



BANK OF ENGLAND

# Staff Working Paper No. 560

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# Mortgage debt and entrepreneurship

Philippe Bracke,<sup>(1)</sup> Christian Hilber<sup>(2)</sup> and Olmo Silva<sup>(3)</sup>

### Abstract

We study the link between mortgage debt and entrepreneurship using a model of occupational choice and housing tenure in a setting where homeowners do not default on their debt. Our model predicts that, as long as the mortgage interest rate exceeds the rate of interest on liquid wealth: (i) mortgage debt, by amplifying risk aversion, diminishes the likelihood of entrepreneurship; and (ii) the negative relation between leverage and entrepreneurship increases with income volatility. Our model also shows that the link between housing wealth and entrepreneurship is ambiguously signed because of competing portfolio and hedging effects. Using the British Household Panel Survey, we test and confirm the model's predictions. A one standard deviation increase in leverage reduces the probability of entrepreneurship by 10%–12%.

**Key words:** Entrepreneurship, mortgage debt, leverage, risk aversion.

**JEL classification:** L26, D14, G11, R21.

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# 1 Introduction

Excessive mortgage financing has been at the centre of the debate surrounding the causes of the Great Recession (Mian et al., 2013). In this paper we highlight a new channel through which mortgage debt may adversely affect the general economy. We argue that raising mortgage debt hinders entrepreneurial activity, which in turn is considered to be an important driver of innovation and economic growth (Schumpeter, 1934).

Extensive research has highlighted the impact of housing on a household's exposure to risky assets (Flavin and Yamashita, 2002; Cocco, 2005). House purchases are typically leveraged and mortgage debt affects portfolio choices – in an opposite direction to home equity wealth, as pointed out by Chetty and Szeidl (2012). While most of the literature focuses on the effect of mortgage debt on stock holdings, in this paper we consider its effect on entrepreneurial activity – interpreting the latter as an asset with an expected return and variance. We first provide a model of occupational choice and housing tenure that formalises the entrepreneurial decision of homeowners with varying degrees of financial leverage. We then test the model predictions using the British Household Panel Survey (BHPS) for the period 1991–2008.

In our model agents choose occupation as dependent workers or entrepreneurs, conditional on their housing tenure and the extent of their mortgage debt. Entrepreneurship in our setting has both benefits and costs. In line with previous work, we assume that entrepreneurship provides non-pecuniary benefits (Hurst and Pugsley, 2011) whose magnitude varies across individuals according to their 'entrepreneurial taste'. On the cost side, we assume that the income of entrepreneurs has a higher variance than that of dependent workers, making entrepreneurship more risky than dependent employment. This is consistent with our data and previous empirical work (Hamilton, 2000).

Our theoretical framework yields two main testable propositions. First, as long as the mortgage rate paid by individuals exceeds the rate of interest earned on liquid wealth, higher levels of mortgage debt diminish the likelihood that leveraged homeowners start a business (Proposition 1). Second, the negative relation between financial leverage and entrepreneurship is more pronounced when considering homeowners who choose to work in sectors where profits are more volatile (Proposition 2).<sup>1</sup>

The intuition behind these predictions can be summarised as follows. When agents increase

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<sup>1</sup>Our model provides a counterpoint to Davidoff (2006) who shows that individuals whose labour income co-varies strongly with housing values purchase relatively inexpensive homes. Differently from him, we analyse occupational choice conditional on housing tenure. The timing of transitions into entrepreneurship and homeownership in our data suggests this is a more natural sequence, at least in the UK.

their mortgage debt – for a given amount of total wealth and housing – they correspondingly increase the amount of liquid wealth in their portfolio. As long as the cost faced by individuals on the additional mortgage debt exceeds the rate of interest earned on the additional liquid wealth, this implies a reduction in net wealth and amplifies the degree of the borrower’s risk aversion. In turn, this increases the likelihood that the utility loss from income uncertainty associated with entrepreneurship exceeds the non-pecuniary benefits associated with entrepreneurship, and reduces the probability that leveraged homeowners become entrepreneurs (Proposition 1). All else equal, an increase in income uncertainty strengthens this effect (Proposition 2).

Wealth effects in entrepreneurship have been previously documented in the literature (Hurst and Lusardi, 2004; Kerr et al., 2014). However, the wealth effect underpinning our model has a very specific nature: it alters individuals’ risk aversion. The second prediction of our model (Proposition 2) directly tests the validity of this intuition. This prediction distinguishes our framework from previous work that has emphasised the luxury/consumption value of entrepreneurship and its link to an individual’s wealth.

One important feature of our model is the assumption that leveraged homeowners do not default on their mortgages. As we discuss later in the paper, this assumption stems from the characteristics of the UK mortgage market, where mortgages are recourse and default rates are extremely low compared to the US (Aron and Muellbauer, 2010). We see this feature of UK mortgages as a form of ‘commitment’ in the sense that leveraged homeowners can neither default nor easily renegotiate the owed amount in the case of negative income shocks. This assumption is crucial for our two main propositions. We note that even in countries where mortgages are non-recourse – yet defaulting on debt is costly – our propositions are likely to hold.

Our model also yields a prediction with respect to the impact of housing wealth on entrepreneurship, although this prediction is ambiguously signed. This is because two competing forces are at play. On the one hand, an increase in housing wealth – attained by an increase in either housing quantity or values – reduces the share of labour income in an individual’s total wealth, thus reducing the importance of labour income risk and making entrepreneurship more attractive. On the other hand, more housing increases an individual’s exposure to house price risk and discourages entrepreneurship. This ambiguously-signed finding is in sharp contrast with the predictions of a simple model with credit constraints and bank lending against housing where a rise in house prices would raise the collateral value of housing and allow for more borrowing from banks to start an entrepreneurial activity.

In an extension of our model, we consider housing consumption commitments, i.e. the inability to adjust housing consumption because moving house is very costly for owner-occupiers (Chetty and Szeidl, 2007; Shore and Sinai, 2010). We find that Propositions 1 and 2 continue to hold independent of whether consumption commitments are absent or present. The model extension however yields two distinguishing predictions relative to our baseline model, namely that: (i) an increase in the quantity of housing in an individual's portfolio, all else equal, now has an unambiguously negative effect on entrepreneurship; but (ii) the house value still has no clearly signed effect on the likelihood of starting a business.

An important feature of our model is that we allow individuals to differ in unobserved ways in their innate taste for entrepreneurship and the extent of mortgage debt used to finance their housing purchase. In our setting, some homeowners with mortgages still decide to start a business because of their strong preferences to be entrepreneurs. Correspondingly, in the empirical analysis we control for unobserved individual characteristics using a fixed-effects strategy.

To do so, we exploit the longitudinal dimension of the British Household Panel Survey (BHPS) covering the period between 1991 and 2008. We construct a detailed monthly-spell dataset that tracks individuals' job histories and tenure choices, coupled with information on time-varying background characteristics. We use this dataset to identify the precise timing of individuals' transitions into homeownership and entrepreneurial jobs. Our data reveals that a higher percentage of people transits into homeownership than into entrepreneurship, and at an earlier age. Thus it seems natural to focus on the relation between homeownership and entrepreneurship in this order.

One empirical concern is the need to distinguish between genuine entrepreneurship and other kinds of self-employment (Hurst and Pugsley, 2011; Faggio and Silva, 2014). In this paper, we define entrepreneurs as self-employed individuals with dependent workers. By doing so, we are able to study the link between leverage, housing and genuine entrepreneurship, rather than self-employment out of necessity or as a last-resort option (Alba-Ramirez, 1994; Martinez-Granado, 2002).

We begin our analysis by presenting some stylised facts. OLS estimates indicate a positive association between homeownership and entrepreneurship. However, this relation turns negative once we use fixed effects to control for time-invariant unobservables, such as innate entrepreneurial preferences or persistent wealth. The magnitude of this relation is sizable: individuals who become homeowners are about 25% less likely to become entrepreneurs.

We then proceed with our main empirical investigation and test the model predictions. We

show that the negative relation between homeownership and entrepreneurship is only significant for leveraged homeowners, and this negative link is increasing in the extent of mortgage debt. Using individual time-varying information on the loan-to-value (LTV) ratio of the mortgage, we find that a one standard deviation increase in the LTV is associated with approximately a 10% reduction in the probability of becoming an entrepreneur, consistent with Proposition 1 of our model.

To address concerns about endogeneity in our estimates of the link between an individual's tenure status, LTV and entrepreneurship, we extend our main specification in a number of directions. First, we replace individual fixed effects – which control for time-invariant unobservables – with individual-specific housing-spell effects. This specification focuses on the variation in LTV within a specific housing spell, and accounts for changes in individual unobservables when they first become homeowners and at any time when they move home or change their tenure status. This approach helps us addressing the endogeneity of tenure choice. These specifications yield an even stronger negative link between leverage and entrepreneurship.

Next, we devise an instrumental variable (IV) strategy based on information on the LTV of newly originated mortgages in the area of an individual's residence obtained from the Survey of Mortgage Lenders (SML). We use this area-level data to predict an individual's LTV. The validity of this approach rests on the assumption that: (i) an individual's LTV changes over time partly because of refinancing decisions dictated by the nature of the mortgages predominantly available in the UK (fixed rates for 2-5 years, and floating afterwards); and (ii) most of the mortgage (re-)financing conditions are dictated by the local housing market and banking circumstances (Muellbauer, 2002). To account for the confounding effect of local economic cycles, we further control for variation in local wages and employment. Supplementing our fixed-effect models with this IV strategy fully confirms our previous findings and suggests that a one standard deviation increase in the LTV reduces the propensity to become an entrepreneur by about 12%.

Finally, we directly assess whether leveraged homeowners shy away from riskier entrepreneurial ventures. We collect data on company profits at a detailed sectoral level and construct a proxy for the riskiness of entrepreneurial ventures based on profit variability. Using this information, we show that the negative link between a homeowner's LTV and entrepreneurship holds for homeowners operating in risky sectors, but not for homeowners working in industries with lower profit variability, in line with Proposition 2 of our model.

At a first glance, our main findings could also be consistent with a theory based on credit constraints, whereby leveraged home buyers are prevented from taking on additional credit to

start a business. While such an interpretation would not alter our main message – i.e., that high indebtedness reduces the likelihood that individuals start a business – we cannot find any empirical evidence to support it. In particular, for this explanation to hold true, we should detect a positive relationship between house price increases and entry into entrepreneurship: as house values increase, LTV ratios are pushed down and housing becomes a collateral that can be used to borrow. Empirically, however, we find that house price variation has no explanatory power in predicting entrepreneurship and cannot account for the negative link between leveraged homeownership and entrepreneurship. In particular, we show that neither self-reported current housing values nor capital gains accrued since the time of first purchase enter our regressions significantly. This is irrespective of whether we follow Chetty and Szeidl (2012) and instrument housing value appreciation using national house price variation in interaction with proxies for the local elasticity of housing supply. This finding is very similar to Hurst and Lusardi (2004) and Disney and Gathergood (2009) and supports our theoretical framework which indicates an ambiguously-signed relation between housing wealth and entrepreneurship.

By highlighting a new channel through which mortgage debt hinders productive investments, our paper contributes to the debate on the adverse consequences of household debt on the general economy. Our findings are of general relevance because most countries subsidise mortgage financing. For the US, recent research suggests that the mortgage interest deduction (MID) increases the loan size of individual borrowers substantially (Munroe, 2014).<sup>2</sup> Our framework indicates that, by increasing leverage, mortgage subsidies may increase risk aversion and discourage alternative investments such as entrepreneurship. However, mortgage subsidies may also lower the effective mortgage interest rate and – if the subsidy is sufficiently strong – the effective mortgage cost could be lower than the interest from liquid wealth, thus reversing the prediction of our model. Other policies that only affect leverage directly – and not indirectly via lowering interest rates – can be expected to have the unintended effect of discouraging entrepreneurial activity.

## 2 Context: Literature and Institutional Background

### 2.1 Contribution to the literature

Our work contributes to several strands of the literature.

Both owner-occupied housing and entrepreneurship play a prominent role in the context of portfolio decisions. Henderson and Ioannides (1983) and Brueckner (1997) show that when the in-

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<sup>2</sup>Hilber and Turner (2014) further show that the policy may not raise homeownership on aggregate.

vestment constraint induced by owner-occupied housing is binding, homeowners cannot adequately diversify their portfolio. Flavin and Yamashita (2002) examine a household portfolio problem when housing matters both as consumption and investment. They find that the optimal consumption level might exceed the optimal investment quantity. More recently, Cocco (2005) and Chetty and Szeidl (2012) document that homeownership – and in particular homeownership associated with large mortgages – significantly reduces a household’s exposure to risky assets, such as stocks. In a similar vein, Heaton and Lucas (2000) show that running a private business has a significant impact on portfolio choices. Entrepreneurs invest proportionally less in stocks than other dependent workers. Faig and Shum (2002) bring together housing and entrepreneurial ventures in their analysis and demonstrate that households who plan to invest in one of these two activities, which they call ‘illiquid projects’, hold significantly safer portfolios. Our results are nested within this literature: mortgage debt amplifies a borrower’s risk aversion and this in turn increases the likelihood that income uncertainty discourages leveraged homeowners from starting their own business.

Our work is also related to the literature that investigates the relation between housing and labour market choices. In a series of seminal articles Oswald (1996, 1998, 1999) and in a recent paper Blanchflower and Oswald (2013) suggest that high rates of homeownership are associated to higher levels of unemployment and, more generally, impair labour markets. The authors suggest this is because homeownership is associated with lower levels of mobility and fewer new businesses.<sup>3</sup> More recently, Ferreira et al. (2010) focus on the relation between mortgage debt – especially negative equity during housing market downturns – and mobility. To the best of our knowledge, we are the first to investigate the link between mortgage debt and new business start-ups. Our theoretical framework and consistent evidence emphasise the role of risk aversion rather than mobility.

Our work also touches upon the large empirical literature that investigates the relation between house prices and entrepreneurship.<sup>4</sup> Two related studies using UK macro data (Black et al., 1996; De Meza and Webb, 1999) suggest that bank loans are secured on an entrepreneur’s house, and argue that liquidity constraints play a major role in determining who sets up a business.<sup>5</sup> More

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<sup>3</sup>A large body of literature has investigated the assertion that homeownership lowers mobility and may thus trigger unemployment (e.g. Munch et al. (2006) and Battu and Phimister (2008)). The evidence suggests that although homeowners are less geographically mobile, they are not more likely to become unemployed or have longer unemployment spells.

<sup>4</sup>A small literature has emerged linking homeownership and entrepreneurship. Fairlie (2010) presents cross-sectional evidence for the US suggesting that homeownership has a small positive effect on business creation (consistent with our OLS results). Wang (2012) investigates the effects on entrepreneurship of a policy that allowed Chinese public-sector employees renting state-owned housing to buy their properties at subsidised prices.

<sup>5</sup>The literature on the role played by credit constraints in the decision to become an entrepreneur is vast (Evans and Jovanovic, 1989; Holtz-Eakin and Rosen, 1994; Blanchflower and Oswald, 1998; Michelacci and Silva, 2007; Fairlie and Krashinsky, 2011; Jensen et al., 2014)



recently Harding and Rosenthal (2013) provide cross-sectional evidence for the US suggesting that house price gains experienced by homeowners promote entrepreneurship, and Adelino et al. (2013) use US data at the MSA level to show that areas with faster house price appreciation between 2002 and 2007 experienced more business start-ups. A different view is provided by Hurst and Lusardi (2004), who suggest that the relation between wealth and entrepreneurship is only significant at the very top of the wealth distribution. Moreover, they find that households living in areas which experience strong house price appreciation are not more likely to start an entrepreneurial venture.<sup>6</sup> Recently, Kerr et al. (2014) cast further doubt on the idea that house price gains promote entrepreneurship by providing a collateral for bank loans. Studying price changes at a very localised level, they provide evidence that most of the small effect of house prices on entrepreneurship comes from wealth effects. Our findings are consistent with the logic that house price appreciation does not necessarily promote entrepreneurship through the alleviation of credit constraints.

## 2.2 Background on the UK Mortgage Market

The features of the UK mortgage market guide our modelling assumptions and empirical analysis.

A key characteristic of UK mortgages is that they are full recourse. This implies that defaulting can be much more costly, and default rates are thus much lower, than in other settings where mortgages have a non-recourse nature (like in the US). In fact, Aron and Muellbauer (2010) document that the repossession rates in the UK are substantially lower than in the US and explain this difference with the fact that UK mortgages are recourse: “Mortgage borrowers can be pursued for up to six years for negative equity remaining after the lender has sold off a home in possession”. Consistent with this intuition, in our model we assume that agents always repay their mortgage and do not default or renegotiate the owed amount vis-à-vis negative income shocks.

Our model and empirical analysis both focus on the effects of changes within an individual over time in the amount of leverage – which we proxy through the loan-to-value (LTV) ratio of the outstanding loan. Conceptually, we allow these changes to be either positive or negative – i.e. individuals can expand or reduce the amount of their outstanding debt. This is consistent with the features that characterise the UK mortgage market.

In terms of mortgage loan reductions (repayments), a recent paper by Cocco (2013) analyses the BHPS and shows that approximately 56% of mortgages over 1991-2008 have principal repayment – the other mortgages being interest-only (IO) loans. We use the same data and find very similar figures for our sample (described in Section 4).

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<sup>6</sup>A similar result is presented in Disney and Gathergood (2009) using British data.

Partly dictated by the types of mortgages predominantly available in the UK, an individual's LTV can also change over time because of refinancing decisions. Contrary to the US, where 30-year fixed rate mortgages are popular, mortgage contracts in the UK tend to have fixed rates for 2 to 5 years only and are floating afterwards. Depending on market conditions, individuals may find it profitable to refinance their loan at the end of the fixed rate period. According to Calza et al. (2013), in the UK refinancing is possible, although penalties make it less common than in the US. According to Benito (2009, p. 52), the typical direct cost of refinancing is relatively small at £500 (the average monthly salary in his sample is £2900, while the average house equity is £66,000). At refinancing, it is likely that individuals with some savings will reduce their LTV: Besley et al. (2013) show that the LTV is one of the main determinants of the individual interest rate charged; by reducing their LTV, households can decrease their monthly payments. A mortgage loan can also be increased through refinancing and equity can be withdrawn (usually, banks permit this when the value of the underlying collateral has gone up – i.e. house prices have increased). In the UK this is not common, however. According to Benito (2009) only 1 in 10 UK homeowners withdrew equity at its peak in the mid-1990's. On average, over the period 1990-2005 this figure was 6-7%.<sup>7</sup>

Importantly, according again to Benito (2009), 72% of those UK homeowners who did withdraw equity spent it on the house itself, while another 9% used it to buy a car. These figures illustrate that in the UK extracting housing equity to finance a business start-up is not common – despite widely held beliefs.<sup>8</sup>

Direct evidence on the use of home-equity loans by entrepreneurs is not available for the UK. However, extensive surveys of small firms' access to finance carried out since 2007 by the UK Department for Business do not consider this category – implicitly backing our intuition that home-equity loans are not widespread among business start-ups in the UK. For the US, Kerr et al. (2014) show that only 9% of start-ups that used some form of financing mention home equity as one of their sources, and that this percentage increased by only 11% during the period 2000-2007 – when house prices increased by 45%. This suggests that housing equity and home-equity loans may only have a quantitatively modest role in driving entrepreneurship.

While in our discussion we focus on voluntary – and, therefore, possibly endogenous – changes in mortgage loans, in our empirical analysis we use an instrumental variable approach, in which

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<sup>7</sup>This is in contrast to the US, where mortgage refinancing and mortgage equity withdrawal was very common before the crisis. In 2005, for instance, 40 percent of existing mortgages were refinanced withdrawing equity (Feldstein, 2007).

<sup>8</sup>The same can be said for the US. Studying a panel of US households, Mian and Sufi (2011) conclude that money extracted from home equity is mostly used for home improvements and consumption.

we predict changes in an individual’s LTV on the outstanding mortgage with variation in local mortgage conditions. This approach rests on the idea that most of the mortgage refinancing terms are dictated by the local housing market and banking conditions. The analysis in Muellbauer (2002) supports this intuition. To account for the confounding effect of local economic cycles, we further control for variation in local wages and employment levels and composition.

### 3 Theoretical framework

This section develops a model of occupational choice as a function of tenure status and mortgage debt. Similar to Chetty and Szeidl (2012), we model the effect of homeownership on risk taking in financial portfolios, distinguishing between home equity wealth and mortgage debt. However, instead of exploring the effect of mortgage debt on a continuous variable such as stock-holding, we consider its effect on a binary occupational choice – dependent work versus entrepreneurship – treating the latter as an asset with an expected return and variance.

In our framework, agents repay their mortgage debt, consistent with our discussion of the UK mortgage market where loans are completely recourse. Stated differently, agents commit not to default on the amount owed in the case of negative income shocks. This assumption is crucial for our main predictions. Housing consumption commitments may also be at work. As we show in Section 3.3 below, this form of consumption commitment is not necessary to obtain our main results.

The main insight from our model is that, conditional on individual innate characteristics – including persistent wealth and ‘taste for entrepreneurship’ – and assuming that mortgage rates exceed interest rates on liquid wealth, increasing mortgage debt *reduces* the likelihood of being an entrepreneur. This occurs because mortgage payments increase the effect of income risk on an individual’s utility. Therefore leveraged homeowners avoid occupations, such as entrepreneurial activities, where income risk is greatest.

#### 3.1 Assumptions

**Utility function:** We envisage a two-period setting (period 0 and period 1), in which agents maximise period-1 utility:

$$\mathbb{E}_0 \frac{\left(C_1^{1-\mu} H_1^\mu\right)^{1-\gamma}}{1-\gamma}$$

under a budget constraint. Individuals derive utility from the consumption of a standard composite good ( $C$ ) and housing ( $H$ ) and the utility function is characterised by constant relative risk aversion (CRRA). Empirical evidence suggests that household expenditure in housing  $\mu$  is a constant fraction of income (Davis and Ortalo-Magné, 2011). Our utility functions also embeds complementarity between housing and consumption of the composite good, i.e.  $U_{ch} \geq 0$ , as in Chetty and Szeidl (2007). This assumption has been extensively used and documented in both the macro and micro finance literature (Lustig and Nieuwerburgh, 2005; Piazzesi et al., 2007; Flavin and Nakagawa, 2008).<sup>9</sup> This simplified two-period setting allows us to isolate: (1) the moment in which mortgage debt is issued or the outstanding loan modified; and (2) the moment in which mortgage debt is repaid. These are the two events needed in our model to highlight the increase in effective risk aversion brought about by debt. Since mortgages are recourse in our setting, prospective entrepreneurs expect to repay their debt in full, and the amount owed becomes the crucial variable driving their investment choices.<sup>10</sup>

**Budget constraint:** Agents decide to consume the numeraire good and housing out of their total available wealth at the beginning of period 1:

$$C_1 + P_1 H_1 = W_1.$$

Similar to Chetty and Szeidl (2012), we represent wealth as:

$$W_1 = Y_1 + P_1 H_0 - M_0(1 + R_M) + L_0(1 + R_F), \quad (1)$$

where the housing endowment is  $H_0$ , the mortgage debt outstanding at period 0 is  $M_0$  which is charged at interest rate  $R_M$ , and the liquid wealth outstanding in period 0 is  $L_0$  and it earns an interest of  $R_F$ . We take these endowments as given and estimate their effect on individuals' occupational choice. Stated differently, we do not endogenise choice of tenure and amount of mortgage debt (though we deal with these endogeneities in our empirical analysis by using individual housing-spell effects and an instrumental variable approach). For simplicity, we omit the subscript

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<sup>9</sup>Our utility functions further assumes prudence in the consumption of the standard composite good, i.e.  $U_{CCC} > 0$ . This is equivalent to requiring that additional risk reduces consumption, and it is a common condition in the literature on precautionary savings (Shore and Sinai, 2010).

<sup>10</sup>One could imagine a multi-period setting in which income shocks lead to *current* mortgage payment renegotiations, thus seemingly moderating the effect of mortgage debt on risk aversion. However, the point remains that higher mortgage debt means higher overall repayments and therefore higher risk aversion, independently of the precise temporal allocations of those repayments. When a payment is delayed, the current relief is simply matched by an increase in future liabilities.

$i$  from all these expressions. However, conceptually, individuals can differ in terms of their overall wealth  $W_1$  as well as in their initial allocation of  $M_0$  and  $L_0$ . Similarly,  $R_M$  could differ across individuals because it is partly determined by the prevailing market rates, but it is also related to the borrower's characteristics, in particular the loan-to-value ratio of the mortgage (see evidence in Besley et al., 2013).<sup>11</sup> In our empirical analysis, we account for this unobserved individual heterogeneity using a number of specifications.

In terms of individual housing tenures, we can think of the following specific cases:

- a renter has  $M_0 = 0$  and  $H_0 = 0$ ,
- a homeowner without mortgage has  $M_0 = 0$  and  $H_0 > 0$ , and
- a homeowner with mortgage has  $M_0 > 0$  and  $H_0 > 0$ .

Because period 1 is the last period for all agents,  $P_1$  is both a purchase and a rental price (i.e., there is no material difference between buying and renting).

**Occupational choice:** In our setup, workers choose between two occupations, which determine their income. Dependent workers receive constant income  $\bar{Y}$  and entrepreneurs receive variable income  $Y_e$ . We assume that the income of an entrepreneur is a mean-preserving spread of an employee's income:

$$\mathbb{E}Y_e = \bar{Y},$$

with  $\sigma_e^2$  indicating the entrepreneurial income variance.<sup>12</sup> This assumption is consistent with the literature on entrepreneurial labour choice: Hamilton (2000) shows that entrepreneurs earn on average the same or less than comparable dependent workers, though their income volatility is significantly larger. In our empirical analysis, we replicate this fact (see Section 5).

Evidence in Evans and Leighton (1989), Blanchflower and Oswald (1992), and Hurst and Pugsley (2011) suggests that non-pecuniary benefits (e.g. being one's own boss or having flexible working hours) play a first-order role in the business formation decision. Thus, we assume that agents get a positive utility shift  $\alpha_i > 0$  when they decide to become entrepreneurs, and we allow this 'taste for entrepreneurship' to vary across individuals as indicated by subscript  $i$ .<sup>13</sup> We posit that the

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<sup>11</sup>For simplicity we can think of  $R_F$  as being the same for all individuals and predominately determined by financial markets.

<sup>12</sup>Dependent work carries risks too and a more complete model would include a variance for the income of dependent workers,  $\sigma_w^2$ . In practice, as long as  $\sigma_e^2 > \sigma_w^2$ , this has no material impact on the prediction of our model.

<sup>13</sup>This setting is different from a model à la Lucas (1978) where individuals' entrepreneurial choices are driven by 'business acumen', i.e. the ability to generate extra gains by running a business.

$\alpha_i$ 's follow a generic cumulative distribution  $F(\alpha)$  where  $\alpha$  is bounded between 0 and infinity. The total utility for agent  $i$  can be characterised as:<sup>14</sup>

$$\begin{aligned} U(C, H) & \quad \text{if agent } i \text{ is a worker, and} \\ \frac{1}{\alpha_i} U(C, H) & \quad \text{if agent } i \text{ is an entrepreneur.} \end{aligned}$$

Individuals maximise their indirect utilities, which depend on wealth  $W$  and are denoted by  $V(W)$ . Before the uncertainty is resolved and a value for  $Y$  is drawn, individuals have to choose whether to be workers or entrepreneurs. To do so, they compare the expected utilities of the different employment possibilities.

### 3.2 The entrepreneurship decision

We study employment decisions conditional on tenure status. An agent chooses to become an entrepreneur if parameter  $\alpha_i$  is above some threshold  $\alpha^*$ , and the fraction of agents that do *not* start an entrepreneurial venture is equal to  $F(\alpha^*)$ . The threshold  $\alpha^*$  is defined by:

$$\alpha^* \equiv \frac{\mathbb{E}V(W_1^e)}{\mathbb{E}V(W_1^w)}. \quad (2)$$

In Appendix A (where we provide proofs), we start from the equivalence shown by equation (2) and assume that entrepreneurial income and house price growth are lognormally distributed. Using a standard approximation, we derive a closed form solution for the entrepreneurship threshold:

$$\log \alpha^* = \frac{(1 - \gamma)^2}{2} \eta_Y \left( \underbrace{\eta_Y \sigma_e^2 + 2\eta_H \sigma_{ep}}_{\text{portfolio effect}} \quad \underbrace{-2\mu\sigma_{ep}}_{\text{hedging effect}} \right), \quad (3)$$

where  $\eta_Y$  and  $\eta_H$  are the fractions of total wealth associated with labour income and housing, respectively, and  $\sigma_{ep}$  is the covariance between house prices and entrepreneurial income. Intuitively, a higher risk aversion  $\gamma$  leads to a higher threshold  $\alpha^*$  because, when entrepreneurial income is more volatile, only agents with a strong preference for entrepreneurship start a business. The threshold  $\alpha^*$  also increases when labour income is a large fraction of wealth ( $\eta_Y$  is high), because under CRRA preferences this leads to a greater cost of entrepreneurial income volatility.

The covariance between house prices and entrepreneurial income instead has an ambiguous effect on the decision to start a business.<sup>15</sup> On the one hand,  $\sigma_{ep}$  increases the overall risk of

<sup>14</sup>Since utilities of the CRRA form take on negative values so that a higher  $\alpha_i$  in  $\frac{1}{\alpha_i}U(C, H)$  leads to a higher utility level.

<sup>15</sup>Strictly speaking, since both the income of dependent workers and entrepreneurs are expected to covary with

the portfolio and therefore reduces the likelihood of choosing an entrepreneurial occupation – a standard *portfolio effect*. On the other hand, since agents need to consume housing in period 1 (because  $\mu > 0$ ), entrepreneurship can offer an insurance against housing costs and becomes more attractive as an occupational choice – a *hedging effect*. This mechanism is similar to the one highlighted in Sinai and Souleles (2005).<sup>16</sup> When  $\mu = 0$ , households do not want to consume any housing and the model reduces to a standard portfolio choice setup. The competing portfolio and hedging effects in our model stem from the dual nature of housing as both consumption and investment good.

### 3.3 Comparative statics

In this subsection we explore the effects of mortgage debt and housing wealth on occupational choice. It is important to study these two components of wealth separately since, as we show below, the model predicts an unambiguous negative effect of mortgage debt in contrast to an ambiguous effect of housing wealth.

#### 3.3.1 The effect of mortgage debt

Our objective is to evaluate the effect of a change in mortgage debt ( $M_0$ ), keeping initial wealth ( $W_0$ ) constant. We consider an increase in the amount of debt outstanding  $M_0$  matched by an equivalent change in liquid wealth  $L_0$  (assuming that the choice of  $H_0$  has already been made and is treated as exogenous). In this case, net assets in the last period are:

$$W_1 = Y_1 + P_1 H_0 - (M_0 + \Delta M_0)(1 + R_M) + (L_0 + \Delta M_0)(1 + R_F),$$

and the effective change in wealth is:

$$\frac{d W_1}{d M_0} = -(R_M - R_F).$$

This implies that an increase in the initial mortgage amount – i.e., the leverage in period 0 – decreases net wealth as long as  $R_M > R_F$ . In our empirical setting  $R_M > R_F$  is highly likely to

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house prices,  $\sigma_{eP}$  represents the additional covariance associated with entrepreneurial income relative to dependent employment. We ignore the case  $\sigma_{eP} < 0$  because in our data entrepreneurial income is strongly and positively correlated with house prices, and more so than the income of dependent workers.

<sup>16</sup>The house price variance  $\sigma_p^2$  does not enter equation (3) above, despite influencing individual utility (house price variability is disliked by risk averse agents). Both workers and entrepreneurs are affected by  $\sigma_p^2$  in the same way; when the two utilities are compared, this term cancels out.

hold since in Britain (unlike in the US) mortgage interest cannot be deducted from income taxes.<sup>17</sup>

With constant relative risk aversion, the variability of entrepreneurial income has a higher utility cost when wealth is lower because risky labour income represents a larger fraction of total wealth ( $\eta_Y$  in equation (3) is bigger). Moreover, a lower wealth increases the impact of house price co-movements with entrepreneurial income on utility through the term  $\eta_H$  in equation (3). Hence, an increase in mortgage debt has a negative effect on the likelihood to become an entrepreneur as long as  $R_M > R_F$ :

**Proposition 1.** *Under the assumption that  $R_M > R_F$ , the link between homeownership and entrepreneurship depends negatively on the extent of mortgage debt.*

In addition, equation (3) points to an important interaction between the wealth share associated with labour income ( $\eta_Y$ ) and entrepreneurial risk ( $\sigma_e^2$ ). An increase in  $\sigma_e^2$  makes agents more reluctant to become entrepreneurs and this effect is amplified at high levels of mortgage debt, provided that  $R_M > R_F$ . Hence, we expect that an increase in mortgage debt will have a particularly strong adverse effect on the propensity of a homeowner to become an entrepreneur in sectors where profit variability is high:

**Proposition 2.** *Under the assumption that  $R_M > R_F$ , the negative link between financial leverage and entrepreneurship is greater in sectors where profits have a higher variance.*

This second proposition allows us to distinguish our framework from those of previous studies that have emphasised the luxury/consumption value of entrepreneurship and explored its link to individuals' wealth. The wealth effect that underpins our model takes a very specific form: it affects an individual's risk aversion. Proposition 2 is a direct test of the validity of this channel.

We test these propositions in our data by looking at the effect of mortgage debt while holding overall wealth constant. To do so, we exploit the longitudinal nature of our data and use individual fixed effects to control for persistent wealth and an individual's 'entrepreneurial taste'  $\alpha_i$ . We also use detailed information on individual and household income sources to account for changes over time in their financial situation.

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<sup>17</sup>The Mortgage Interest Relief at Source (MIRAS), introduced in 1983, was phased out between 1988 and 2000. Even in the early years of our sample period (spanning 1991 to 2008), the MIRAS subsidy was very limited in scope compared to the US Mortgage Interest Deduction. Thus, in our empirical investigation,  $R_M$  likely exceeds  $R_F$  during the entire sample period.



### 3.3.2 The effect of housing wealth

The value of housing is reflected in the  $H_0P_1$  term of an agent's wealth. Overall, the effect of a change in  $H_0P_1$  is ambiguous. On the one hand, it increases wealth, making  $\eta_Y$  smaller and decreasing the risk associated with labour income. On the other hand, it increases the wealth share of housing ( $\eta_H$ ), making the overall portfolio position more risky.<sup>18</sup> To translate our model into empirical predictions, it is useful to distinguish between the effects of changes in housing quantities ( $H_0$ ) and prices ( $P_1$ ).

When analysing changes in  $H_0$ , we would ideally like to compare the same individual with different quantities of housing but the same level of initial wealth  $W_0$ . When the agent has less housing, she holds more risk-free liquid assets  $L_0$ . We assume that housing is expected to appreciate more than  $R_F$  because it is risky. Therefore, when the agent has more housing, she has a lower  $\eta_Y$ , which reduces  $\alpha^*$ . At the same time, more housing brings more risk in the agent's portfolio through  $\eta_H$ , which pushes  $\alpha^*$  up. As a result, the overall effect is ambiguous. In the empirical analysis, we mainly use a binary measure of  $H_0$  (homeownership) instead of a continuous one (quantity of housing in the portfolio). Therefore, we study this (ambiguously-signed) prediction by focusing on the effect of introducing housing into the portfolio – i.e. going from being a renter to being an owner – in specifications that control for the level of debt and housing values, and hold wealth constant. In some extensions, we use ‘number of rooms’ for homeowners to provide a more continuous proxy for  $H_0$ .

The effect of an increase in house prices  $P_1$  is similarly ambiguous. On the one hand, an increase in  $P_1$  raises the agent's wealth and decreases  $\eta_Y$  – reducing the negative effect of entrepreneurial income variation. On the other hand, it also increases  $\eta_H$  – thus pushing up the detrimental effect of co-movements of income and house prices. The overall effect depends on the specific magnitude of the parameters that govern the two opposing forces: portfolio and hedging effects (as shown in more detail in Appendix A.1). We investigate this ambiguously-signed prediction directly in our data by exploiting a rich set of information on house values at the individual and local level.

Note that, in contrast to our setting, in a simple model with credit constraints and bank lending against housing – but no portfolio and hedging considerations – an increase in house prices would raise the collateral value of housing and allow for more borrowing from banks to start some entrepreneurial activities. Hence, in such models, the effect of an increase in house prices on entrepreneurship is unambiguously positive.

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<sup>18</sup>By contrast, when evaluating the effect of mortgage debt, both  $\eta_Y$  and  $\eta_H$  move in the same direction. As a result the effect is unambiguously negative.

### 3.3.3 Comparative statics in the no-mobility case

So far we have assumed that agents are free to relocate at the end of period 0. Suppose instead that  $H_1 = H_0 = \bar{H}$  because of moving costs or other impediments to housing trades. Stated differently, individuals face a consumption commitment because they cannot freely adjust housing quantity.

In this case we have that:<sup>19</sup>

$$\log \tilde{\alpha}^* = \frac{(1 - \gamma)^2(1 - \mu)^2}{2} \tilde{\eta}_Y^2 \sigma_e^2, \quad (4)$$

where  $\tilde{\eta}_Y$  is the fraction of *non-housing* wealth associated with labour income. The threshold  $\tilde{\alpha}^*$  does not contain any reference to  $H_0 P_1$  nor  $\sigma_{eP}$ , because agents cannot adjust their housing consumption in period 1.

The results on leverage and its interaction with the variance of entrepreneurial income (Propositions 1 and 2) still hold. However, the comparative statics with respect to housing wealth change. First, house price movements have no effects: capital gains are irrelevant if agents cannot move. Second, with no mobility, changes in the quantity of housing ( $H_0$ ) have an unambiguous negative effect on entrepreneurship. Suppose an agent increases her share of housing, e.g. by buying rather than renting the place in which she lives: this has the indirect effect of increasing her labour wealth share  $\tilde{\eta}_Y$ . If a larger portion of wealth is ‘tied up’ in housing that cannot be traded, labour income risk has a higher impact on an agent’s consumption.

To sum up, when leveraged homeowners are immobile and unable to trade housing, our comparative statics are as follows: (i) Propositions 1 and 2 continue to hold; (ii) the effect of an increase in the quantity of housing now becomes unambiguously negative; and (iii) house price considerations have no effect for agents that are committed to a fixed level of housing. We test these predictions in our empirical section.

## 4 Data

The BHPS is a panel dataset covering the period 1991-2008 and providing detailed information on households’ tenure choices and characteristics, as well as individuals’ current occupations, job-history between interviews, personal characteristics, income and financial situation. The first wave of the panel consists of approximately 5,500 households and more than 10,000 individuals living in the UK. One of the advantages of the BHPS is that it is quite successful in following the same

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<sup>19</sup>Appendix A contains the relevant derivations.

individuals over time, even when they move residence or form new households (e.g., the children of the original BHPS families or divorcees).

At the time of the interview (normally in September), respondents are asked to describe their current labour force status. If they are working, detailed information about their occupation is collected. Respondents are also asked whether their labour force status has changed since their last interview. If the answer is positive, a set of detailed questions is asked about all the occupational spells that occurred between the interview taking place and September of the previous year.<sup>20</sup>

To identify the relation between housing tenure, mortgage debt and entrepreneurship, we need information about individuals' tenure choices with special attention to the timing of events. We first gather information about respondents' present tenure status. The possible categories are: homeowners with mortgage, homeowners without mortgage, private tenants, and social tenants.<sup>21</sup> We then use the date in which respondents say they moved to their present address to identify the timing of changes in an individual's tenure. If the respondents changed their tenure status from one wave to another and there is a moving date, we take this date as the transition date. Approximately 93% of all individuals have a moving date when making a transition into/out of homeownership. If respondents change their tenure but there is no moving date, the transition date is imputed as the date of the current interview.<sup>22</sup>

Other controls – such as education level, age, marital status and number of children – are treated as constant between the two waves. Changes are attributed to the date of the annual interview.

In terms of sampling, we begin with an initial set including all respondents who gave a full interview in Wave 1 or one of the following waves. We then follow them until they exit the survey for the first time, even if they come back at a later stage. This restriction is imposed to construct a continuous account of an individual's labour force status for every month combined with precise information on her tenure status. In Wave 1 (1991) we have 9,892 individuals. In Wave 18 (2008) we have 6,309 individuals, of which 3,642 are from the initial sample. Observations decrease gradually, reflecting aging and attrition in the original sample, but children and spouses of original members

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<sup>20</sup>The way in which the BHPS is structured makes it possible that some inconsistencies arise in the description of the same labour force spell provided by the same person in two different waves. Several authors have discussed the complicated task of reconstructing detailed monthly spells from the BHPS (Paull, 2002; Maré, 2006). We follow the principle that information recorded closest to the date of the beginning of the spell is the most accurate. A similar approach is used in Upward (1999) and Battu and Phimister (2008). We provide a detailed description of our procedure to assemble the data in the Online Data Appendix.

<sup>21</sup>There are other rare options, such as living in an accommodation paid by the employer, which we do not consider in our analysis. This exclusion does not affect our findings.

<sup>22</sup>It is possible to change tenure status without changing address. In the UK, for instance, the 'Right-to-Buy' programme allows social tenants to buy their house or flat from the local authority (van Ham et al., 2010). Similarly, individuals could buy from their current private landlord. However, this does not seem widespread.

join the dataset, partially counterbalancing the decreasing tendency.

In our analysis, we focus on heads of households in their prime working age (between 20 and 55) and consider only their employment spells – either as workers or as self-employed. By focusing on these individuals, we limit the importance of issues related to labour market participation, since in our data ‘head of household’ refers to the individual within the household who manages the financial aspects and is the main economic actor.<sup>23</sup>

We only focus on individuals living in England, because for this group we can match precise information about prevailing local housing market conditions. To merge in such information, we use a (restricted-access) identifier for the Local Authority (LA) where the individual lives.<sup>24</sup> We use LA identifiers to merge LA-specific LTV data from the Survey of Mortgage Lenders (SML) to the BHPS.<sup>25</sup> Additionally, we match LA-specific house price data coming from the SML (until 1995) and from the Land Registry (from 1995).<sup>26</sup> Finally, we collate some proxies for the elasticity of local housing supply – i.e. the LA-specific percentage of developed land and the LA-level refusal rate – as derived by Hilber and Vermeulen (2014).

After implementing these restrictions and cleaning the data, our sample includes approximately 360,000 observations (i.e., individual monthly spells) and 5,200 individuals. The richness and detail of the dataset is a novel element of our analysis. Most panel-type studies of entrepreneurship (Hurst and Lusardi, 2004; Disney and Gathergood, 2009) and their link with housing rely on annual observations and have scant information on mortgage debt.

## 5 Preliminary descriptive evidence

### 5.1 Descriptive statistics

The first set of descriptive statistics is presented in Table 1. The first row of Panel A presents descriptive statistics for our proxy for entrepreneurship, i.e. self-employment with dependent workers, indicating that 4.7% of employment spells are classified as entrepreneurial. This figure is substantially lower than the one obtained considering other proxies used in the literature, for example ‘all

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<sup>23</sup>Including unemployment and other labour market status spells in our analysis does not alter our results because prime-age heads of households are predominantly employed.

<sup>24</sup>LAAs are local constituencies empowered to exercise planning functions, and can be thought of as self-contained housing markets from a regulatory point of view. England consists of 354 LAs.

<sup>25</sup>The SML has a broad coverage of UK mortgage lenders in addition to building societies, and collects a wide range of mortgage-related information, including purchase price and mortgage amount.

<sup>26</sup>We use annual LA-level mix-adjusted house prices – see Hilber and Vermeulen (2014) for details of the computation – and merge this data to our monthly BHPS data at a yearly frequency.

self-employed' – at 14.4% in our sample.<sup>27</sup>

Panel A shows that the fraction of homeowners in the monthly spell data is 81%.<sup>28</sup> Around 71% of the observations involve homeownership with a mortgage, whereas 9.6% refer to owners with no mortgage. For the former, the LTV on the mortgage is on average 48.8%. This variable is time-varying and calculated as the ratio between individuals' outstanding mortgage debt and self-assessed house value. Approximately 15% of the overall variation is within-individual over time, with a larger incidence of individuals reducing their LTV than increasing it. Note that this ratio varies over time because of amortization and refinancing, as well as changes in the value of the asset.<sup>29</sup> On average, individuals report housing values of approximately £120,000, though this figure is associated with a large standard deviation of £110,000. Finally, the cumulative house price gains experienced by individuals between the time of purchase and the current spell are on average around £40,000.

Panel B tabulates descriptive statistics for background characteristics. These show that the average individual is 39.4 years old; males represent 79% of observations; 75% of the spells refer to individuals who live in a household as couples, and 46% to individuals with children under the age of 16. Finally, individual and household total incomes in the year prior to the survey stand at £21,060 and £31,839 respectively.

In Table 2, we present additional descriptive statistics on individuals' incomes. A comparison of the first and second row reveals that entrepreneurs earn a slightly larger average income than dependent workers, but the median income for these two groups is very close at £18,500 and £18,322, respectively. The last two columns show that entrepreneurship is a riskier choice than dependent employment. The overall standard deviation of entrepreneurs' incomes is 2.3 times larger than the figure for dependent workers (respectively at £33,608 and £14,528). The same holds true if we look at the standard deviation of incomes within-individuals over time. This evidence is consistent with Hamilton (2000) and supports our modelling assumptions.

In Table 3, we display the incidence of transitions into and out of homeownership and entrepreneurship. Around 18% of all individuals make at least one homeownership transition (for example 'rent' to 'own') and 5.4% at least two transitions (e.g. 'rent' to 'own', to 'rent' again). The figures also illustrate that more people transit into homeownership than out of it, and that more

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<sup>27</sup>The percentage of self-employment in our sample is consistent with Blanchflower and Shadforth (2007), who use several years of data from the Labour Force Survey to document that self-employment in the UK has stayed between 12% and 15% in the 1991 to 2007 period.

<sup>28</sup>This figure is close to the one reported by Battu and Phimister (2008), at 79%. They use the same data to study the effect of homeownership on unemployment duration.

<sup>29</sup>A substantially larger fraction of the within-individual variation in LTV is explained by within-individual variation in the outstanding amount of loan rather than by within-individual variation in housing values.

transitions involve mortgages than outright ownership. A substantial fraction of individuals with mortgages transits into outright homeownership, though some of them – as well as some outright owners – revert back to renting. We find that 5.9% of the spells involve one transition into or out of entrepreneurship, and 3.3% involve more than one entrepreneurial transition.

We also investigate the characteristics of individuals who transit into and out of homeownership and entrepreneurship. Our findings are presented in Table 4. Relative to those who become homeowners without a mortgage, individuals who use a loan to purchase their property are (i) younger (30.4 vs. 37.4 years), (ii) less likely to have children/to be in a relationship (62.3% vs. 67.7%), and (iii) less affluent (£13,547 vs. £16,105). Individuals who become entrepreneurs are older (at 35.4) than individuals transiting into homeownership with a mortgage, but younger than outright owners. This suggests a time-line where individuals first purchase a property with a mortgage, then decide whether to become entrepreneurs, and eventually pay off the mortgage. This is consistent with our modelling framework and empirical analysis, where we focus on the effect of housing and mortgage debt on occupational choices.

We also find that individuals who become entrepreneurs are better off in terms of prior income and are more likely to be in a relationship and have children. We do not detect any clear pattern in terms of age, family arrangements and income for people transiting out of homeownership or entrepreneurship. This suggests that these movements cannot be easily explained by demographic factors and that other individual specific considerations might be taking place in ways that simultaneously affect the tenure status and entrepreneurship. We return to these issues below.

## 5.2 Descriptive stylised facts

In Table 5, we present a descriptive regression analysis that relates entrepreneurship to homeownership. Regression coefficients are obtained from fitting the following linear probability model:

$$Entrep_{ilt} = \eta_i + \beta own_{ilt} + X_{ilt}\gamma + \phi_l + \omega_t + \varepsilon_{ilt} \quad (5)$$

where the dependent variable  $Entrep_{ilt}$  is our proxy for an entrepreneurial job, and the explanatory variable of interest is an individual's housing tenure status  $own_{ilt}$ . The subscript  $ilt$  identifies individual  $i$  living in location  $l$  at time  $t$ .  $X_{ilt}$  is the set of time-varying controls discussed above, while  $\phi_l$  and  $\omega_t$  represent location and time fixed effects. Location (LA) fixed effects ( $\phi_l$ ) include persistent geographical disparities in labour and housing markets and differences in local political and institutional factors, whereas the time fixed effects ( $\omega_t$ ) capture unobserved factors that are

specific to the year and/or month of interview. Finally,  $\eta_i$  captures unobserved individual factors, such as taste for entrepreneurship ( $\alpha_i$  in our model) and persistent wealth (related to  $W_1$ , the balance between  $M_0$  and  $L_0$ , and the mortgage cost  $R_M$ ), which may simultaneously determine occupational choice and tenure status. The error-term  $\varepsilon_{it}$  is assumed to be uncorrelated with all the right-hand side variables, although we allow for correlation in residual shocks across individuals within locations and cluster standard errors at the LA level.

Columns (1) and (2) of Table 5 present cross-sectional (OLS) estimates of Equation 5. In Column (1), we append year-of-interview and month-of-interview effects, as well as dummies for the sector of employment (using the SIC92 classification at 1-digit level), while in Column (2) we further include the controls detailed in Table 1, as well as LA dummies. The two specifications indicate a positive and significant association between homeownership and entrepreneurship. Although the estimated coefficients are attenuated when adding individual controls and LA effects, the estimates remain sizable and highly significant.

In Columns (3) to (7), we control for individuals' unobservables –  $\eta_i$  in Equation 5 – by estimating fixed-effect models. In stark contrast to the OLS regressions, we find that the correlation between homeownership and entrepreneurship is negative and significant. To assess the robustness of this finding to time-varying characteristics and local unobservable factors, in Column (4) we add the control variables detailed in Table 1, as well as LA dummies. The set of controls includes both individual and household total income in the year prior to the survey (in logs). Conditional on individual fixed effects, these variables capture changes in the financial situation of an individual and her household with respect to the previous year, and therefore proxy for changes in an individual's wealth. Finally, in Column (5) we retain the set of controls included in Column (4), but drop LA dummies since only 30% of the individuals change their place of residence over the period of our analysis. The results in Columns (4) and (5) still present a significant, negative correlation between homeownership and entrepreneurship.

Part of the findings documented in Column (3)-(5) might be driven by individuals who sell their property in order to extract equity from their home and then become entrepreneurs. To explore the relevance of this channel, in Columns (6) and (7) of Table 1, we focus on individuals' spells that correspond to transitions into and out of homeownership, respectively. In Column (6) we follow individuals who start off as renters and then become homeowners (plus individuals who start off as owners and stay as such throughout the period). In Column (7), by contrast, we track individuals who finish as renters after having been homeowners (plus individuals who start off as

renters and do not change tenure throughout the sample period). Our findings suggest that the negative correlation between homeownership and entrepreneurship comes from individuals who become homeowners. The estimated effect is larger and more precisely estimated than before. Conversely, the link between tenure status and entrepreneurship for individuals switching out of homeownership is estimated to be small and insignificant.

In Column (8) we augment the specification of equation (5) with a dummy variable that identifies homeowners with a mortgage. We find that the negative correlation between homeownership and entrepreneurship is sizable and significant *only* for homeowners with a mortgage. Conversely, the association between outright ownership and business start-ups is small and insignificant.

Finally, we study the time-evolution in the correlation between homeownership and entrepreneurship by estimating fixed-effect models that add to the baseline specification of equation (5) a linear and a quadratic term in the monthly duration since the time of becoming a homeowner. Our results show that the linear count carries a positive and significant coefficient (0.016; s.e. 0.008), while the squared duration carries a negative and borderline significant estimate (-0.005; s.e. 0.003). This implies an inverted U-shaped relationship between the time since becoming a homeowner and the probability of becoming an entrepreneur. Our results are presented graphically in Figure 1. These illustrate that on impact the correlation between homeownership and entrepreneurship is -0.018, but that as time goes by, this negative relation becomes less quantitatively meaningful. It takes 4 years (48 months) for the effect to become statistically insignificant at the 5% level. However, the effect of homeownership never turns positive, even when considering fairly long time horizons, e.g. after 10 years (120 months).<sup>30</sup> The pattern in these estimates is consistent with the possibility that as time passes by and homeowners repay some of their mortgages – i.e. they de-leverage – the negative association between tenure and entrepreneurship becomes less marked.

To sum up, the stylised facts collected in this section are consistent with the insights from our theoretical framework. In the next section, we directly test its predictions.

## 6 Main findings: Taking the model to the data

### 6.1 Proposition 1: The negative link between leverage and entrepreneurship

To test Proposition 1, we start by adding to the specification described in equation (5) the time-varying measure of the LTV ratio described above. We further control for the direct effect of

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<sup>30</sup>Consistent with this observation, if we only include in the empirical model the linear duration term, we find a very small and insignificant coefficient implying that the relation between time in homeownership and entrepreneurship never crosses the zero line.



housing wealth by including in our empirical model self-assessed housing values alongside the dummy for owner occupation. Our first set of results is reported in Columns (1) and (2) of Table 6. In Column (1) we present OLS associations. These show that homeownership *per se* is not associated with entrepreneurship. Conversely, housing wealth displays a significant correlation with entrepreneurship. A £100,000 increase in housing values – approximately a one standard deviation change – is associated with a 40% increase in entrepreneurship. This is consistent with previous cross-sectional findings in the literature (Black et al., 1996). Finally, the LTV of the outstanding mortgage has no significant association with entrepreneurship.

In Column (2) we move to an individual fixed-effect specification. As already discussed, this accounts for unobserved individual factors ( $\eta_i$  in our empirical model) such as taste for entrepreneurship – which we denoted by  $\alpha_i$  – and persistent wealth – which in our theoretical framework is related to  $W_1$ , the balance between  $M_0$  and  $L_0$ , and the mortgage cost  $R_M$  faced by individuals. The results reveal that homeownership is not significantly associated with entrepreneurship – its effect is estimated to be very close to zero. We further test this finding by adding to our specification a variable counting the ‘number of rooms’ for homeowners to proxy more continuously for the quantity of owner-occupied housing consumed. This extension does not change our results: neither the dummy for owner-occupation nor the number of rooms for homeowners enter the regression significantly. This is so irrespective of whether we allow the latter to have a linear and/or quadratic effect, or a more flexible impact by including separate dummies for different numbers of rooms (up to 10). Similarly, self-assessed house values have no impact on entrepreneurship. Conversely, the LTV ratio enters our specification with a negative, sizable and significant effect. The point estimate implies that a one standard deviation increase in the LTV is associated with a reduction in the probability of being an entrepreneur by about 9.5%.<sup>31</sup>

These findings are consistent with the predictions of our model. First, the negative relation between LTV and entrepreneurship supports Proposition 1. Second, the lack of a clear association between entrepreneurship and homeownership (or house values/other proxies for housing quantity) is consistent with the ambiguous effect of housing wealth. The results are not affected if we replace self-assessed housing values with a measure of the net equity held by individuals in their home – i.e. the difference between the value of the property and the amount of the outstanding loan. The fixed-effects specification still yields insignificant coefficients on homeownership and net equity, but

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<sup>31</sup>We tested the robustness of our results to the inclusion of LA fixed effects or the inclusion of Travel-To-Work Area (TTWA) effects – on top of individual fixed effects. TTWAs are 243 functional areas drawn by the Office for National Statistics to identify self-contained local labour markets. We also experimented with alternative clustering structures, including two-way clustering at the individual and LA level. None of these checks affects our conclusions.

a sizable, negative and significant effect of the LTV. Similarly, our results on the negative effect of LTV do not change if we drop from our specifications the controls for housing values or net equity.

In some extensions, we further investigate whether the effects of LTV are non-linear. To do so, we create twenty dummies each containing 5% of the LTV distribution and test their effects on the probability of being an entrepreneur. We find little evidence of non-linearities: the effects gradually increase as we move to higher LTV levels and are clearly significant from the 30th percentile upwards. Dividing the LTV distribution into five groups (each containing 20% of the observations) yields comparable results. Using a similar approach, we also find little evidence that the effect of housing values is non-linear: their impact remains flat across the house price distribution.

One concern with our fixed-effect estimation is that, although it partials out individual, household, location and time-invariant unobservables, it cannot control for time-varying unobserved factors. Adding time-varying individual and household level controls mitigates this problem. In particular, we control for the number of children and marital status, which have been shown to be strongly associated with homeownership and entrepreneurship (Linneman and Wachter, 1989; Evans and Leighton, 1989; Hilber, 2007). Moreover, we control for individual and household-level income in the year prior to the survey. Conditional on individual fixed effects, these variables capture changes in households' financial conditions over time and therefore proxy for wealth changes. Nevertheless, the potential for biases in our estimates remains, and we next present a set of extensions that help address these issues.

To begin with, in Columns (3) and (4) we replace individual fixed effects with individual-housing-spell effects. These specifications exploit the variation in LTV within a specific housing spell, and account for changes in individuals' unobservables when they first become homeowners and any time they move home or change their tenure status. In short, these specifications help addressing the endogeneity of tenure choice, and the potential endogenous variation in the LTV when individuals move between homes – i.e. when they change spell *within* homeownership. These specifications yield a slightly stronger negative link between leverage and entrepreneurship. In Column (3), we include all individuals in our estimation sample and find that a one standard deviation increase in LTV reduces the probability of being an entrepreneur by approximately 14%. In Column (4) we focus only on homeowners (i.e. we drop renters from the estimation sample), thus by-passing the possibility that the endogeneity of the home-ownership decision biases our results. This specification confirms our previous finding: a one standard deviation change in LTV

reduces entrepreneurship by approximately 12%. Once again, we find that using net equity – instead of housing values – provides the same conclusions irrespective of the exact details of the individual-housing-spell specification used.

One additional concern is that the LTV at which an individual initially borrows as well as the LTV on the outstanding mortgage may be endogenous. Individuals have some discretion about their initial LTV as well as the LTV on the outstanding amount of mortgage because of refinancing decisions (as discussed in Section 2). To address these concerns we devise an instrumental variable (IV) strategy based on information on the LTV of newly originated mortgages in the area of an individual's residence. Using data from the Survey of Mortgage Lenders (SML), we construct an instrument which equals the time-varying local LTV in the LA of an individual's residence for homeowners (and is set to zero for renters). The aim of this variable is to predict the exogenous part of the initial LTV at which an individual borrows and the subsequent values of the LTV on the outstanding mortgage. The validity of this approach rests on the assumption that most of the mortgage financing and refinancing terms will be dictated by the local housing market and banking conditions. Muellbauer (2002) provides supporting evidence. One problem with this approach is that local variation in LTV might proxy for the local economic cycle – which could directly affect entrepreneurship. To deal with this problem, our IV specifications control for variation in wages and in local employment at the local level.<sup>32</sup>

We also address the potential endogeneity of self-reported housing values by following the approach used by Chetty and Szeidl (2012) and instrumenting this variable using the variation in national house prices in interaction with (time-fixed) proxies for local housing supply elasticities, namely the share of developed land in the LA and the average LA planning refusal rate. In essence, our approach treats local LTVs and the interaction between local housing supply elasticity and national house prices as exogenous to individuals' unobservables.

Column (5) in Table 6 reports our individual fixed-effect IV estimates and confirms our previous conclusions. A one standard deviation change in LTV reduces the probability of becoming an entrepreneur by approximately 11.5%. Conversely, housing wealth has no effect on entrepreneurship. Further augmenting this specification with LA fixed effects yields a very similar coefficient on the LTV at -0.022 (10% significant). This is not surprising given that only 30% of individuals change their LA of residence. Similarly, controlling for the effect of outright ownership in this specification does not substantially affect our point estimates – increasing slightly to -0.024 – although the effect

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<sup>32</sup>More specifically, we control for total weekly gross earnings for full-time male workers and total adult employment at the LA level. Details are provided in Hilber and Vermeulen (2014).

of the LTV becomes less precisely estimated.<sup>33</sup>

In Appendix B we discuss an additional set of checks that we perform on our main specification (tabulated in Appendix Table 1). The results are all based on specifications that include individual fixed effects and support our conclusions so far.

## 6.2 Proposition 2: The role of entrepreneurial risk

To test for Proposition 2, we collect information contained in the Structural Business Statistics prepared by Eurostat.<sup>34</sup> We assemble data on industry-level profits at the NACE 2-digit sector level on an annual basis for the 1997 to 2007 period. This sectoral level of aggregation can be mapped to the standard industry classification provided in the BHPS (SIC92), providing a sufficient level of detail by dividing the economy into 45 sectors.

Using this data, we calculate the coefficient of variation of industry-level profits (i.e. profit variability adjusted for mean returns) for the available period as a proxy for business riskiness, and split our dependent variable into entrepreneurs in risky sectors and entrepreneurs in non-risky sectors. We then run separate regressions with these two outcomes to investigate whether the negative link between entrepreneurship and mortgage debt is more pronounced and significant in industries characterised by more risk.<sup>35</sup>

Our results are displayed in Columns (1) and (2) of Table 7, where we split our dependent variable using the median of the distribution of the coefficient of variation of profits in the individual sample (at 0.131). A comparison of the two columns reveals that entrepreneurship is only adversely affected by mortgage debt for homeowners in risky sectors. Using the median of the raw standard deviation of profits (i.e. profit variability *unadjusted* for mean returns) strengthens our findings. The negative effect of mortgage debt on the chances of becoming an entrepreneur in sectors with standard deviation of profits above the median is -0.019 (5% level of significance), but this becomes much smaller at -0.007 and insignificant for entrepreneurs in sectors with profit variability below the median. These results are fully consistent with Proposition 2.

Our model also predicts that – unless leveraged homeowners are perfectly immobile (i.e., fully committed in terms of housing consumption) – the effect of mortgage debt should be more sig-

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<sup>33</sup>Individual-housing-spell IV estimates of the LTV are substantially smaller, at -0.007, and not significant. We believe this specification yields less meaningful estimates because a substantial part of the instrument's power comes from predicting the initial LTV. This variation is effectively absorbed with individual-housing-spell effects.

<sup>34</sup>This can be accessed at [http://epp.eurostat.ec.europa.eu/portal/page/portal/european\\_business/data/database](http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/data/database), where more information on the data construction and availability is also provided.

<sup>35</sup>An alternative way of performing this test is to split our sample into individuals who work in risky sectors and those who do not. When we do this and run two regressions with two different samples – as opposed to two different dependent variables – we find similar results. Results are available from the authors upon request.

nificant when profits are highly correlated with house prices. Conversely, if homeowners cannot relocate and are tied to a fixed housing amount, house price considerations should not magnify the negative effect of leverage on entrepreneurship.

We investigate this possibility in the subsequent columns of Table 7. To start with, we use prices at the LA level to measure their correlation with profits in different sectors of the economy. We then construct alternative dependent variables that consider individuals who are entrepreneurs working in sectors and living in areas that display an above median/below median correlation between profits and local house prices. We present our findings in Columns (3) and (4), respectively.<sup>36</sup>

Our results reveal that the effect of mortgage debt is substantially larger and only significant in areas that entail house price risk that correlates strongly with entrepreneurial profits. In particular, the effect of mortgage debt for individuals who are entrepreneurs and live in areas where the correlation between house prices and profits is above the median is ten times bigger (-0.020) than the effect for individuals facing lower correlation (-0.002). We find a very similar pattern when we consider the covariance (instead of correlation) between local house prices and sector profits (-0.019 vs. -0.004), or the correlation between national house prices (instead of local) and profits (also -0.020 vs. -0.002).<sup>37</sup>

These findings complement the evidence presented in Section 6.1 on the ambiguous effect of housing quantity. Overall, they suggest that housing consumption commitments are not empirically important in our setting and support our main modelling assumptions (which allow for mobility and changes in the amount of housing consumed).

### 6.3 Credit constraints as an alternative explanation?

The results discussed so far could be consistent with an alternative theory based on credit constraints: leveraged homeowners find it hard to obtain additional finance to start their business because they are already burdened with a substantial loan on their house. For this explanation to hold true, we should detect a positive relationship between house price increases and entry into entrepreneurship. This is because, as home values increase, LTV ratios are pushed down and housing becomes a collateral that can be used to relax credit constraints. The results discussed in

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<sup>36</sup>This approach assumes that the correlation between profits and *local* house prices captures the relevant margin of variation. Evidence on the relative immobility of entrepreneurs supports this intuition (Michelacci and Silva, 2007; Faggio and Silva, 2014).

<sup>37</sup>We also split our regressions to consider individuals living in areas with above/below median house price volatility as measured by the coefficient of variation. We find that the effect of mortgage debt on entrepreneurship is slightly more sizable (at -0.010) in areas with high price variation than in areas with low price volatility (at -0.007) – however this difference is much less pronounced than the heterogeneity presented in Table 7. This suggests that the effective ‘risk margin’ is the one represented by the variation of profits and their correlation with house prices, as suggested by our model.

Section 6.1 broadly dispel this possibility (at least for the UK). In this section, we provide additional evidence, which is inconsistent with this alternative explanation. The results are presented in Table 8.

To begin with, we calculate the cumulative change in housing values using the variation in an individual's self-assessed house value, and considering the change between the time when the property was purchased and the current date. This gives a neat measure of any capital gains (or losses) accrued to an individual through homeownership, allowing us to test whether the equity position built into someone's real estate investment can be used as a collateral in setting up a business.

As shown in Column (1), OLS estimates point to a positive correlation between cumulative house price gains and entrepreneurship: a one standard deviation increase in this variable is associated with an 18% increase in the probability of being an entrepreneur. Homeownership is also positively associated with entrepreneurship, while the LTV is not. However, as soon as we include individual fixed effects in Column (2), cumulative house price gains are neither positively nor significantly associated with entrepreneurship. Conversely, we still find a negative and significant association between mortgage debt and entrepreneurship.

These patterns are not affected if we consider non-linearities in the effect of the LTV and/or cumulative house price gains following the approach we used in Section 6.1. Furthermore, we find no evidence of interaction effects with cumulative house price gains (entered either linearly or non-linearly in our specification) having no differential effects for individuals with higher/lower levels of LTV.

In the next two columns of the table we address endogeneity concerns that might affect our findings. In Column (3), we control for individual-housing-spell effects and focus on homeowners only (as in Column 4 of Table 6). We still find a sizable and negative association between LTV and entrepreneurship, but no evidence that cumulative house price gains affect the probability of being an entrepreneur. Next, in Column (4), we follow the strategy used in Column (5) of Table 6 and supplement our fixed-effects approach with an IV strategy. For the individual LTV, we use the same instrument we adopted in Section 6.1. For self-assessed cumulative house price gains, we create two instruments by first computing the national cumulative house price changes for the period relevant to each individual, and then by multiplying these figures by our proxies for the local elasticity of supply of housing. This is only a slight modification of the instruments used above and follows the logic of Chetty and Szeidl (2012).<sup>38</sup> Results from these specifications still

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<sup>38</sup>Using these instruments separately leads to very similar conclusions.

provide no evidence that cumulative house price gains matter. Conversely, the negative effect of mortgage debt on entrepreneurship maintains its size and significance.

To further investigate the importance of credit constraints, we conduct an additional set of exercises. First, we estimate the effect of cumulative house price gains while controlling for the difference between the outstanding value of the loan and the initial house value. This allows us to isolate the effect of ‘actual’ equity gains as opposed to equity gains potentially used to reduce the outstanding amount of the loan (via re-financing). This modification does not change our results. Next, we replace cumulative house price gains measured in pounds with cumulative house price gains expressed as a percentage of the initial house value. This has no effect on our conclusions. Finally, we follow Adelino et al. (2013) and investigate whether our findings differ for individuals operating in capital intensive sectors. To do so, we exploit figures on the average investment per employee obtained from Eurostat and interact both variables of interest – namely the LTV and the cumulative house price gains – with the capital intensity of the sector where individuals work. Both interactions display very small and insignificant coefficients, and the overall effect of cumulative house price gains remain insignificant. Instead, the effect of mortgage debt on entrepreneurship retains its size and significance.<sup>39</sup>

Overall, our checks suggest that credit constraints are not the mechanism behind our findings. The results are instead consistent with our theoretical framework, in which the effect of house prices on entrepreneurship is not clearly signed and depends on the relative strength of portfolio and hedging considerations. Our findings are consistent with Hurst and Lusardi (2004) who show that households living in areas which experience strong house price appreciation are not significantly more likely to start an entrepreneurial venture.<sup>40</sup>

## 7 Conclusion

In this paper we study the link between mortgage debt and entrepreneurship. Our interest in this relationship rests on the notion that flourishing entrepreneurial activities can be conducive to higher economic growth and an acceleration of innovation. Our work contributes to a small, but growing literature that stresses the perils of excessive mortgage financing in the aftermath of the Great Recession (Mian et al., 2013). Our findings highlight a new channel through which excessive

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<sup>39</sup>We also address this issue by running regressions similar to the ones presented in Table 7 and splitting our dependent variable to consider leveraged homeowners working in sectors with average investment per employee above/below the median value of the investment distribution (approximately £5,800). This does not change our conclusions.

<sup>40</sup>In a similar vein, Disney and Gathergood (2009) replicate Hurst and Lusardi (2004)’s results using BHPS data.

mortgage debt may hinder economic activities and adversely affect the general economy.

In the first part of our work, we develop a model of occupational choice and housing tenure, where entrepreneurship is associated with non-pecuniary benefits that vary across individuals and costs arising from greater income uncertainty. The model yields two testable predictions: (i) conditional on individual characteristics, wealth and preferences, and as long as mortgage rates exceed the rate of interest of liquid wealth, mortgage debt diminishes the likelihood that individuals start a business; and (ii) the negative relation between mortgage debt and entrepreneurship is more pronounced for homeowners working in risky sectors.

In our empirical analysis we exploit the longitudinal dimension of the British Household Panel Survey to test these predictions while controlling for individual time-fixed unobservables and time-varying observables. Our findings confirm both predictions and support the mechanism proposed in our model whereby an increase in mortgage debt reduces net wealth and thereby amplifies the borrower's risk aversion. In turn, this implies that leveraged homeowners will be less likely to take up a risky entrepreneurial activity. We also empirically test an alternative mechanism based on credit constraints, but find no evidence in support of it.

Our findings have important policy implications. Virtually all developed countries – including the United States and the United Kingdom – have set in place policies that favour homeownership, mostly by making it easier to finance home purchases with a loan. These policies include mortgage interest rate deductibility, non-taxation of owner-occupation related capital gains and imputed rents, the creation of government-sponsored enterprises (such as Fannie Mae and Freddie Mac) with implicit or explicit government backing (thus subsidising the cost of securitised mortgages) or direct government guarantees of mortgages (such as Britain's Help to Buy policy). Recent research (Glaeser and Shapiro, 2003; Frame and White, 2005; Hilber and Turner, 2014) argues that these policies are associated with huge costs and can have perverse effects by raising prices and lowering homeownership attainment of low and moderate income households.

Do policies that promote homeownership by encouraging increasing financial leverage always depress entrepreneurial activities? Our answer is nuanced. Consider the mortgage interest deduction (MID). According to our theoretical framework, the MID increases leverage (Munroe, 2014) and thus increases risk aversion and discourages entrepreneurship.

However, our theoretical predictions rest on the assumption that leveraged homeowners do not default on their debt. While this is essentially true in the United Kingdom, where mortgages are recourse, it is, for example, less the case in many states of the United States, where mortgage



debt is non-recourse and renegotiations, at least during the Great Recession, were common place. Nevertheless, there are stigma-related psychological and economic costs associated with defaulting (at least during ‘normal times’) and Chetty and Szeidl (2007) provide evidence consistent with the idea that American households are committed to their housing and related mortgage payments. In short, even in settings with non-recourse mortgages, our theoretical propositions are likely to hold.

A second caveat is that the MID lowers the effective mortgage cost and – if the subsidy is strong enough – may reverse our assumption that the (effective) mortgage rate exceeds the rate of interest from liquid wealth, and thereby the main prediction of our model. To assess this possibility, we consider the case of the U.S. MID and use data from Poterba and Sinai (2011) who report the average mortgage interest deduction subsidy rate for various age-income groups. The group with the highest average subsidy rate is the one for household heads aged 25-35 who have an annual household income over \$250,000. For this group the average subsidy rate is 0.315. Using the Freddie Mac primary mortgage rate (as a proxy for the before-tax  $R_M$ ), the Treasury yields from Bloomberg (as a proxy for  $R_F$ ), and the maximum average subsidy rate of 0.315 to compute the after-tax mortgage interest rate (effective  $R_M$ ), we find that during the last 15 years the after-tax rate typically significantly exceeded the Treasury yield. However, during the period between 2004 and early 2007 – a period with an extraordinarily low risk premium attached to mortgages – the spread between the after-tax mortgage rate and the Treasury yield was essentially zero. Moreover, depending on the state of an individual’s residence and her specific tax status, the combined subsidy rate for some households may exceed 50%, generating a negative  $R_M - R_F$  spread during time periods with ultra-low risk premia. Nevertheless, our back-of-the-envelope calculations suggest that even in the US, where the mortgage interest deduction is sizable, under normal circumstances and for the majority of households the effective cost of borrowing significantly exceeds the yield on liquid risk-free assets. Thus our model predictions are likely to hold.

Much more clear-cut is the effect of policies that affect leverage directly – and not indirectly via lowering interest rates – and therefore very likely have the unintended consequence of discouraging entrepreneurial activity.

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# Appendices

## A Proofs

### A.1 The baseline case

The indirect utility of an agent with wealth  $W_1$  is:

$$\begin{aligned}
 V(W_1) &= \frac{1}{1-\gamma} \left\{ [(1-\mu)W_1]^{1-\mu} \left( \frac{\mu W_1}{P_1} \right)^\mu \right\}^{1-\gamma} \\
 &= \frac{1}{1-\gamma} \underbrace{\left\{ (1-\mu)^{1-\mu} \mu^\mu \right\}^{1-\gamma}}_{\phi} \left( W_1^{1-\mu} \frac{W_1^\mu}{P_1^\mu} \right)^{1-\gamma} \\
 &= \phi \left( \frac{W_1}{P_1^\mu} \right)^{1-\gamma}.
 \end{aligned} \tag{A.1}$$

**The entrepreneurship choice:** Our goal is to compute  $\alpha^*$  in equation 2, namely the level of  $\alpha_i$  that makes the agent indifferent between entrepreneurship and employed work. Using equation A.1, we can write  $\alpha^*$  as follows:

$$\begin{aligned}
 \alpha^* &= \frac{\phi \mathbb{E} \left( W_1^e P_1^{-\mu} \right)^{1-\gamma}}{\phi \mathbb{E} \left( W_1^w P_1^{-\mu} \right)^{1-\gamma}} \\
 &= \frac{\mathbb{E} \left( \frac{Y_e + H_0 P_1 - M_1 + L_1}{P_1^\mu} \right)^{1-\gamma}}{\mathbb{E} \left( \frac{\bar{Y} + H_0 \bar{P}_1 - M_1 + L_1}{P_1^\mu} \right)^{1-\gamma}}
 \end{aligned} \tag{A.2}$$

We can rewrite wealth and house prices in the following way:

$$W_1 = (\bar{Y} + H_0 \bar{P}_1 - M_1 + L_1)(1 + \eta_Y \tilde{y} + \eta_H \tilde{p}) \approx (\bar{Y} + H_0 \bar{P}_1 - M_1 + L_1) e^{\eta_Y \tilde{y} + \eta_H \tilde{p}},$$

$$P_1 = \bar{P}_1(1 + \tilde{p}) \approx \bar{P}_1 e^{\tilde{p}},$$

where  $\eta_y$  is the share of income out of total wealth,  $\eta_h$  is the share of housing, and the variables denoted with a tilde represent percentage deviations from expected values.

Since the constant part of indirect utility is the same for both workers and entrepreneurs, we can rewrite equation A.2 as:

$$\alpha^* = \frac{\mathbb{E} e^{[\eta_Y \tilde{y} + (\eta_H - \mu) \tilde{p}](1-\gamma)}}{\mathbb{E} e^{(\eta_H - \mu) \tilde{p}(1-\gamma)}}.$$



Assuming lognormality, the above equation reduces to:

$$\alpha^* = \frac{\exp\left\{\frac{(1-\gamma)^2}{2} [\eta_Y^2 \sigma_e^2 + 2\eta_Y(\eta_H - \mu)\sigma_{eP} + (\eta_H - \mu)^2 \sigma_P^2]\right\}}{\exp\left\{\frac{(1-\gamma)^2}{2} [(\eta_H - \mu)^2 \sigma_P^2]\right\}},$$

or

$$\alpha^* = \exp\left\{\frac{(1-\gamma)^2}{2} [\eta_Y^2 \sigma_e^2 + 2\eta_Y(\eta_H - \mu)\sigma_{eP}]\right\}, \quad (\text{A.3})$$

which leads directly to equation 3.

**The effect of housing:** Define  $H_0 P_1 = H^*$ . We are interested in the derivative with respect to  $H^*$  of equation 3:<sup>41</sup>

$$\frac{d \eta_Y}{d H^*} (\eta_Y \sigma_e^2 + 2\eta_H \sigma_{ep} - 2\mu \sigma_{ep}) + \eta_Y \left( \frac{d \eta_Y}{d H^*} \sigma_e^2 + 2 \frac{d \eta_H}{d H^*} \sigma_{ep} \right).$$

We have that:

$$\eta_Y = \frac{Y_1}{Y_1 + H^* - M_1 + L_1} = \frac{Y_1}{W_1}$$

$$\eta_H = \frac{H^*}{Y_1 + H^* - M_1 + L_1} = \frac{H^*}{W_1}$$

and therefore:

$$\frac{d \eta_Y}{d H^*} = -\frac{Y_1}{W_1^2}$$

$$\frac{d \eta_H}{d H^*} = \frac{1}{W_1} - \frac{H^*}{W_1^2} = \frac{W_1 - H^*}{W_1^2} = \frac{Y_1 - M_1 + L_1}{W_1^2} \approx -\frac{d \eta_Y}{d H^*},$$

where the last step in the equation above assume  $L_1 - M_1 \approx 0$ . The derivative becomes:

$$\frac{d \eta_Y}{d H^*} (2\eta_Y \sigma_e^2 + 2\eta_H \sigma_{ep} - 2\mu \sigma_{ep}) - \eta_Y 2 \frac{d \eta_Y}{d H^*} \sigma_{ep}$$

$$= 2 \frac{d \eta_Y}{d H^*} [\eta_Y \sigma_e^2 + (\eta_H - \eta_Y) \sigma_{ep} - \mu \sigma_{ep}].$$

The sign of  $\frac{d \eta_Y}{d H^*}$  is negative, but the sign of the expression inside the parenthesis is ambiguous.

To see this more conveniently, we can rearrange the equation as follows:

$$2 \frac{d \eta_Y}{d H^*} [\eta_Y (\sigma_e^2 - \sigma_{ep}) + (\eta_H - \mu) \sigma_{ep}].$$

<sup>41</sup>For notational simplicity, we ignore the term  $\frac{(1-\gamma)^2}{2}$ . This has no bearing on this discussion.

Focusing on the first expression in the square brackets, an increase in  $H^*$  promotes entrepreneurship because it reduces the share of wealth associated with labour income and so the effect of income risk. However, this effect is mitigated by the covariance  $\sigma_{ep}$ , which increases risk. These two opposing forces are standard portfolio effects. Turning to the next expression,  $(\eta_H - \mu)\sigma_{ep}$  highlights the potential for a beneficial hedging effect of housing. This depends on the difference between the actual housing share ( $\eta_H$ ) and the desired one ( $\mu$ ). When the agent owns more housing than what is desired ( $\eta_H > \mu$ ), she plans to sell some housing in period 1 (she is long on housing). Hence, an increase in the value of housing (for instance through an increase in prices  $P_1$ ) is beneficial for entrepreneurship. Since the derivative in the above equation is negative and  $\eta_H > \mu$ , the threshold  $\alpha^*$  is reduced. This benefit is proportional to the covariance between entrepreneurial income and house prices, which is a measure of entrepreneurial risk. A high covariance makes entrepreneurship less likely in the first place, and this is when the benefits of a house price increase are the greatest. Conversely, when the agent is short on housing ( $\eta_H < \mu$ ), an increase in the value of housing has a detrimental effect on entrepreneurship because the agent expects higher future expenses. In this case, because a high covariance between entrepreneurial income and house prices favours entrepreneurship in the first place, an increase in housing values is particularly detrimental in terms of moving the threshold  $\alpha^*$  upwards.

## A.2 The case with housing consumption commitment

When homeowners cannot move, the quantity of housing they consume is fixed and is denoted by  $\bar{H} = H_0 = H_1$ . Their indirect utility becomes:

$$\begin{aligned}
 V_{nm}(W_1) &= \frac{(C_1^{1-\mu} \bar{H}^\mu)^{1-\gamma}}{1-\gamma} \\
 &= \frac{1}{1-\gamma} [(W_1 - P_1 \bar{H})^{1-\mu} \bar{H}^\mu]^{1-\gamma} \\
 &= \underbrace{\frac{\bar{H}^{\mu(1-\gamma)}}{1-\gamma}}_{\phi_{nm}} (W_1 - P_1 \bar{H})^{(1-\mu)(1-\gamma)} \tag{A.4}
 \end{aligned}$$

$$= \phi_{nm} (Y_1 - M_1 + L_1)^{(1-\mu)(1-\gamma)}. \tag{A.5}$$

Notice that house prices do not appear in the last expression above. Therefore, house prices and the co-movement of house prices and entrepreneurial income have no effect on the entrepreneurial choice of agents who cannot move.

**The entrepreneurship choice:** Using the same approximation as in section A.1, equation A.5 can be rewritten as  $\phi_{nm}(\bar{Y} - M_1 + L_1)e^{\tilde{\eta}_Y \bar{y}}$ . Notice that share  $\tilde{\eta}_Y$  is higher than the share of income out of total wealth ( $\eta_Y$ ) because housing is not included in the computation of  $\tilde{\eta}_Y$  (i.e. it cancels out because it stays the same):

$$\tilde{\eta}_Y = \frac{Y_1}{W_1 - P_1 \bar{H}} = \frac{Y_1}{Y_1 - M_1 + L_1}.$$

In the case with housing consumption commitment, we thus have that:

$$\begin{aligned} \tilde{\alpha}^* &= \frac{\phi_{nm} \mathbb{E}(Y_1^e - M_1 + L_1)^{(1-\mu)(1-\gamma)}}{\phi_{nm} \mathbb{E}(Y_1^w - M_1 + L_1)^{(1-\mu)(1-\gamma)}} \\ &= \frac{(\bar{Y} - M_1 + L_1) \mathbb{E}e^{\eta_Y \bar{y}(1-\mu)(1-\gamma)}}{(\bar{Y} - M_1 + L_1) \mathbb{E}e^0} \\ &= \mathbb{E}e^{\tilde{\eta}_Y \bar{y}(1-\mu)(1-\gamma)} \\ &= \exp \left\{ \frac{(1-\mu)^2(1-\gamma)^2}{2} \tilde{\eta}_Y^2 \sigma_e^2 \right\}, \end{aligned} \tag{A.6}$$

where we take advantage of the assumption that non-entrepreneurial labour income is not risky.

As in the case with free mobility, because of risk aversion, the expected utility for entrepreneurs is lower than that for dependent workers. However, it is not possible to establish whether immobility raises or diminishes the likelihood of starting a business relative to the case without consumption commitments. Comparing the above formula with equation 3, we have that, on the one hand,  $\tilde{\eta}_Y > \eta_Y$ , but on the other hand,  $(1-\mu)^2(1-\gamma)^2 < (1-\gamma)^2$ . Moreover, equation 3 contains the additional term  $2(\eta_H - \mu)\sigma_{ep}$ , which represents the potential hedging benefits of housing. This is absent when individuals cannot sell and further complicates the comparison of equation 3 with equation A.6.

## B Additional robustness checks

In this section, we briefly discuss an additional set of robustness checks we perform on our main specification. The related findings are present in Appendix Table 1. In Column (1) we perform our analysis using only yearly data. This approach relies only on the housing tenure and the employment status declared at the time of the interview, and uses the variation in these variables between annual surveys. Our previous findings are confirmed: we still find a negative and sizable association between LTV and entrepreneurship.

Columns (2) and (3) assess the robustness of our results along geographical dimensions. First,

we investigate whether the results may be driven by the geographical mobility of workers upon becoming homeowners. For example, individuals who choose to purchase a bigger house – thus taking larger mortgages – might leave urban areas, directly affecting their chances of becoming entrepreneurs. Previous evidence shows that more entrepreneurs cluster into denser cities because of urbanization and localization economies (Glaeser, 2009; Glaeser and Kerr, 2010). To address this concern, in Column (2) we exclude from our analysis individuals who make either urban-to-rural or rural-to-urban residential moves (approximately 13% of the observations). Despite the reduction in sample size, our results are not affected. Similarly, excluding London from our sample (Column 3) or considering separately predominantly urban and predominantly rural areas (results not tabulated) does not affect our findings.

Finally, we check whether our results only stem from a handful of sectors or whether they are economy-wide. In Column (4), we exclude the following sectors from our analysis: agriculture; fishing and forestry; electricity, gas and water; public administration; private households with employees; and workers of international organizations/bodies. This approach follows Glaeser (2009) and Faggio and Silva (2014) who use self-employment data to study the spatial distribution of entrepreneurial activities in the US and UK, respectively. These restrictions do not change our conclusions. We also investigate whether our results differ for services and manufacturing. Although our conclusions remain valid for both sectors, the point estimates are smaller and not significant when we only consider manufacturing. This finding may be due to the fact that only approximately 25% of the observations come from individuals working in manufacturing. Moreover, the share of self-employed with dependent workers – i.e. our entrepreneurs – is significantly smaller for this sector, at only 2.3%.

# Tables and figures

TABLE 1: SUMMARY STATISTICS – BHPS INDIVIDUAL LEVEL MONTHLY DATASET

Variable	Mean	Std. Dev.
<i>Panel A: Entrepreneurs &amp; homeowners</i>		
Entrepreneur	0.046	0.210
Homeowner	0.810	0.392
Homeowner, with mortgage	0.713	0.452
Homeowners, outright (no mortgage)	0.097	0.296
Loan-to-value ratio on outstanding mortgage (owners with mortgage)	0.488	0.261
House value (all owners)	119,887	109,052
Cumulative house price gains (all owners)	39,597	86,557
<i>Panel B: Controls</i>		
Age	39.36	8.96
Male	0.787	0.409
Household total income (previous year)	31,839	22,033
Individual total income (previous year)	21,060	16,144
Children under 16 (yes=1, no=0)	0.457	0.498
Coupled (yes=1, no=0)	0.745	0.436
Education: Higher Degree	0.038	0.192
Education: First Degree	0.152	0.359
Education: Higher Non Degree/Teaching Qual.	0.080	0.272
Education: A Level (or equiv.)	0.229	0.420
Education: O Level (or equiv.)	0.266	0.442
Education: CSE (or equiv.)	0.070	0.255
Education: None of these	0.165	0.371

Note: The sample only includes heads of household aged between 20 and 55 living in England (excludes Scotland and Wales). Summary statistics of control variables refer to the sample where all controls are non-missing. Number of observations: 366,168. Number of individuals: 5193. Panel is unbalanced. 'Entrepreneur' includes self-employed with dependent employees. Loan-to-value ratio of outstanding mortgage is time-varying and calculated as the value of outstanding mortgage liabilities divided individual self-reported assessment of property value (measured in GB pounds). LTV capped at 1.25; values above 1.25 recoded as 1.25. House value is time-varying, self-reported and measured in GB pounds. Cumulative house price gains measure the cumulative house price change expressed in GB pounds experienced by homeowners from time of purchase up to the period under consideration. In the regression analysis age is controlled semi-parametrically by including the following dummies: age between 20 and 24; age between 25 and 29; age between 30 and 34; age between 35 and 39; age between 40 and 44; age between 45 and 49; age between 50 and 54; age 50 or above.

TABLE 2: SUMMARY STATISTICS – INCOME VARIATION FOR WORKERS AND ENTREPRENEURS

Individual total income (previous year):	Mean	Median	Standard Deviation	Within-individual Standard Deviation
Dependent workers (employees)	21,195	18,332	14,528	7,050
Entrepreneurs: dependent	27,407	18,500	33,608	14,354

Note: Within-individual standard deviation shows average within-individual over-time standard deviation of individual income for different employment categories. See Table 1 for further information on sample construction and variable definitions.

TABLE 3: TRANSITIONS INTO AND OUT OF HOMEOWNERSHIP AND ENTREPRENEURSHIP

	% (numbers) of individuals making at least...	
	One transition	Two transitions
<i>Panel A: Homeownership</i>		
Overall	18.3 (949)	5.8 (303)
Transition in	13.3 (691)	0.9 (46)
Transition out	10.8 (561)	1.0 (53)
<i>Panel B: Homeownership with mortgage</i>		
Overall	25.5 (1326)	7.7 (402)
Transition in	16.2 (840)	1.4 (72)
Transition out	17.1 (888)	1.7 (86)
<i>Panel C: Homeownership without mortgage</i>		
Overall	12.6 (654)	3.6 (188)
Transition in	9.7 (504)	1.0 (50)
Transition out	6.5 (338)	0.6 (30)
<i>Panel D: Entrepreneur, dependent</i>		
Overall	5.9 (305)	3.3 (173)
Transition in	4.8 (249)	1.1 (59)
Transition out	4.4 (229)	1.0 (53)

Note: The sample only includes heads of household aged between 20 and 55 living in England (excludes Scotland and Wales). Total number of individuals: 5193. Panel is unbalanced.

TABLE 4: SUMMARY STATISTICS OF INDIVIDUAL CHARACTERISTICS –  
TIME OF TRANSITIONS INTO AND OUT OF HOMEOWNERSHIP AND ENTREPRENEURSHIP

	Time of transition into...	Time of transition out of...
<i>Panel A: Homeownership with mortgage</i>		
Age	30.35 (7.87)	33.88 (9.22)
Children	0.325 (0.469)	0.378 (0.485)
Coupled	0.623 (0.485)	0.626 (0.484)
Individual total income	13,647 (9,161)	14,969 (10,418)
<i>Panel B: Homeownership without mortgage</i>		
Age	37.40 (8.49)	32.31 (8.82)
Children	0.429 (0.495)	0.302 (0.460)
Coupled	0.677 (0.468)	0.559 (0.497)
Individual total income	16,105 (11,781)	14,596 (10,715)
<i>Panel C: Entrepreneur</i>		
Age	35.42 (8.42)	35.89 (8.13)
Children	0.494 (0.501)	0.498 (0.501)
Coupled	0.803 (0.398)	0.830 (0.377)
Individual total income	17,539 (15,246)	17,225 (14,896)

Note: Sample includes heads of household aged between 20 and 55 living in England (excludes Scotland and Wales). Number of individuals: 5193. Panel is unbalanced. Figures are means and standard deviations (in parenthesis) of listed characteristics.

TABLE 5: THE CORRELATION BETWEEN HOMEOWNERSHIP AND ENTREPRENEURSHIP - OLS AND FIXED-EFFECT REGRESSIONS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable is:	OLS	OLS	FE All Trans.	FE All Trans.	FE All Trans.	FE Trans. In	FE Tran. Out	FE All Trans.
Entrepreneur								
Homeowner	0.036 (0.006)***	0.014 (0.006)**	-0.011 (0.005)**	-0.012 (0.006)**	-0.013 (0.005)**	-0.022 (0.009)**	-0.009 (0.010)	-0.002 (0.009)
Homeowner, with mortgage								-0.012 (0.007)*
Year & month dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
LA dummies	No	Yes	No	Yes	No	No	No	No
Controls	No	Yes	No	Yes	Yes	Yes	Yes	Yes

Note: See Table 1 for information on sample characteristics and variable definitions. Year dummies refer to the year when the BHPS interview was carried out. Month dummies refer to months during which the interview took place. LA dummies refer to the Local Authority of residence (343 LAs matched to English-resident BHPS individuals). Household and individual income included in logs. Column (6) only includes people who are or become homeowners. Column (7) only includes people who are or become renters. Standard errors clustered at the LA level. \*\*: 5% significant; \*\*\*: 1% significant. Controls as listed in Table 1.



TABLE 6: HOMEOWNERSHIP AND ENTREPRENEURSHIP – THE ROLE OF MORTGAGE DEBT

	(1)	(2)	(3)	(4)	(5)
	OLS	Ind. FE	Spell FE	Spell FE	Ind. FE + IV
	Full	Full	Full	Owners	Full
	Sample	Sample	Sample	Only	Sample
Homeowner	-0.000 (0.009)	0.001 (0.009)	0.019 (0.013)		
Loan-to-value (LTV) of mortgage	-0.005 (0.010)	-0.017 (0.008)**	-0.025 (0.009)***	-0.022 (0.010)**	-0.021 (0.012)*
House value ( $\times$ £100,000)	0.018 (0.004)***	-0.000 (0.002)	-0.001 (0.002)	-0.001 (0.002)	0.003 (0.006)
<i>Kleibergen-Paap</i> <i>First Stage</i>	--	--	--	--	59.73

Note: Regressions run on the monthly dataset. All regressions include year dummies; monthly dummies; SIC92 1-digit sector dummies; and individual controls. See notes to Table 1 and 5 for more details. Standard errors clustered at the LA level. \*: 10% significant; \*\*: 5% significant; \*\*\*: 1% significant. Instrumental variable (IV) regression in Column (5) instruments individual's LTV with local LTV obtained using data from the Survey of Mortgage Lenders at the LA level; and self-reported house values with national house price variation interacted with local proxies for the elasticity of housing supply (LA-level percentage of developed land and LA-level refusal rates). The instruments are time-varying and set to zero for years in which individuals are renters. This specification further controls for time-varying average wages and employment counts at the LA level.

TABLE 7: ENTREPRENEURS WITH DEPENDENT WORKERS – MORTGAGE DEBT AND RISK

	(1)	(2)	(3)	(4)
	FE	FE	FE	FE
	<i>Coeff. of Variation of Profits</i>		<i>Correlation of Profits and Local HP</i>	
	Above Median	Below Median	Above Median	Below Median
LTV of mortgage	-0.016 (0.009)*	-0.010 (0.006)	-0.020 (0.007)**	-0.002 (0.007)
<i>Additional controls</i>	<i>House Val. &amp; Own</i>	<i>House Val. &amp; Own</i>	<i>House Val. &amp; Own</i>	<i>House Val. &amp; Own</i>

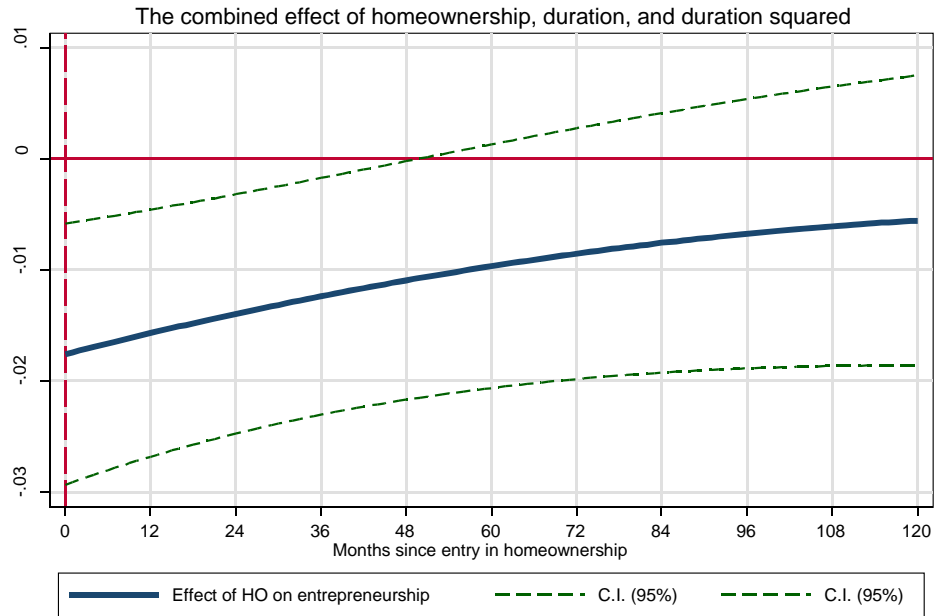
Note: Regressions run on the monthly dataset. All regressions include year dummies; monthly dummies; SIC92 1-digit sector dummies; and individual controls. See notes to Tables 1 and 5 for more details. Standard errors clustered at the LA level. \*: 10% significant; \*\*: 5% significant; \*\*\*: 1% significant. Columns (1) and (2) split the dependent variable using the median of the coefficient of variation of profits in the sector of employment. Data obtained from Eurostat for the years 1997 to 2007 and merged using NACE sectors at the 2-digit level. Columns (3) and (4) split the dependent variable using the median of the correlation between sectoral profits and house prices at the LA level. House price series at the LA level obtained from the Land Registry for the years 1997 to 2007. Median values of coefficient of variation of profits and correlation between profits and local house price: 0.131; and 0.845, respectively.

TABLE 8: HOMEOWNERSHIP AND ENTREPRENEURSHIP – HOUSE PRICES GAINS

	(1)	(2)	(3)	(4)
	OLS Full Sample	Ind. FE Full Sample	Spell FE Owners Only	Ind. FE + IV Full Sample
Homeowner	0.016 (0.009)*	0.003 (0.008)		
Loan-to-value (LTV) of mortgage	-0.009 (0.012)	-0.018 (0.009)**	-0.021 (0.010)**	-0.017 (0.010)**
Cumulative house price gains ( $\times$ £100,000)	0.0098 (0.0045)**	-0.0023 (0.0045)	-0.0015 (0.0057)	-0.000 (0.008)
<i>Kleibergen-Paap First Stage</i>	--	--	--	<i>87.87</i>

Note: Regressions run on the monthly dataset. All regressions include year dummies; monthly dummies; SIC92 1-digit sector dummies; and individual controls. See notes to Table 1 and 5 for more details. Standard errors clustered at the LA level. \*: 10% significant; \*\*: 5% significant; \*\*\*: 1% significant. Cumulative house price (HP) gains measured as the cumulative house price change expressed in GB pounds experienced by homeowners from time of purchase up to the period under consideration. These are based on individuals' self-reported housing values. Column (4) instruments cumulative house price gains using national house price cumulative gains interacted with local proxies for the elasticity of housing supply (LA-level percentage of developed land and LA-level refusal rates); and LTV using local LTV obtained using data from the Survey of Mortgage Lenders at the LA level. The instruments are time-varying and set to zero for years in which individuals are renters. This specification further controls for time-varying average wages and employment counts at the LA level.

FIGURE 1: THE LINK BETWEEN HOMEOWNERSHIP AND ENTREPRENEURSHIP OVER TIME



Note: Results used to obtain the graph come from the specification including homeownership and both a linear and a quadratic term in the months elapsed since becoming homeowner (and controls as in Column 5, Table 5). Estimated effects as follows. Homeownership:  $-0.018$  ( $0.006$ )\*\*\*; Months since homeowner, linear term ( $\times 100$ ):  $0.016$  ( $0.008$ )\*\*; Months since homeowner, quadratic term ( $\times 1000$ ):  $-0.0005$  ( $0.0003$ )\*. Dashed lines are confidence intervals at the 95% level obtained from standard errors clustered at the LA level.

# Appendix: Additional results

APPENDIX TABLE 1 : HOMEOWNERSHIP AND ENTREPRENEURSHIP – FURTHER ROBUSTNESS CHECKS

	(1)	(2)	(3)	(4)
	Yearly Data	Immobile Workers	Excluding London	Excl. Selected Sectors
Homeowner	-0.014 (0.008)*	-0.018 (0.009)**	-0.015 (0.009)*	-0.021 (0.009)**
<i>Additional controls</i>	<i>House Val. &amp; Own</i>	<i>House Val. &amp; Own</i>	<i>House Val. &amp; Own</i>	<i>House Val. &amp; Own</i>

Note: All regressions include year dummies; monthly dummies (except for Column 1); SIC92 1-digit sector dummies; and individual controls. See notes to Tables 1 and 5 for more details. Standard errors clustered at the LA level. \*: 10% significant; \*\*: 5% significant; \*\*\*: 1% significant. Column (1) uses BHPS annual datasets. All other regressions run on the monthly dataset. Column (2) only considers individuals always living either in urban areas or in rural areas (no urban-to-rural and rural-to-urban movers). Urban and rural areas determined on the basis of population density (see Faggio and Silva, 2014) for more details; sample includes approximately 87% of the observations. Column (3) excludes London; sample includes around 88% of the observations. Regressions in Column (4) exclude the following sectors: Agriculture; Fishing and Forestry; Mining; Electricity, Gas and Water; Public Administration; Household with Employees; and International Organizations. Sample includes approximately 88% of the observations.

## Online appendix:

# Construction of monthly job histories from the British Household Panel Survey

In this section, we provide a description of the way we construct monthly job spells and solve inconsistencies in the BHPS. We follow the principle that information recorded closest to the date of the beginning of the spell is the most accurate. A similar approach is used in Upward (1999) and Battu and Phimister (2008).

To begin with, consider that the BHPS contains a longitudinal file identifying every person that ever appeared in the survey, indicating in which waves he or she was interviewed. From this file we construct the list of individuals that belong to the initial sample, i.e. those with a full interview in Wave 1, as well as those who fill in a full interview for the first time in one of the subsequent waves.

Next, in every wave of the BHPS, interviewed individuals appear in a ‘respondent file’, which contains information on the current labour force and occupational status — and if they have changed their labour market status between two waves — in a ‘job history file’ that collects detailed information for every occupational spell, such as job characteristics, starting date, ending date and sector of occupation. In order to construct labour market spells, we use the following iterative strategy for every wave, starting from Wave 1 (1991) or the first wave in which an individual first appears, and working towards the most recent wave (Wave 18 in 2008):

1. We carry out consistency checks in the ‘job history file’ and, separately, in the ‘respondent file’ (more details on this below);
2. We append the ‘respondent file’ on top of the ‘job history file’ in order to check the consistency between the two — in particular regarding the starting date of the current job and the history of jobs reported in the history file. We name the resulting file ‘wave w’ file, where w indicates the wave under consideration;
3. We append the file ‘wave w’ on top of the combined file from the previous wave, that is, ‘wave w-1’, and check the consistency of the information provided in the two files.
4. After having appended all waves, we compute the duration in months of every spell and we expand the dataset so that every observation corresponds now to one specific month. We call the resulting file the ‘labour spell file’.

In the original data, every labour market spell comes with a starting/ending date, and inconsistencies arise because of overlaps between these dates. In order to address inconsistencies, we look for problematic cases both: (a) in the within-file, i.e. within the ‘job history file’ and separately within the ‘respondent file’; and (b) within-wave, i.e. within the combined file obtained by appending the ‘respondent’ and the ‘job history’ files. The general idea is to resolve overlaps by preferring answers recorded closest to the date of the beginning of the spell. Note that our ‘within-file’ and ‘within-wave’ approach also solves situations that could arise because of between-wave overlaps. In detail, we proceed as follows:

- *Within-file checks:* (a) Spells that display a starting date earlier than the interview of the previous year are recoded as starting on the day of the interview of the previous year. This is because, up to the date of the previous interview, we trust information from the previous wave more than retrospective information; (b) Spells starting after the current date of interview are considered as starting on the date of interview. Discrepancies of this type probably emerge as a coding error in the original data; (c) For the ‘job history file’ only, we check that the sequence of spell starting dates is increasing. If this is not the case, we drop the spell(s) that cause the inconsistency.
- *Within-wave checks:* (a) If a spell from the ‘job history file’ has a missing starting date, the starting date is imputed as the mean of the starting dates of the two adjacent job history spells. Stated differently, we centre this job spell in the middle of the two adjacent ones; (b) If a spell from the ‘respondent file’ has a missing starting date, two possibilities arise. If there is no ‘job history file’ spell for the same individual, the starting date of this spell is imputed as the date of the previous interview. If instead there is a pre-dating spell in the ‘job history file’, the starting date of the current job is imputed as the date of the current interview; (c) We check that the sequence of starting dates in the combined ‘respondent’/‘job history’ file —i.e. the ‘wave’ file —is increasing. If not, we drop the spell that causes the inconsistency; (d) We check that point (c) holds true when we iteratively append ‘wave files’ from subsequent waves of the BHPS.