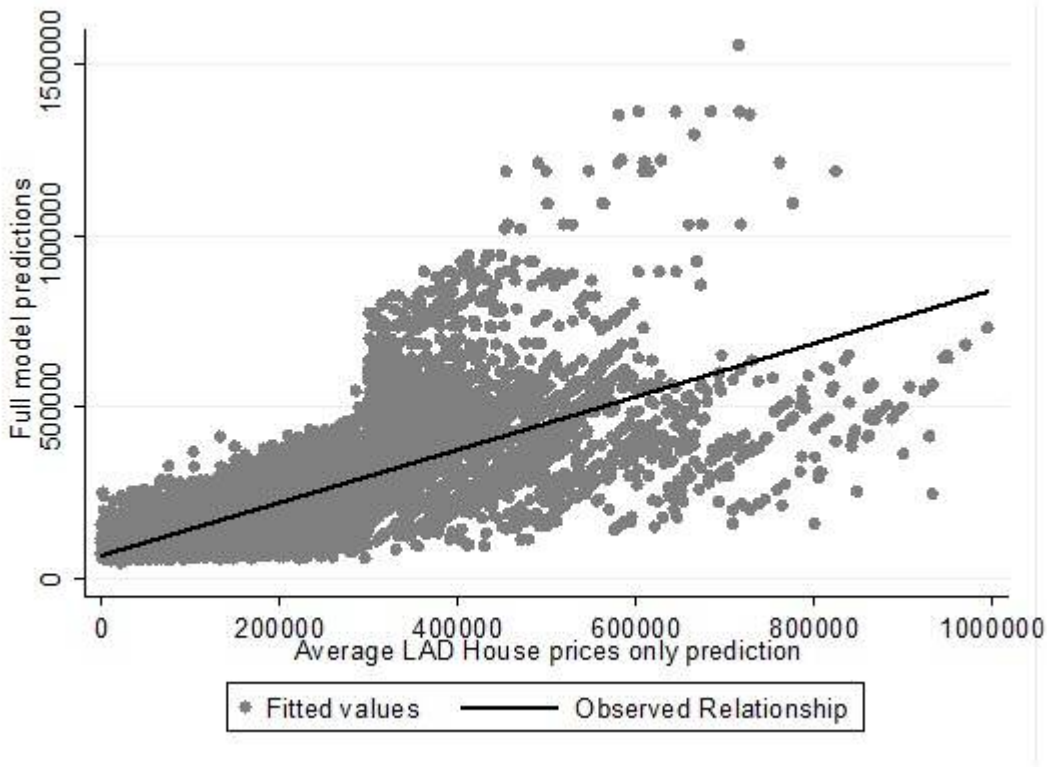
Appendix A Additional Figures and Tables

Figure A.1: Examining the goodness of predicted house values: predicted residuals



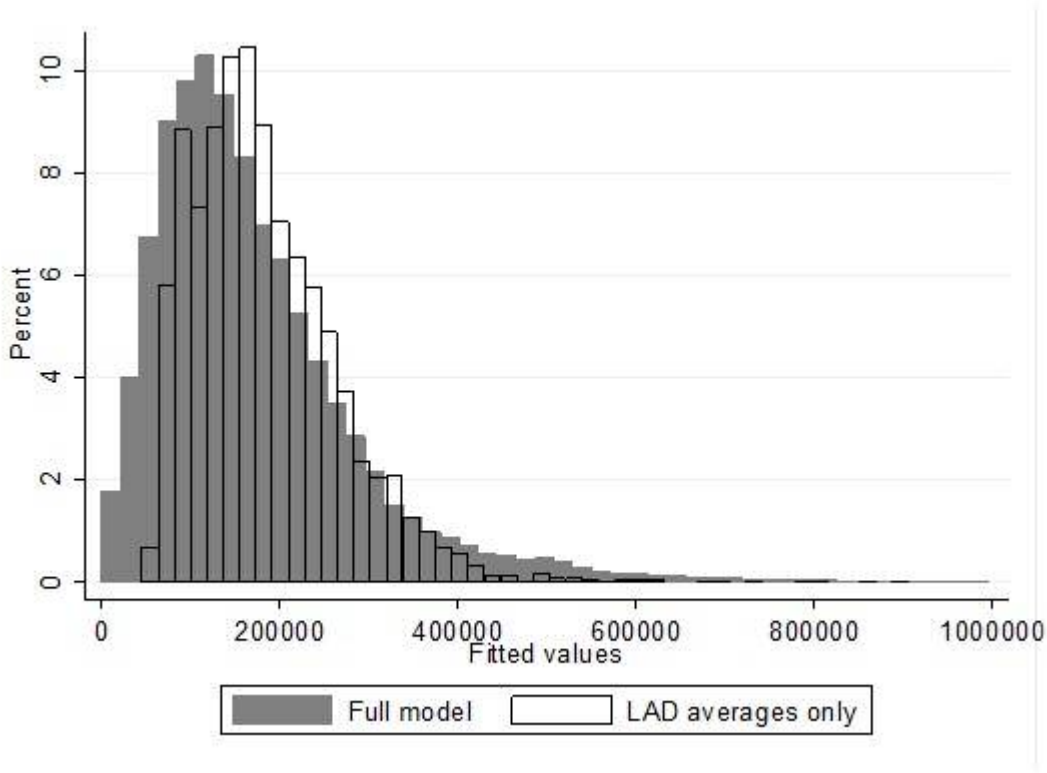
Source: authors' representation from BHPS data 1999-2008.

Figure A.2: The relationship between the two predicted values: full model and reduced model



Source: authors' representation from BHPS data 1999-2008.

Figure A.3: Comparing the distribution of predicted house values



Source: authors' representation from BHPS data 1999-2008. For graphical clarity, we censor the observations at £1,000,000.

Table A.1: First Stage model of predicted Right to Buy discount on ownership

	Coefficient	Robust Std. Error
Local average house prices	0.94***	0.01
Number of rooms: 1	Reference category	
Number of rooms: 2	33682.62**	14425.07
Number of rooms: 3	86025.43***	15701.48
Number of rooms: 4	127422.40***	17861.81
Number of rooms: 5	171141.30***	20585.72
Number of rooms: 6	224716.30***	23718.35
Number of rooms: 7	287368.40***	27162.64
Number of rooms: 8	343803.40***	30809.78
Number of rooms: 9	392865.60***	34507.7
Number of rooms: 10	635098.90***	38751.21
Number of rooms: >10[a]	Included[a]	
Type of accommodation: detached	Reference category	
Type of accommodation: Semi-detached	-12676.18**	5448.71
Type of accommodation: End-Terrace	-16062.47**	8968.31
Type of accommodation: Terrace	-45912.85***	7109.76
Type of accommodation: Purpose built flat	-58109.84***	16059.21
Type of accommodation: Converted flat	-49361.92***	17839.57
Council tax band: A	Reference category	
Council tax band: B	1895.92	2149.46
Council tax band: C	10447.62***	2199.59
Council tax band: D	20214.81***	2301.62
Council tax band: E	41516.69***	2715.82
Council tax band: F	73290.57***	3206
Council tax band: G	171740.90***	3471.27
Council tax band: H	283549.70***	6319.64
Other household characteristics[b]	Yes	

Standard errors are clustered at local authority level. Significance: * p<0.1; ** p<0.05; *** p<0.01.

a: We included the number of rooms up to 20. The coefficients are all monotonically increasing, and statistically significant at p<0.001.

b: Other controls include the central heating fuel type, if there is a separate toilet/bathroom, if the kitchen is open-plan, if there is a garden/terrace, if there is an indoor toilet, if there are neighbourhood problems with either crime/vandalism and/or pollution/the environment. We additionally interact the number of rooms with property type. The coefficient sizes and significance levels are available on request. We omit them here due to reasons of brevity.

Table A.2: Marginal Effects following Second Stage models of physical and psychological health outcomes, treating self-assessed health and ordinal and applying an ordered logit model

	(1)	(2)	(3)	(4)	(5)
	$SAH = 1$	$SAH = 2$	$SAH = 3$	$SAH = 4$	$SAH = 5$
Panel (a): One stage model					
Becomes a home owner	-0.0166	-0.0437	-0.0526	0.0633	0.0495
	(0.0028)***	(0.0072)***	(0.0086)***	(0.0104)***	(0.0080)***
Panel (b): Two stage model					
Becomes a home owner	-0.0107	-0.0283	-0.0340	0.0409	0.0320
	(0.0058)*	(0.0153)*	(0.0183)*	(0.0221)*	(0.0173)*
First stage residual	-0.0021	-0.0057	-0.0068	0.0082	0.0064
	(0.0002)***	(0.0005)***	(0.0006)***	(0.0008)***	(0.0006)***

Marginal effects calculated at the means of independent variables. The models contain all additional variables as reported in Table 6. Sample includes initial public renters only, 2000 – 2008. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table A.3: Effects of years after ownership on health

	(1) SAH	(2) SAH	(3) GHQ	(4) GHQ	(5) #Probs.	(6) #Probs.
Years of ownership (cts.)	0.0518*		0.443**		-0.0519	
	(0.030)		(0.192)		(0.038)	
Years after ownership (Base= 0)						
1 year		0.589***		0.435**		-0.124
		(0.145)		(0.192)		(0.184)
2 years		0.0716		0.0144		-0.185
		(0.156)		(0.994)		(0.197)
3 years		0.150**		0.136		-0.292
		(0.076)		(1.026)		(0.203)
4 years		0.0626		1.050*		-0.447**
		(0.181)		(0.555)		(0.229)
5 years		0.363*		1.551		-0.250
		(0.202)		(1.289)		(0.255)
6 years		0.220		2.886*		-0.0647
		(0.244)		(1.559)		(0.308)
7 years		0.214		4.024*		-0.539
		(0.340)		(2.175)		(0.430)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	595	595	595	595	595	595

The models contain all additional variables as reported in Table 6. Sample includes initial public renters who went onto become owners, 2000 – 2008. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table A.4: First and Second Stage models of physical and psychological health outcomes for sub-sample with constant LSOA of residence

	(1)	(2)	(3)	(4)
Outcome:	Owner	SAH	GHQ	#Probs
Model:	Logit	2SRI OLS	2SRI OLS	2SRI Nbreg
Calculated RtB disc./1000	0.0386			
	(0.010)***			
Time lived at property (years)	-0.0310			
	(0.012)***			
Log(average LAD house price)	-1.236			
	(0.234)***			
Becomes a home owner		0.155	2.243***	-0.491***
		(0.066)**	(0.725)**	(0.126)
First stage residual		0.0476	-0.477***	0.0498*
		(0.031)	(0.183)	(0.028)
Observations (NT)			3908	

Sample includes initial public renters ($N = 983$) who keep the same LSOA of residence throughout their time in the sample only, 2000 – 2008. We have information on N=983 individuals.

Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Marginal effects, from second stage models, calculated at the means of independent variables. The models contain all additional variables as reported in Table 6.