Mortgage Debt and Entrepreneurship*

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Abstract

We study the link between mortgage debt and entrepreneurship using a model of occupational choice and housing tenure in a setting where loans are recourse—like in the UK and several US states. Our model shows that as long as the mortgage interest rate exceeds the risk-free rate: (i) mortgage debt diminishes the likelihood of entrepreneurship by amplifying risk aversion; and (ii) the negative relation between mortgage debt and entrepreneurship increases with income volatility. Our model also shows that the link between housing equity and entrepreneurship is ambiguously signed because of competing portfolio and wealth effects. We use the British Household Panel Survey to test and confirm the model predictions, and deal with unobservable heterogeneity employing three research designs — individual fixed effects, housing-spell fixed effects, and instrumental variables. A one standard deviation increase in leverage reduces the probability of entrepreneurship by 10-20 percent.

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 economy. We argue that raising mortgage debt — all else equal — hinders entrepreneurial activity, which in turn is considered to be an important driver of innovation and economic growth (Schumpeter, 1934; Acs and Audretsch, 2003; Casson et al., 2008).

Extensive research has highlighted the impact of housing and mortgage debt on a household's exposure to risky assets (Flavin and Yamashita, 2002; Cocco, 2005; Chetty et al., 2017).[1] 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 and exploiting the longitudinal nature of the data to control for individual time-fixed unobservables, such as entrepreneurial preferences or business ability.

In our model agents choose their occupation as dependent workers or entrepreneurs, conditional on their housing tenure and the extent of their mortgage debt.[2] We make two important assumptions. First, we assume that agents do not default on their mortgage. This assumption is consistent with a setting where mortgages are recourse and default rates low (Aron and Muellbauer, 2016). Recourse mortgages are not only a feature of our study area — the UK — but also of the majority of US states and of much of the developed world (most of Continental Europe, Australia, Canada, Japan and Korea). Second, we assume that entrepreneurship provides individual-specific advantages. In our main model specification, these come in the form of non-pecuniary benefits (Hurst and Pugsley, 2011) with magnitudes that vary across individuals according to their 'entrepreneurial taste'. We also extend our framework to consider the case where these advantages

[1] In a similar vein, Heaton and Lucas (2000) show that 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. This conclusion is consistent with the insights of Henderson and Ioannides (1983) and Brueckner (1997) who show that homeowners cannot adequately diversify their portfolio when the investment constraint induced by owner-occupied housing is binding.

[2] 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. In contrast to Davidoff, we analyse occupational choice conditional on housing tenure. Our work also relates to the literature on the economic impact of homeownership — for example on unemployment (Oswald, 1996; Blanchflower and Oswald, 2013) or on business start-ups (Fairlie, 2010; Wang, 2012). However, our focus is on the role of financial leverage rather than homeownership *per se*.

take the form of an income premium dependent on business acumen (Lucas, 1978; Manso, 2016). 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).

The comparative statics of our model focus on the effect of an exogenous variation in property values on the entrepreneurship decision. First and foremost, we study the effect of an increase in property values, holding home equity wealth fixed, at the time of purchase — meaning, at the time of the first purchase as well as at any time individuals move to a new property by selling their current accommodation and buying a new one. This static implies an increase in mortgage debt and, as long as the mortgage interest rate paid by individuals exceeds the risk-free rate, an increase in housing (mortgage) cost and thus a reduction in lifetime wealth. This in turn amplifies the degree of the borrower's risk aversion, resulting in a lower likelihood of a transition into entrepreneurship.[3] This comparative static yields two main testable propositions. First, as long as the mortgage rate paid by individuals exceeds the risk-free rate, higher levels of mortgage debt diminish the likelihood that leveraged homeowners start a business (Proposition 1). Second, the negative relation between increased mortgage debt and entrepreneurship is more pronounced when considering leveraged homeowners who choose to work in sectors where profits are more volatile or more highly correlated with house prices (Proposition 2).

The main mechanism underpinning Proposition 1 is a wealth effect. This effect has been previously documented in the entrepreneurship literature (Hurst and Lusardi, 2004; Kerr et al., 2014). However, the wealth effect underpinning our model has a very specific nature: *it alters an individual's risk aversion.* The second prediction of our model (Proposition 2) directly tests the validity of this intuition. This novel prediction distinguishes our framework from previous work that has emphasised the luxury/consumption value of entrepreneurship and its link to an individual's wealth. We focus on housing (rather than other components of an individuals wealth) because there is a significant body of research that studies the effect of housing on entrepreneurship — in particular the positive effect of house price growth on business formation (Hurst and Lusardi, 2004; Adelino et al., 2015; Corradin and Popov, 2015; Schmalz et al., 2016). Our conceptualization, however, is new to this literature: we highlight that mortgage debt — for the vast majority of people the main source of funding home purchases — may discourage entrepreneurial activities because of

[3]The mechanisms underpinning this result imply that our prediction applies to other occupations that entail significant risks — for example, jobs in highly cyclical non-tradable sectors. However, as shown by Kihlstrom and Laffont (1979), entrepreneurs can be conceptualised as the 'residual claimants' of their ventures' profits and thus the ultimate bearers of economic risk; thus, within any economic activity, they are always more at risk than their employees.

the risks this entails. Furthermore, housing is the biggest component of a households balance sheet — both on the asset and the liability side — and likely to have a large (and possibly dominant) impact on household decisions.

We also analyse the effect of an increase in property values while holding mortgage debt fixed. This comparative static implies an increase in home equity wealth, which in turn has two opposing effects. On the one hand, it increases lifetime wealth, in turn reducing risk aversion and encouraging entrepreneurship. On the other hand, it increases the share of housing wealth in the portfolio and thereby an agent's exposure to the covariance between entrepreneurial profits and house values. This reduces the propensity to become an entrepreneur. The net effect of home equity wealth on entrepreneurship is therefore ambiguously signed. This ambiguous prediction differentiates our framework from alternative models with credit constraints and bank lending against housing in which increases in house prices (holding mortgage debt constant) raise the value of individuals' collateral and stimulate entrepreneurial activities.

An important feature of our model is that we allow individuals to differ in unobserved ways in their innate taste for entrepreneurship or business ability. This means that in our setting some homeowners with mortgages still decide to start a business because of their strong preferences to be entrepreneurs, or their expected ability to generate a higher income. In our empirical analysis, we deal with these unobservables by controlling for individual fixed effects.

In order to do so, we construct a detailed monthly-spell dataset that tracks individuals' job histories and tenure choices, coupled with information on time-varying background characteristics. The data identifies the precise timing of individuals' transitions into homeownership and entrepreneurial jobs, and 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 mortgage debt, housing wealth 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 empirical analysis by presenting OLS estimates that indicate a positive association between house values and entrepreneurship, and no relation with the level of mortgage debt, as

proxied in our empirical analysis by an individual's loan-to-value ratio (LTV) on the outstanding mortgage. However, this relation is biased by individual unobservables, either time invariant ones — such as entrepreneurial preferences or ability — or time varying ones — such as liquid wealth.

In order to deal with these unobservables, we employ three complementary research designs. The first one controls for individual time-fixed unobservables by using individual fixed effects (alongside a rich set of time varying observables). Using this approach, we find a negative and significant relation between LTV and entrepreneurship — consistent with Proposition 1 of our theoretical framework. The effect that we identify is sizable: a one standard deviation increase in the LTV — corresponding to approximately £32,000 — is associated with approximately a 10% reduction in the probability of becoming an entrepreneur. We also find that, conditional on individual fixed effects, there is neither a significantly positive nor a significantly negative association between house values and entrepreneurship. This lack of a precisely estimated effect is consistent with the ambiguously signed prediction stemming from the second comparative static of our model.

Our other two research designs refine the fixed effects approach but do not change its results. The second design replaces individual fixed effects with individual-specific housing-spell effects. This specification focuses on the variation in LTV within a specific housing spell only, and accounts for changes in individuals' unobservables when they first become homeowners and at any time they move home or change tenure status. Stated differently, this approach partials out variation in individual unobservables that coincides with housing-related transitions. These specifications yield an even stronger negative link between LTV and entrepreneurship. They also confirm the lack of association between house values and entrepreneurship.

Our third research design is an instrumental variable (IV) strategy that predicts an individual's variation in the two main explanatory variables — housing values and the LTV — using exogenous changes in house prices. More specifically, we instrument an individual's variation in house values using variation in *current* house prices at the national level interacted with local proxies for the elasticity of housing supply. We instead instrument the LTV using variation in national house prices *in the year of purchase*, once again interacted with local supply elasticity proxies. This is similar to the approach of Chetty et al. (2017). The underlying rationale is that higher house prices *at the time of purchase*—while holding constant current housing wealth—predict a higher LTV. Conversely, higher *current* house prices—holding the LTV constant— increase home equity wealth. The second stage estimates lend support to the predictions of our theoretical framework

— and confirm the findings that we obtained using the two fixed-effect strategies.

We also directly assess whether leveraged homeowners shy away from riskier entrepreneurial ventures, thus testing our Proposition 2. 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 or a low correlation between house prices and profits.

At first glance our main finding could also be consistent with theories based on credit constraints: leveraged home buyers may be prevented from taking on additional credit to start a business; however, as house values increase and LTV ratios are pushed down, housing becomes collateral that may be used to borrow and become an entrepreneur — as suggested, for instance, by two early studies using UK aggregate data (Black et al., 1996; De Meza and Webb, 1999). While such an interpretation would not alter our main message — i.e. that high indebtedness reduces the likelihood of starting a business — we do not find empirical evidence to support it once we control for individual unobservables. Indeed, although we find that house prices are positively correlated to entrepreneurship if we only control for local-area time-varying shocks (as in previous research; see for example Adelino et al., 2015; Corradin and Popov, 2015), this association vanishes when we focus on within-individual variation over time by using fixed-effect specifications. This is irrespective of whether we focus on individuals' self-reported *current* house values or *cumulated* capital gains accrued since the time of the first purchase; irrespective of whether we control for house prices linearly or non-linearly; and irrespective of whether we instrument house value appreciation using the approach discussed above. These findings are similar to Hurst and Lusardi (2004) and Disney and Gathergood (2009) and consistent with Schmalz et al. (2016) who find evidence of a positive association between house price appreciation and business start-ups *only* for homeowners without mortgages.

By highlighting a new channel through which increased mortgage debt hinders productive investments, our paper contributes to the debate on the adverse consequences of household debt on the economy. Our findings are of general relevance because most countries subsidise mortgage financing. For instance, the UK has recently introduced a 'Help to Buy' policy to promote (leveraged) homeownership. For the US, recent research suggests that the mortgage interest deduction (MID) increases the loan size of individual borrowers substantially (Munroe, 2014), while not notably raising homeownership attainment on aggregate (Hilber and Turner, 2014). Our framework

indicates that, by increasing leverage, mortgage subsidies may increase risk aversion and crowd out alternative productive (but risky) investments — such as entrepreneurship.

2 Theoretical framework

We model the effect of owner-occupied housing on risk taking in financial portfolios, distinguishing between home equity wealth and mortgage debt. We use exogenous movements in house prices as the key economic force driving the comparative statics stemming from our model. This is similar to the approach of Chetty et al. (2017). However, we do not explore the effect of mortgage debt and equity on a continuous variable such as stock-holding. Instead, 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 the institutional setting in the UK, where loans are full recourse: borrowers can be pursued for up to six years for any negative equity remaining after the lender has sold off a home in repossession. This implies that defaulting is much more costly than in other settings — such as in some US states (e.g., California, Nevada or Arizona) — where mortgages are non-recourse, and as a consequence default and repossession rates are lower. Aron and Muellbauer (2016) document that during the last crisis the repossession rate in the UK reached 0.5% at its 2009 peak, compared to 4.6% in the US at its 2010 peak.[4]

2.1 Assumptions

Utility function: We envisage a two-period setting in which agents choose their occupation in period 0 to maximise their expected period 1 utility:

$$\mathbb{E}_0 \frac{\left(C_1^{1-\mu} H_1^{\mu}\right)^{1-\gamma_i}}{1-\gamma_i} \quad \text{if } i \text{ is employed,}$$

$$\mathbb{E}_0 \frac{1}{\alpha_i} \frac{\left(C_1^{1-\mu} H_1^{\mu}\right)^{1-\gamma_i}}{1-\gamma_i} \quad \text{if } i \text{ is an entrepreneur.}$$

under a budget constraint. Individuals derive utility from the consumption of a standard composite good (C) and housing (H). The utility function is characterised by constant relative risk

[4]Rather than assuming that agents always repay their debt, we could have allowed costly defaults. If default costs are positively related to the amount of leverage, the mechanism of our model would carry through because increases in mortgage debt would mechanically entail higher costs of default. If default costs are fixed, whether our results carry through depends on the exact magnitude of the default cost. However, even in instances where there are no financial consequences associated with default, research has shown that psychological costs can be significant (see among others Guiso et al., 2013).

aversion (CRRA), complementarity between housing and consumption of the composite good, and, consistent with empirical evidence (Davis and Ortalo-Magné, 2011), a constant expenditure share in housing μ. Given the importance of risk attitudes for entrepreneurial choices (Kihlstrom and Laffont, 1979), we allow the coefficient of risk aversion γ to be individual specific, as indicated by the subscript i. We assume that agents are characterized by a time-invariant parameter α_i (bounded between 0 and infinity) denoting their preference for entrepreneurial jobs. 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. One could assume an alternative setting akin to a model à la Lucas (1978) where individuals' entrepreneurial choices are driven by 'business acumen' and the returns earned through experimenting with new ideas (Manso, 2016). In Appendix A.1, we provide the derivation of our results for the case in which α is an income shifter. Our results do not depend on the framework we choose as long as these time-invariant features — i.e. the γ_i's and the α_i's — are controlled for by the inclusion of individual fixed effects in our empirical analysis.[5]

Note finally that we could allow agents to differ along their housing preferences (by indexing μ by i). As will become clearer in the remaining part of this section, we do not endogenise the choice of H_0 and the specific value of μ has no bearing for our comparative statics. Hence, for simplicity, we ignore heterogeneity along this dimension.

Budget constraint: In our setting, agents consume the numeraire good and housing out of their total available wealth in period 1:

$$W_{1i} = Y_1 + \tilde{P}_1 H_{0i} - M_{0i}(1 + R_{Mi}) + L_{0i}(1 + R_F), \tag{1}$$

where

$$Y_1 = \begin{cases} \overline{Y} & \text{if } i \text{ is employed,} \\ \tilde{Y}_e & \text{if } i \text{ is an entrepreneur.} \end{cases}$$

[5]Both frameworks assume that α is known to the agents. However, it is conceivable that in some cases entrepreneurs do not know this parameter. This uncertainty is likely to further deter risk-averse individuals with mortgages from becoming entrepreneurs. This effect would be more pronounced if uncertainty about α was positively correlated with house prices. Similarly, we do not consider the possibility that individuals learn about their entrepreneurial ability by 'experimenting' with entrepreneurship spells. Once again, omitting this aspect does not alter the predictions of the model because the *ex-ante* uncertainty about an individual's earnings as entrepreneur is likely to increase if learning is considered. In turn, this adds an additional layer of uncertainty, strengthening the negative link between mortgage debt and entrepreneurship.

The tilde indicates stochastic variables: entrepreneurial labor income ($\tilde{Y}_e$) and house prices ($\tilde{P}_1 = P_0(1+\tilde{R}_P)$, where $\tilde{R}_P$ denotes the growth rate of house prices).

In our setup, the only choice that agents face is between employment, which yields constant income $\overline{Y}$, and entrepreneurship, which yields variable income $\tilde{Y}_e$. We assume that $\tilde{Y}_e$ is a mean-preserving spread of an employee's income ($\mathbb{E}Y_e = \overline{Y}$), with σ_e^2 indicating the entrepreneurial income variance. This assumption is consistent with the evidence in Hamilton (2000) who shows that the median entrepreneur earns on average the same or less than comparable dependent workers, though her income volatility is significantly larger. In our empirical analysis, we replicate this fact (see Section 3.2).[6]

When they choose their occupation, agents are endowed with three pre-determined variables: their initial housing endowment H_{0i}; the mortgage debt outstanding at period 0, M_{0i}, which is charged at interest rate R_{Mi}; and the liquid wealth outstanding in period 0, L_{0i}, which earns a risk-free interest of R_F. Agents use this risk-free rate to discount the future (i.e., to calculate the period 0 value of period 1 utility).[7] We take these endowments as given and estimate their effects on an individual's occupational choice. Stated differently, we do not endogenise the housing choice and the amount of mortgage debt (though we deal with these endogeneities in our empirical analysis by controlling for spell fixed effects and using an IV approach). Similarly, we allow initial liquid wealth L_{0i} to vary across individuals as previous research has documented a strong link between an individual's wealth and entrepreneurship (see evidence in Hurst and Lusardi, 2004). However, as we are not interested in the role of non-housing wealth, we take it as a pre-determined variable and control for it in the empirical analysis.

The mortgage interest rate R_{Mi} also differs across individuals because it is determined by both the prevailing market rates and the borrower's characteristics, in particular the LTV-ratio of the mortgage (see evidence in Besley et al., 2013; Best et al., 2015).

Our simplified two-period setting has a recursive interpretation and allows us to isolate the moment in which agents choose their occupation given (1) their idiosyncratic preferences (α_i and γ_i), (2) their endowments (H_{0i}, M_{0i}, and L_{0i}), and (3) how the value of these endowments evolves over time (i.e. through $\tilde{P}_1, R_{Mi}$, and R_F). Period 0 refers to any instance when this choice takes place, for example at the time when individuals first purchase their home or move between properties, or when the loan is refinanced. In the next section we describe how our empirical research

[6] Dependent work carries risks too, and, a more complete model would include a variance for the income of dependent workers, σ_w^2. In practice, as long as $\sigma_e^2 > \sigma_w^2$, this has no material impact on the predictions of our model.

[7] For simplicity we think of R_F as being the same for all individuals and predominantly determined by financial markets.

designs link to this model and allow us to isolate the relevant variation.

2.2 The entrepreneurship decision

An agent chooses to become an entrepreneur if parameter α_i is above some individual threshold α_i^*. This threshold is defined by:

$$\alpha_i^* \equiv \frac{\mathbb{E}V(W_{1i}^e)}{\mathbb{E}V(W_{1i}^w)}, \tag{2}$$

where $V(W_{1i}^e)$ is an agent's indirect utility as entrepreneur and $V(W_{1i}^w)$ is an agent's indirect utility as employed worker. 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 log-normally distributed. Using a standard approximation, we derive a closed-form solution for the entrepreneurship threshold:

$$\log \alpha_i^* = \frac{(1-\gamma_i)^2}{2}\eta_{Yi}\ (\ \eta_{Yi}\sigma_e^2 + 2\eta_{Hi}\sigma_{ep} - 2\mu\sigma_{ep}), \tag{3}$$

where η_{Yi} and η_{Hi} are the fractions of total wealth associated with labour income and housing, respectively, σ_{ep} is the covariance between house prices and entrepreneurial income, and μ is the utility parameter related to the fraction of income spent on housing. Intuitively, a higher risk aversion γ_i leads to a higher threshold α_i^* because, when entrepreneurial income is more volatile, only agents with a strong preference for entrepreneurship start a business. The threshold α_i^* also increases when labour income is a large fraction of wealth (η_{Yi} is high), which leads to a greater cost of entrepreneurial income volatility under CRRA preferences.

The covariance between house prices and entrepreneurial income instead has an ambiguous effect on the decision to start a business.[8] On the one hand, σ_{eP} increases the overall risk of 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).When $\mu = 0$, households do not want to consume any housing and the model reduces to a standard portfolio choice. As stated previously, the specific value of μ is not important for our comparative statics, to which we turn next.

[8]Strictly speaking, as both the income of dependent workers and entrepreneurs are expected to co-vary with house prices, σ_{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.

2.3 Comparative statics

Our analysis follows the work by Chetty et al. (2017) and focuses on the effect of exogenous variation in property values (P_0) on the entrepreneurship decision. More precisely, we concentrate on two comparative statics: a change in property values keeping home equity wealth constant and a change in property values keeping mortgage debt constant. The first comparative static corresponds to a variation in the amount of mortgage used by individuals to fund their housing consumption; the second comparative static instead corresponds to a variation in the amount of equity tied in housing.

It is important to study the effect of variation in mortgage debt and variation in home equity separately since, as explained below, the model predicts an unambiguous negative effect of variation in mortgage debt in contrast to an ambiguous effect of variation in housing equity.

As shown in equation (1), an increase in property values while holding home equity wealth fixed requires an increase in mortgage debt (M_{0i}) with each additional unit of leverage at time 0 costing $(1 + R_{Mi})$ units of wealth in period 1.[9] With agents discounting the future at rate R_F, an increase in the initial mortgage amount therefore decreases lifetime wealth as long as $R_{Mi} > R_F$. With constant relative risk aversion, the variability of entrepreneurial income has a higher utility cost when wealth is lower. This is because risky labour income represents a larger fraction of total wealth (η_{Yi} in equation (3) is bigger). Moreover, less wealth combined with higher property values increases the impact of house price co-movements with entrepreneurial income on utility through the term η_{Hi} in equation (3). These two channels give rise to the following prediction:

Proposition 1. *Under the assumption that $R_{Mi} > R_F$, an increase in initial housing cost, holding equity constant, implies an increase in mortgage debt. This in turn has a negative effect on the likelihood of becoming an entrepreneur.*

The assumption $R_{Mi} > R_F$ is needed in our framework so that the present value of the additional cost of leverage is greater than one. In our empirical setting, this assumption is highly likely to hold since in Britain (unlike in the US) mortgage interest cannot be deducted from income taxes.[10]

[9] Given that house prices at time 0 are linked one-to-one with house prices at time 1, and given that these enter agents' wealth, their increase does not lead to a reduced housing consumption in this model. However, such an increase in P_0 does require a corresponding increase in mortgage debt, because agents must optimally allocate their resources across time periods.

[10] The Mortgage Interest Relief at Source (MIRAS), introduced in the UK 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_{Mi} likely exceeds R_F during the entire sample period.

Furthermore, in our framework, the negative net effect on lifetime wealth of a change in house prices holding equity constant — that is, an increase in mortgage debt — stems from the product of M_{0i} and R_{Mi} (discounted to present using R_F). This captures the present value of all future mortgage payments. In our empirical work, we proxy for the extent of an individual's mortgage burden by using the LTV on the outstanding loan. The evidence in Besley et al. (2013) and Best et al. (2015) shows that a borrower's LTV is among the most important determinants of the interest rate charged by the lender. Therefore our proxy captures the joint effect of M_{0i} and R_{Mi} by exploiting the fact that a larger loan (relative to the house value) will correspond to a larger LTV; and that a larger LTV will lead to a larger R_{Mi}.

In addition, equation (3) points to an important interaction between the wealth share associated with labour income (η_Y) and entrepreneurial risk (σ_e^2), as well as between the share associated with housing (η_{Hi}) and the covariance between house prices and entrepreneurial profits (σ_{ep}). Hence, we expect that an increase in mortgage debt will have a particularly strong adverse effect on the propensity of a (leveraged) homeowner to become an entrepreneur in sectors where profit variability and the covariance between profits and house prices are high. This gives rise to the following proposition:

Proposition 2. *Under the assumption that $R_{Mi} > R_F$, the negative link between mortgage debt and entrepreneurship is greater in sectors where profits have a higher variance and where profits covary more with house prices.*

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 an individual's wealth. The wealth effect that underpins our model takes a very specific form: *it affects an individual's risk aversion.*

Our second comparative static of interest is the effect of a change in property values (P_0) keeping mortgage debt constant. On the one hand, this increases home equity, making η_{Yi} smaller and decreasing the risk associated with labour income. On the other hand, it increases the wealth share of housing (η_{Hi}), making the overall portfolio position more risky. This gives rise to an ambiguously signed prediction for the effect on entrepreneurship.[11]

Note that, in contrast to our setting, in a simple model with credit constraints and bank lending against housing — but no portfolio considerations — an increase in house prices (holding mortgage debt constant) would raise the collateral value of housing and allow for more borrowing from banks

[11] By contrast, when evaluating the effect of mortgage debt, both η_{Yi} and η_{Hi} move in the same direction. As a result the effect is unambiguously negative.

to start some entrepreneurial activities. Hence, in such models, the effect of an increase in house prices on entrepreneurship is unambiguously positive.[12]

In the next sections, we explain how we empirically investigate Propositions 1 and 2, as well as the ambiguously-signed prediction of the effect of a change in home equity on entrepreneurship. Importantly, when we do so, we take numerous steps to control for the dimensions of an agent's heterogeneity that matter for occupational choices—risk aversion (γ_i), taste for entrepreneurship (α_i), and initial liquid wealth (L_{0i}, the amount of money not tied in housing)—while focusing on the relevant exogenous variation in P_0.

3 Description of data

3.1 Data source

We use data from the BHPS, 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 successful in following the same 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 and whether this 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. We use this information to track an individual's employment status over time with a monthly frequency.[13]

To identify the relation between housing tenure, mortgage debt and entrepreneurship, we need

[12] Another possibility would be that leverage provides individuals with liquidity and that entrepreneurial income depends on the amount of liquid wealth invested in the business. Assuming that the return on this investment earns more than the cost of servicing the loan, two contrasting forces would push the model predictions in opposing directions. On the one hand, the uncertainty about entrepreneurial income would reduce an individual's propensity to become an entrepreneur. This negative effect would still be increasing in the extent of mortgage debt. On the other hand, if leveraging and ploughing liquidity into the business venture generates extra revenues, this would create a wealth effect — reducing individuals' risk aversion and pushing agents to become entrepreneurs. Although this is an interesting possibility, it is one that we do not explore given that our empirical results show an unambiguously negative link between leverage and entrepreneurship.

[13] The BHPS structure 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). Similar to Upward (1999) and Battu and Phimister (2008), we follow the principle that information recorded closest to the date of the beginning of the spell is the most accurate. We provide a detailed description of our procedure to assemble the data in the Online Data Appendix.

information about individuals' tenure choices with special attention to the timing of events. We first gather information about a respondent's present tenure status. The possible categories are: homeowner with mortgage, homeowner without mortgage, private tenant, and social tenant.[14] 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.

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 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.[15]

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 individuals live.[16] We use LA identifiers to merge LA-specific house price data coming from the Survey of Mortgage

[14]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.

[15]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.

[16]LAs 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 such LAs.

Lenders (SML, until 1995)[17] and from the Land Registry (from 1995).[18] We also merge in two proxies for the elasticity of local housing supply — the LA-specific percentage of developed land and the LA-level rate of refusal of major residential projects — as derived by Hilber and Vermeulen (2016).

After implementing these merges and cleaning the data, our sample includes approximately 360,000 observations (i.e., individual monthly spells) and 5,200 individuals.

3.2 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 self-employed' — at 14.4% in our sample.[19]

Panel A shows that the fraction of homeowners in the monthly spell data is 81%.[20] 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 an individual's outstanding mortgage debt and the corresponding 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. This variation stems from changes in outstanding mortgage debt, as well as changes in the value of the asset. However, a larger fraction of the within-individual variation in LTV is explained by within-individual variation in the outstanding amount of the loan rather than by within-individual variation in housing values. Changes in the outstanding loan amount can be driven by amortization and refinancing decisions. Regarding the former, Cocco (2013) analyses the BHPS and shows that approximately 56% of mortgages over the 1991 to 2008 period have principal repayment — with the other mortgages being interest-only (IO) loans. We find similar shares in our dataset. Refinancing decisions are common given the types of mortgages mainly available in the UK: contrary to the US, where 30-year fixed rate mortgages are very popular, mortgage contracts in the UK tend to have

[17] 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.

[18] We use annual LA-level mix-adjusted house prices — see Hilber and Vermeulen (2016) for details of the computation — and merge this data to our monthly BHPS dataset at a yearly frequency.

[19] 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% during the 1991 to 2007 period.

[20] 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.

fixed rates between 2 and 5 years only and floating rates afterwards, making it potentially profitable to refinance at the end of the fixed rate period. At refinancing, it is likely that individuals with some savings will *reduce* their LTV: Besley et al. (2013) and Best et al. (2015) show that the LTV is among the most important determinants of the individual interest rate charged; by reducing their LTV, households can decrease their monthly payments. Obviously, at refinancing, a mortgage can also be *increased* and equity withdrawn. However, this is not common in the UK. According to Benito (2009), only 1 in 15 UK homeowners (6-7%) withdrew equity on average, over the period from 1990 to 2005.[21]

Panel A also shows that, on average, individuals report housing values of approximately £120,000, though this figure is associated with a large standard deviation of £110,000. The cumulative house price gains experienced by individuals between the time of purchase and the current spell (on average about 10 years) are 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 supports our modelling assumptions about relative income volatility in the two occupations.

Further, Figure 1 depicts the age distribution of the individuals in our sample making the transition into homeownership and into entrepreneurship. The figure clearly shows that the transition into homeownership predates the transition into entrepreneurship. This evidence is again consistent with our modelling framework which studies the effect of the former (or, rather, one aspect of it: the extent of mortgage debt) on the latter.

In the Appendix, we present additional statistics on the incidence of transitions into and out

[21] This is in contrast to the US, where mortgage refinancing and mortgage equity withdrawal were very common before the crisis. In 2005, for instance, 40 percent of existing mortgages were refinanced, withdrawing equity (Feldstein, 2007).

of homeownership and entrepreneurship (Appendix Table 1) and the characteristics of individuals when they make these transitions (Appendix Table 2). We 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.

4 Main findings: Taking the model to the data

4.1 Proposition 1: The negative link between mortgage debt and entrepreneurship

To test Proposition 1, we run the following linear probability model:

$$Entrep_{ilt} = \beta_1 \ LTV_{ilt} + \beta_2 \ HV_{ilt} + X_{ilt}\gamma + \phi_l + \omega_t + \eta_i + \varepsilon_{ilt} \tag{4}$$

where the dependent variable $Entrep_{ilt}$ is our proxy for an entrepreneurial job, and the explanatory variables of interest are a time-varying measure of the individual LTV ratio and a self-assessed estimate of the value of the property the individual owns (HV_{ilt}). The subscript ilt identifies individual i living in location l at time t. By including these two variables simultaneously in our specification we line up our empirical model with the comparative statics from our theoretical framework. These comparative statics focussed on the impact of variation in house prices which results in higher mortgage debt (proxied here by LTV_{ilt}) when holding home equity constant (i.e., controlling for HV_{ilt})[22], and the effect of variation in house values which results in higher home equity when accounting for the impact of mortgage debt (i.e., the effect of HV_{ilt} controlling for LTV_{ilt}).

Further, X_{ilt} is the set of time-varying controls discussed above, while ϕ_l and ω_t represent location and time fixed effects. In some specifications, X_{ilt} includes an indicator for an individual's homeownership status — so that our regressions isolate the effect of LTV and house values while controlling for any direct effect of tenure on entrepreneurship. Location (LA) fixed effects (ϕ_l) control for persistent geographical disparities in labour and housing markets and differences in local political and institutional factors, whereas the time fixed effects (ω_t) capture unobserved factors that are specific to the year and/or month of interview.

[22] An increase in the value of one's home is normally associated with rising home equity. However, consider the case where an individual moves from a less to a more desirable location. The home equity is constant; what changes is the house value and mortgage debt (leverage).

Finally, η_i captures the unobserved individual factors which we flagged in our model and that may simultaneously determine occupational choice and tenure status, namely: taste for entrepreneurship or entrepreneurial ability (α_i), risk aversion (γ_i) and persistent wealth (related to L_0). In our empirical analysis, we present three complementary research designs that deal with these unobserved factors and allow us to test the model predictions.

Note also that the error-term ε_{ilt} 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.

Our first set of results is reported in Columns (1) and (2) of Table 3. In Column (1) we present OLS associations. These show that housing wealth displays a significant positive correlation with entrepreneurship. A £100,000 increase in house 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). Conversely, there is no evidence of a significant correlation of the LTV of the outstanding mortgage with entrepreneurship. Similarly, homeownership *per se* is not significantly related to entrepreneurship.

These results are however most likely biased by individual unobservables. Our first research design to deal with this issue is to control for individual time-fixed unobserved heterogeneity by including individual fixed effects in our specification. We report our findings in Column (2). We find that now self-assessed house values have no discernible 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 — corresponding to approximately £32,000 — is associated with a reduction in the probability of being an entrepreneur by about 10%.[23]

These findings are consistent with the predictions from our model. First, the negative relation between LTV and entrepreneurship supports Proposition 1. Second, the lack of a clear association between entrepreneurship and house values is consistent with the ambiguous effect of housing wealth, which stems from competing portfolio and wealth considerations.

Since our findings on the impact of house prices are at variance with the literature, we test their robustness along a number of dimensions. To begin with, we follow Corradin and Popov (2015) and replace self-assessed house values with a measure of the net equity held by individuals

[23]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 functional areas drawn by the Office for National Statistics to identify self-contained local labour markets. Our sample consists of 243 such TTWAs. We also experimented with alternative clustering structures, including two-way clustering at the individual and LA level. None of these checks affects our conclusions.

in their home — i.e., the difference between the value of the property and the amount of the outstanding loan. When we also adopt their specification and control for LA-by-year effects (instead of individual fixed effects), we find that net housing wealth is positively and significantly associated to entrepreneurship. A back-of-the-envelope calculation shows that the average house price gains in our data (at approximately 35% of the initial asset value) are associated with increases in entrepreneurship by around 6-7% — an elasticity comparable to the findings of Corradin and Popov (2015). Conversely, the LTV on the outstanding loan is not negatively associated to the likelihood of being an entrepreneur. However, as soon as we focus on the individual-level variation over time by including individual fixed effects, we find an insignificant coefficient on net equity, but a sizable, negative and significant effect of the LTV. Furthermore, our finding of a negative effect of LTV on entrepreneurship does not change if we drop from our specifications the control for house values or net equity. Conversely, we still find no evidence of a positive impact of house prices on entrepreneurship conditional on individual fixed effects even when we drop the LTV variable.[24]

Finally, we investigate whether the effects of the LTV-ratio and house values are non-linear. To do so, we create twenty dummies each containing 5% of the LTV/house value distribution and test their effects on the probability of being an entrepreneur. We find little evidence of non-linearities. The effect of the LTV gradually increases as we move to higher LTV levels and is clearly significant from the 30th percentile upwards. However, we still find no evidence that house values affect entrepreneurship: their impact remains flat across the house price distribution.

One concern with our fixed effects approach is that 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 housing tenure and entrepreneurship (Linneman and Wachter, 1989; Evans and Leighton, 1989; Hilber, 2007), and for individual and household-level income in the year prior to the survey. Nevertheless, the potential for biases in our estimates remains, and we next present the findings of two complementary research designs that help address this concern.

To begin with, in Columns (3) and (4) we replace individual fixed effects with individual-housing-spell effects that change when agents move from renting to owning (or vice versa), and

[24]Similarly, we find no evidence of a positive house price impact conditional on individual fixed effects for older individuals in our sample. While this is at odds with Harding and Rosenthal (2017), it should be noted that our sample still only includes individuals up to age 55 and house price gains may mainly matter for individuals close to retirement age. We also investigate whether our results on the LTV of the outstanding loan are more sizable and significant for older individuals in our sample. We find that this is indeed the case: for example, if we focus on individuals aged 40 or above (the median age in our sample), we find a more sizable and more precisely estimated negative effect of leverage on entrepreneurship, irrespective of the specification we use. The impact of mortgage debt on entrepreneurship remains negative (though not statistically significant) for younger individuals.

any time they change home. Our specifications therefore exploit variation in the LTV and in house values within a specific housing spell. This approach partials out changes in individual unobservables that coincide with housing-related moves: for example, an increase in an individual's liquid wealth (L_{0i} in our model) or a change in the preference for entrepreneurship (α_i) at the beginning of a new housing-tenure spell. This approach also helps address the endogeneity of tenure choice and of the quantity of housing consumed.

These specifications yield a 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 homeownership decision biases our results. This specification confirms our previous finding: a one standard deviation increase in LTV reduces entrepreneurship by approximately 12%. Conversely, we find no evidence of sizable or statistically significant house value effects. Once again, using net equity – instead of house values – yields the same conclusion.

Our third research design — discussed above — is an instrumental variable (IV) approach (coupled with individual fixed effects) that predicts an individual's variation in the two main explanatory variables using exogenous changes in house prices — thus bypassing potential endogeneity issues related to changes in an individual's unobservables.

Specifically, we instrument individual house values using variation in *current* house prices at the national level interacted with local proxies for the elasticity of housing supply: the share of developed land in the LA and the average LA planning refusal rate.[25] We instead instrument mortgage debt using variation in national house prices *in the year of purchase* interacted with local supply elasticity proxies. This IV approach treats the interaction between local housing supply price elasticity and national house prices in the current year and in the year of purchase as exogenous to individuals' time-varying unobservables (as in Chetty et al. (2017)). In order to mitigate concerns about the possible confounding effects of local economic cycles — and their correlation with local housing markets — our IV specifications further control for variation in local wages and employment.

The variation exploited by the first stage of this approach is coherent with the mechanisms underpinning the comparative statistics of our model: we find that higher housing costs at the time of purchase — while holding constant current housing wealth — predict higher leverage,

[25] Using these two instruments separately leads to very similar conclusions.

while higher current house prices holding mortgage debt constant — increase home equity wealth. The first-stage coefficients are reported in Appendix Table 3. The relevant instruments are not only correctly signed, but also strongly significant with an overall F-test statistic of 41.30.[26]

Column (5) of Table 3 reports our second-stage estimates. These lend support to the predictions of our theoretical framework and confirm the findings obtained using the two alternative research strategies. A one standard deviation change in the LTV reduces the probability of becoming an entrepreneur by approximately 23%. Conversely, housing wealth has no effect on entrepreneurship.[27]

We carry out a number of robustness checks. First, we drop the controls for local economic conditions. This does not change our conclusions in any meaningful way. Second, we control for the impact of homeownership in our specifications. This approach still yields a small and insignificant effect of home equity but a larger effect of the LTV with a coefficient of -0.069 (significant at the 10% level). Given the potential endogeneity of the homeownership control (and the lack of a suitable instrument), we prefer the specification reported in Column (5) that does not control for the effect of housing tenure.

In the Online Appendix we tabulate an additional set of checks that we perform on our analysis. To begin with, in Online Appendix Table 1 we verify that our results are robust to: (i) using annual data; (ii) restricting the sample to workers that do not move to other local authorities; (iii) excluding London; and (iv) excluding some sectors in the economy. These checks are all based on specifications that include individual fixed effects and their results fully support our main conclusions. In Online Appendix Table 2 we perform a further check. We replace our measure of current (self-reported) house values with a proxy for cumulative house price gains. This is obtained using the variation in an individual's self-assessed house price and considering the lapse between the time when the property was purchased and the current date. Irrespective of the research design we use, results in this extension still provide no evidence that cumulative house price gains matter. Conversely, the negative effect of the LTV on entrepreneurship maintains its size and significance.

[26]The table also shows that the cross-equation instruments — that is, current prices in the LTV first-stage equation and housing cost at the time of purchase in the current house values first-stage — are less sizable and significant or incorrectly signed and insignificant compared to the relevant instruments. This suggests that the two instrument sets move two different margins and separately identify the impact of LTV and housing equity.

[27]In a previous version of this paper (Bracke et al., 2015) we employed an alternative 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 UK Survey of Mortgage Lenders (SML). Using this area-level data to predict an individual's LTV, we obtained similar results: a one standard deviation increase in the LTV reduces the propensity to become an entrepreneur by about 12%. This supports the exogeneity assumption underpinning the variation used in our individual/spell fixed effect specifications: within-individual variation in LTV is mainly dictated by UK-specific housing market institutional features and local banking supply-side circumstances (see discussion in Section 3.2 and supporting evidence in Muellbauer (2002)).

These patterns are consistent with Hurst and Lusardi (2004) who show that households who live in areas which experience strong house price appreciation are not significantly more likely to start an entrepreneurial venture. Similar evidence is provided by Disney and Gathergood (2009) for the UK.[28] The results are also not at odds with Schmalz et al. (2016) who find evidence of a positive association between house-price appreciation and business start-ups *only* for homeowners without mortgages (representing less than 10% of our sample). Our findings can be seen as complementary: whereas Schmalz et al. (2016) emphasise the potential benefits of housing collateral for outright homeowners, our work stresses the negative consequences of excessive mortgage debt for leveraged homebuyers.

4.2 Proposition 2: The role of entrepreneurial risk

To test Proposition 2, we gather data from Eurostat 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 used in the BHPS (SIC92), providing a sufficient level of detail by dividing the economy into 45 sectors.[29]

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 and 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.[30]

Our results are displayed in Columns (1) and (2) of Table 4, 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). The regression specification is the same as in the last column of Table 3, using our third research design: IV plus individual fixed effects.[31] A comparison of the two columns reveals that entrepreneurship is only adversely affected by mortgage debt in risky sectors: the coefficient

[28]Direct evidence on the use of home-equity loans by entrepreneurs is not available for the UK. 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 the intuition that home-equity loans are not widespread among business start-ups in the UK. According 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 and 5% to buy other consumer goods.

[29]The resulting dataset contains around 200,000 observations (rather than 350,000 as in the main sample). We replicated the regressions of columns (2), (4) and (5) of Table 1 for this subsample and obtained very similar estimates. Results are available from the authors upon request.

[30]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. These are available from the authors upon request.

[31]Simple (non-IV) fixed effects regressions confirm all results discussed in this section.

on LTV is -0.056 compared to -0.009 for sectors with less volatile profits. Using the median of the raw standard deviation of profits (i.e., profit variability *unadjusted* for mean returns) confirms our findings. The negative effect of mortgage debt on the chance of becoming an entrepreneur in sectors with standard deviation of profits above the median is -0.048 (5% level of significance), but this becomes smaller at -0.011 and insignificant for entrepreneurs in sectors with profit variability below the median.

These results are fully consistent with Proposition 2 and lend support to the mechanism underpinning our theoretical framework: increasing mortgage debt negatively impacts entrepreneurship by increasing an individual's risk aversion.

Our model also predicts that the effect of mortgage debt should be more significant when profits are highly correlated with house prices. We investigate this prediction in the subsequent columns of Table 4. To start with, we use house 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.[32]

Our results reveal that the effect of leverage is substantially larger and only significant in areas that entail house price risk that correlates strongly with entrepreneurial profits. In particular, the effect of LTV for individuals who are entrepreneurs and live in areas where the correlation between house prices and profits is above the median is substantially bigger (-0.047 and significant at the 5% level) than the effect for individuals facing lower correlation (-0.017 and insignificant). We find a very similar pattern when we consider the covariance (instead of correlation) between local house prices and sector profits (-0.051 vs. -0.013).[33]

5 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 growing

[32]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).

[33]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 LTV on entrepreneurship is more sizable (at -0.026) in areas with high price variation than in areas with low price volatility (at -0.013) — however this difference is 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.

literature that stresses the perils of excessive mortgage financing in the aftermath of the Great Recession (Mian et al., 2013). We highlight a new channel through which excessive mortgage debt may hinder economic activities and adversely affect the general economy: mortgage debt diminishes the likelihood of entrepreneurship by amplifying risk aversion.

In the first part of our work, we develop a model of occupational choice and housing tenure, where entrepreneurship is associated with benefits (either pecuniary or not) that vary across individuals and costs that arise from greater income uncertainty. We use this model to derive some empirically testable predictions that arise from two comparative statics, both based on the effects of an exogenous variation in housing values.

In the first case, we focus on the impact of an increase in property values holding home equity wealth fixed. This implies an increase in mortgage debt and, as long as the mortgage interest rate paid by individuals exceeds the risk-free rate, a reduction in lifetime wealth which in turn amplifies individuals' risk aversion. This comparative statics leads to the two main testable predictions of our model. First, provided that mortgage interest rates exceed the risk-free rate, higher levels of mortgage debt diminish the likelihood that leveraged homeowners start a business. Second, the negative relation between increased mortgage debt and entrepreneurship is more pronounced when focussing on risky sectors where profits are more volatile or highly correlated with house prices.

The second comparative static instead focuses on an increase in property values while holding mortgage debt fixed — leading to an increase in home equity wealth. This second thought experiment leads to an ambiguously signed prediction because of competing portfolio and wealth considerations.

Our empirical analysis exploits the longitudinal dimension of the British Household Panel Survey to test these predictions. In order to address endogeneity issues, we devise three complementary research designs — individual fixed effects, housing-spell fixed effects, and instrumental variables. Independent of the design we use, our findings confirm both predictions on the impact of mortgage debt 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. Our evidence also shows that the impact of housing values — holding mortgage debt constant — is not clearly signed. This result is again consistent with our model and distinguishes our framework from other work that has emphasised the role of credit constraints and housing collateral in determining individuals' decisions to start a business activity.

Consistent with most of the literature cited in the paper, our theoretical framework and empirical analysis employ a concept of risk that relates to the second moment of the distribution of profits. An alternative view is that agents are mostly concerned about downside risk — i.e., they care about the likelihood of a drop in earnings sufficiently large as to threaten mortgage payments and consumption (see Bozkaya and Kerr, 2014 on unemployment insurance and downside risk for entrepreneurs; and Olds, 2016 on health insurance and entrepreneurship). Given the limitations of the data at hand — our profit measures only cover 12 years — we are unable to investigate this idea with precision, for example by exploiting the right/left skew of the profit distribution. However, we see this as an interesting avenue for future research.

How sizable are these findings? Our main specifications bracket the negative impact of a one standard deviation change in the LTV on the outstanding mortgage — approximately £32,000 — on entrepreneurship at between 10% (fixed effect specification) and 23% (fixed effect IV estimate).

Our results have important policy implications. Virtually all developed countries – including the United States and the United Kingdom – have set in place policies that favour homeownership by making it easier to finance home purchases with a loan. These policies include mortgage interest rate deductibility, 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) points out that these policies are associated with huge costs and can have perverse effects by only benefiting higher income households, and by raising prices and lowering homeownership rates in metro areas with tight restrictions on housing supply.

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, since the MID increases leverage (Munroe, 2014), it increases risk aversion and thus discourages entrepreneurship.

However, the MID lowers the effective mortgage cost. If the subsidy is strong enough, this may reverse our assumption that the (effective) mortgage rate exceeds the risk-free rate, and thereby the main prediction of our model. To assess this possibility, we consider the case of the US 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 to 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 difference 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 have exceeded 50%, making R_M smaller than R_F 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 vast majority of households, the effective cost of borrowing significantly exceeds the risk-free rate — and thus our model predictions 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.

References

Acs, Z. and Audretsch, D. (2003). *Handbook of Entrepreneurship Research.* Kluwer Academic Publishers.

Adelino, M., Schoar, A., and Severino, F. (2015). House prices, collateral, and self-employment. *Journal of Financial Economics*, 117(2):288–306.

Alba-Ramirez, A. (1994). Self-employment in the midst of unemployment: The case of Spain and the United States. *Applied Economics*, 26:189–204.

Aron, J. and Muellbauer, J. (2016). Modelling and forecasting mortgage delinquency and foreclosure in the UK. *Journal of Urban Economics*, 94:32–53.

Battu, Harminder, A. M. and Phimister, E. (2008). Housing tenure, job mobility and unemployment in the UK. *Economic Journal*, 118:311–328.

Benito, A. (2009). Who withdraws housing equity and why? *Economica*, 76(301):51–70.

Besley, T., Meads, N., and Surico, P. (2013). Risk heterogeneity and credit supply: Evidence from the mortgage market. *NBER Macroeconomics Annual, University of Chicago Press*, 27(1):375–419.

Best, M. C., Cloyne, J., Ilzetzki, E., and Kleven, H. J. (2015). Interest rates, debt and intertemporal allocation: evidence from notched mortgage contracts in the United Kingdom. Bank of England working papers 543, Bank of England.

Black, J., de Meza, D., and Jefreys, D. (1996). House prices, the supply of collateral and the enterprise economy. *Economic Journal*, 106:60–75.

Blanchflower, D. and Oswald, A. (1992). Entrepreneurship, happiness and supernormal returns: Evidence from britain and the us. NBER Working Papers 4228, National Bureau of Economic Research, Inc.

Blanchflower, D. and Oswald, A. (2013). Does high home-ownership impair the labour market? NBER Working Papers 19079, National Bureau of Economic Research, Inc.

Blanchflower, D. and Shadforth, C. (2007). Entrepreneurship in the UK. Foundations and Trends in Entrepreneurship, 3:1–108.

Bozkaya, A. and Kerr, W. R. (2014). Labor regulations and european venture capital. *Journal of Economics and Management Strategy*, 23(4):776–810.

Bracke, P., Hilber, C., and Silva, O. (2015). Mortgage debt and entrepreneurship. Bank of England working papers 560, Bank of England.

Brueckner, J. K. (1997). Consumption and investment motives and the portfolio choices of homeowners. *Journal of Real Estate Finance and Economics*, 15:159–180.

Casson, M., Yeung, B., and Basu, A. (2008). *The Oxford handbook of entrepreneurship*. Oxford University Press.

Chetty, R., Sándor, L., and Szeidl, A. (2017). The effect of housing on portfolio choice. *The Journal of Finance*, page forthcoming.

Cocco, J. (2005). Portfolio choice in the presence of housing. *Review of Financial Studies*, 18:535–567.

Cocco, J. F. (2013). Evidence on the benefits of alternative mortgage products. *The Journal of Finance*, 68(4):1663–1690.

Corradin, S. and Popov, A. (2015). House prices, home equity borrowing, and entrepreneurship. *Review of Financial Studies*, 28(8):2399–2428.

Davidoff, T. (2006). Labor income, housing prices, and homeownership. *Journal of Urban Economics*, 59:209–235.

Davis, M. A. and Ortalo-Magné, F. (2011). Household expenditures, wages, rents. *Review of Economic Dynamics*, 14(2):248–261.

De Meza, D. and Webb, D. (1999). Wealth, enterprise and credit policy. *Economic Journal*, 109:153–163.

Disney, R. and Gathergood, J. (2009). Housing wealth, liquidity constraints and self-employment. *Labour Economics*, 16:79–88.

Evans, D. S. and Leighton, L. S. (1989). Some empirical aspects of entrepreneurship. *American Economic Review*, 79(3):519–35.

Faggio, G. and Silva, O. (2014). Self-employment and entrepreneurship in urban and rural labour markets. *Journal of Urban Economics*, 84:67–85.

Faig, M. and Shum, P. (2002). Portfolio choice in the presence of personal illiquid projects. *Journal of Finance*, 57(1):303–328.

Fairlie, R. W. (2010). The great recession and entrepreneurship. *mimeo*, University of California Santa Cruz.

Feldstein, M. S. (2007). Housing, Credit Markets and the Business Cycle. NBER Working Papers 13471, National Bureau of Economic Research, Inc.

Flavin, M. and Yamashita, T. (2002). Owner-occupied housing and the composition of the household portfolio. *The American Economic Review*, 92(1):345–362.

Frame, W. S. and White, L. (2005). Fussing and fuming over Fannie and Freddie: How much smoke, how much fire? *Journal of Economic Perspectives*, 19:159–184.

Glaeser, E. (2009). Entrepreneurship and the city. in Entrepreneurship and Openness: Theory and Evidence, D. Audretsch, R. Litan and R. Strom eds. (Northampton: Edward Elgar Publishing,).

Glaeser, E. and Kerr, W. (2010). Local industrial conditions and entrepreneurship: How much of the spatial distribution can we explain? *Journal of Economics and Management Strategy*, 18 , 623–663.

Glaeser, E. L. and Shapiro, J. M. (2003). The benefits of the home mortgage interest deduction. In *Tax Policy and the Economy, Volume 17*, NBER Chapters, pages 37–82. National Bureau of Economic Research, Inc.

Guiso, L., Sapienza, P., and Zingales, L. (2013). The determinants of attitudes toward strategic default on mortgages. *The Journal of Finance*, 68(4):1473–1515.

Hamilton, B. H. (2000). Does entrepreneurship pay? An empirical analysis of the returns to self-employment. *Journal of Political Economy*, 108(3):604–631.

Harding, J. P. and Rosenthal, S. S. (2017). Homeownership, housing capital gains and self-employment. *Journal of Urban Economics*, 99:120–135.

Heaton, J. and Lucas, D. (2000). Portfolio choice and asset prices: The importance of entrepreneurial risk. *Journal of Finance*, 55(3):1163–1198.

Henderson, J. V. and Ioannides, Y. (1983). A model of housing tenure choice. *American Economic Review*, 73:98–113.

Hilber, C. (2007). The determinants of homeownership across Europe: Panel data evidence. *mimeo LSE*.

Hilber, C. and Turner, T. (2014). The mortgage interest deduction and its impact on homeownership decisions. *Review of Economics and Statistics*, 96(3):618–637.

Hilber, C. and Vermeulen, W. (2016). The long-term impact of supply constraints on house prices in England. *Economic Journal*, 126(591):358–405.

Hurst, E. and Lusardi, A. (2004). Liquidity constraints, household wealth, and entrepreneurship. *Journal of Political Economy*, 112:319–347.

Hurst, E. and Pugsley, B. W. (2011). What do small businesses do? *Brookings Papers on Economic Activity*, 43(2 (Fall)):73–142.

Kerr, S. P., Kerr, W., and Nanda, R. (2014). Housing money and entrepreneurship. *mimeo, Harvard University.*

Kihlstrom, R. and Laffont, J.-J. (1979). A general equilibrium entrepreneurial theory of firm formation based on risk aversion. *Journal of Political Economy*, 87:719–48.

Linneman, P. and Wachter, S. (1989). The impacts of borrowing constraints on homeownership. *Journal of the American Real Estate and Urban Economics Association*, 17:389–402.

Lucas, Jr, R. E. (1978). On the size distribution of business firms. *The Bell Journal of Economics*, pages 508–523.

Manso, G. (2016). Experimentation and the returns to entrepreneurship. *Review of Financial Studies*, page forthcoming.

Maré, D. (2006). Constructing consistent work-life histories: A guide for users of the British Household Panel Survey.

Martinez-Granado, M. (2002). Self-employment and labour market transitions: A multiple state model. CEPR Discussion Paper 3661.

Mian, A., Rao, K., and Sufi, A. (2013). Household balance sheets, consumption, and the economic slump. *The Quarterly Journal of Economics*, 128(4):1687–1726.

Michelacci, C. and Silva, O. (2007). Why so many local entrepreneurs? *Review of Economics and Statistics*, 89:615–633.

Muellbauer, J. (2002). Mortgage credit conditions in the UK. *Economic Outlook*, 25:10–17.

Munroe, D. (2014). Response of home equity debt to mortgage policy: Evidence from a kink and a notch. *Mimeo, Columbia University.*

Olds, G. (2016). Entrepreneurship and Public Health Insurance. Harvard Business School Working Paper 16-144.

Oswald, A. (1996). A conjecture on the explanation for high unemployment in the industrialised nations: Part 1. Warwick Economic Research Papers.

Paull, G. (2002). Biases in reporting of labour market dynamics. *IFS Working Paper*.

Poterba, J. M. and Sinai, T. (2011). Revenue costs and incentive effects of the mortgage interest deduction for owner-occupied housing. *National Tax Journal*, 64(2):531–64.

Schmalz, M. C., Sraer, D. A., and Thesmar, D. (2016). Housing Collateral and Entrepreneurship. *Journal of Finance*, page forthcoming.

Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Transaction Publishers.

Sinai, T. and Souleles, N. (2005). Owner-occupied housing as a hedge against rent risk. *The Quarterly Journal of Economics*, 120(2):763–789.

Upward, R. (1999). Constructing data on unemployment spells from the PSID and the BHPS. *Centre for Research on Globalisation and Labour Markets*, School of Economic Studies, Nottingham.

Wang, S.-Y. (2012). Credit constraints, job mobility, and entrepreneurship: Evidence from a property reform in China. *Review of Economics and Statistics*, 94(2):532–551.

Appendices

A Proofs

A.1 The baseline case

The indirect utility of an agent with wealth W_1 is:

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

The entrepreneurship choice with a utility premium — setting (a): Our goal is to compute α^* in equation 2, namely the level of α_i that makes the agent indifferent between entrepreneurship and employed work. Using equation A.1, we can write α^* as follows:

$$\begin{aligned} \alpha^* &= \frac{\phi\,\mathbb{E}\left(W_1^e P_1^{-\mu}\right)^{1-\gamma}}{\phi\,\mathbb{E}\left(W_1^w P_1^{-\mu}\right)^{1-\gamma}} \\ &= \frac{\mathbb{E}\left(\frac{Y_e+H_0P_1-M_1+L_1}{P_1^{\mu}}\right)^{1-\gamma}}{\mathbb{E}\left(\frac{\overline{Y}+H_0P_1-M_1+L_1}{P_1^{\mu}}\right)^{1-\gamma}} \end{aligned} \tag{A.2}$$

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

$$W_1 = (\overline{Y} + H_0\overline{P}_0 - M_1 + L_1)(1 + \eta_Y\tilde{y} + \eta_H\tilde{p}) \approx (\overline{Y} + H_0\overline{P}_0 - M_1 + L_1)e^{\eta_Y\tilde{y}+\eta_H\tilde{p}},$$

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

where η_y is the share of income out of total wealth, η_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:

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

or

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

which leads directly to equation 3.

Entrepreneurship choice with an income premium — setting (b): In this alternative setting, we model the individual-specific parameter α as having an effect on an individual's income as entrepreneur. In this case, α can be thought of as a proxy for an individual's 'entrepreneurial ability' and business acumen.

We assume that individuals know their own ability — that is, α is not a random variable. This assumption is in keeping with the two features we want to nest within this setting. First, we want individuals' ability to affect their expected entrepreneurial income, but not necessarily its variance σ_e^2. A priori, we have no reason to believe that more able individuals should have higher or lower entrepreneurial income variation. Second, we would like the parameter α to mirror the individual unobservable characteristics that we account for in our empirical work with individual fixed-effect specifications. While these attributes are unobserved to us (the econometricians), it is reasonable to assume that they are known to the individuals.

In this setting, an agent is indifferent between entrepreneurship and employed work when:

$$\begin{aligned} 1 &= \frac{\phi\ \mathbb{E}\left[W_1^e(\alpha^*)P_1^{-\mu}\right]^{1-\gamma}}{\phi\ \mathbb{E}\left[W_1^w P_1^{-\mu}\right]^{1-\gamma}} \\ &= \frac{\mathbb{E}\left(\frac{Y_e+\alpha^*+H_0P_1-M_1+L_1}{P_1^\mu}\right)^{1-\gamma}}{\mathbb{E}\left(\frac{\overline{Y}+H_0P_1-M_1+L_1}{P_1^\mu}\right)^{1-\gamma}} \end{aligned} \tag{A.4}$$

Similar to before, we can write wealth as:

$$W_1 = (\overline{Y} + \alpha^* + H_0\overline{P}_0 - M_1 + L_1)(1 + \eta_Y\tilde{y} + \eta_H\tilde{p})$$

$$\approx (\overline{Y} + \alpha^* + H_0\overline{P}_0 - M_1 + L_1)e^{\eta_Y\tilde{y}+\eta_H\tilde{p}}.$$

In this case, we can rewrite equation A.4 as:

$$1 = \frac{(\overline{Y} + \alpha^* + H_0\overline{P}_0 - M_1 + L_1)\mathbb{E}e^{[\eta_Y\tilde{y} + (\eta_H - \mu)\tilde{p}](1-\gamma)}}{(\overline{Y} + H_0\overline{P}_0 - M_1 + L_1)\mathbb{E}e^{(\eta_H - \mu)\tilde{p}(1-\gamma)}}$$

$$\frac{\overline{Y} + \alpha^* - \alpha^* + H_0\overline{P}_0 - M_1 + L_1}{\overline{Y} + \alpha^* + H_0\overline{P}_0 - M_1 + L_1} = \frac{\mathbb{E}e^{[\eta_Y\tilde{y} + (\eta_H - \mu)\tilde{p}](1-\gamma)}}{\mathbb{E}e^{(\eta_H - \mu)\tilde{p}(1-\gamma)}}$$

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

where η_α is the share of the entrepreneurship income premium out of total wealth. Assuming lognormality and using the same steps as for the utility premium case, the above equation reduces to:

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

or

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

which leads to

$$\alpha^* = \eta_\alpha^{-1}\left(1 - \exp\left\{\frac{(1-\gamma)^2}{2}\left[\eta_Y^2\sigma_e^2 + 2\eta_Y(\eta_H - \mu)\sigma_{eP}\right]\right\}\right). \tag{A.5}$$

Equation (A.5) is identical to equation (A.3) except that the right-hand side term in equation (A.3) is now preceded by a negative sign and included in the η_α^{-1} (inverse) function (it is also preceded by $+1$ — but this is just scalar and it does not affect the intuition). Since $\eta_\alpha(x) = \frac{x}{\overline{Y} + x + H_0\overline{P}_1 - M_1 + L_1}$ and $\frac{\mathrm{d}\,\eta_\alpha(x)}{\mathrm{d}x} > 0$, $\frac{\mathrm{d}\,\eta_\alpha^{-1}(x)}{\mathrm{d}x} < 0$, and given the negative sign inside the function, the effect of the parameters of interest ($\eta_Y, \sigma_e^2, \eta_H, \mu$, and σ_{eP}) on α^* remains the same as in the case with a utility shifter (setting (a) above and in the text).

Tables and figures

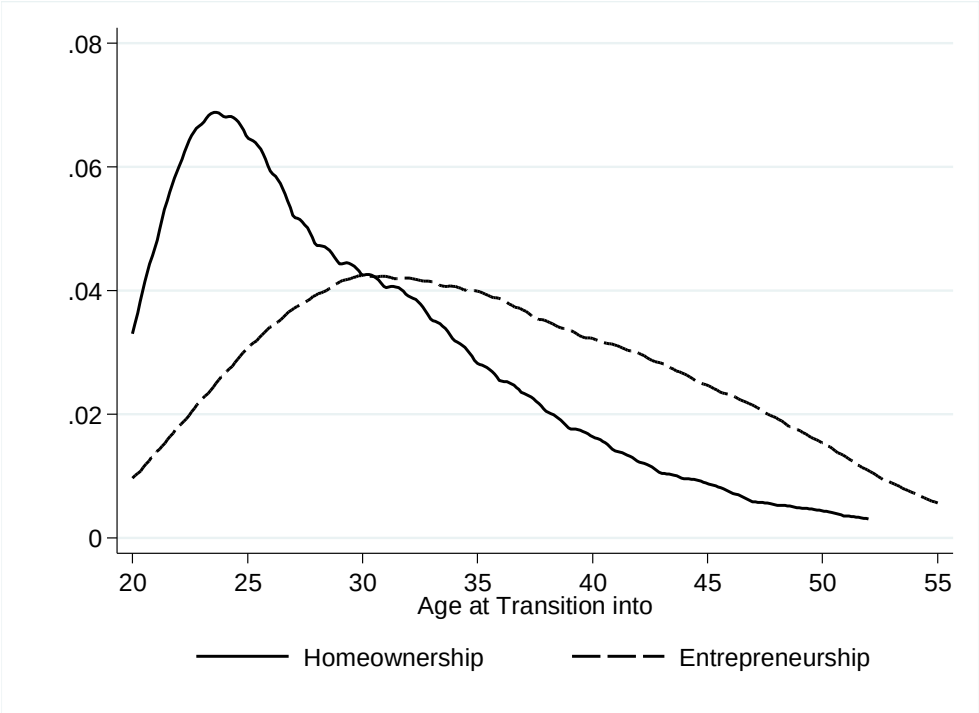

Figure 1: Age at transition into homeownership and entrepreneurship

Note: The figure shows the distribution of ages at which workers in the sample make a transition into homeownership (with or without a mortgage; solid line) and entrepreneurship as defined in the paper (self-employment with dependent workers; dashed line). The sample only includes heads of households aged between 20 and 55 living in England.

TABLE 1: SUMMARY STATISTICS – BHPS INDIVIDUAL LEVEL MONTHLY DATASET

Variable	Mean	Std. Dev.
Panel A: Entrepreneurs & homeowners		
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
Panel B: Controls		
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 (excluding Scotland and Wales) who are either employed or self-employed. 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: Additional 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: Mortgage debt and entrepreneurship

	Dependent variable: entrepreneurship				
	(1)	(2)	(3)	(4)	(5)
	OLS Full Sample	Ind. FE Full Sample	Spell FE Full Sample	Spell FE Owners Only	Ind. FE + IV Full Sample
Loan-to-value (LTV)	-0.005	-0.017	-0.025	-0.022	-0.040
of mortgage	(0.010)	(0.008)**	(0.009)***	(0.010)**	(0.016)**
House value	0.018	-0.000	-0.001	-0.001	0.007
(× £100,000)	(0.004)***	(0.002)	(0.002)	(0.002)	(0.006)
Homeowner	-0.000	0.001	0.019		
	(0.009)	(0.009)	(0.013)		

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 for more details. Standard errors clustered at the LA level. *: 10% significant; **: 5% significant; ***: 1% significant. Instrumental variable (IV) regression in Column (5) instruments (i) individual's LTV with national house prices at the moment of purchase interacted with local proxies for the elasticity of housing supply (LA-level percentage of developed land and LA-level refusal rates) and (ii) self-reported house values with current national house prices 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. The first-stage coefficients and F-statistic are displayed in Appendix Table 3.

TABLE 4: MORTGAGE DEBT, ENTREPRENEURSHIP AND RISK

	Dependent variable: entrepreneurship			
	(1) Ind. FE + IV	(2) Ind. FE + IV	(3) Ind. FE + IV	(4) Ind. FE + IV
	Coeff. of Variation of Profits		*Correlation of Profits and Local HP*	
	Above Median	Below Median	Above Median	Below Median
LTV of mortgage	-0.056 (0.022)***	-0.009 (0.012)	-0.047 (0.019)**	-0.017 (0.014)
House value (× £100,000)	0.010 (0.008)	0.007 (0.006)	0.010 (0.008)	0.008 (0.006)

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 3 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. The number of observations differs from the main sample because of missing data on profits for some sectors in the BHPS. Number of observations: 211,233 corresponding to 3616 individuals. First-stage coefficients for relevant instruments as follows. For LTV first-stage equation: National house prices (when bought) × % Developed land: 0.011 (0.001)***; National house prices (when bought) × Refusal rate: 0.002 (0.001)***. For House Value first-stage equation: National house prices (current) × % Developed land: 13,127 (21,262); National house prices (current) × Refusal rate: 106,759 (22,262)***. Overall Kleibergen-Paap F-Statistic for first-stage equation: 27.41.

Appendix: Additional results

Appendix Table 1: Transitions into and out of homeownership and entrepreneurship

	% (numbers) of individuals making at least…	
	One transition	Two transitions
Panel A: Homeownership		
Overall	18.3 (949)	5.8 (303)
Transition in	13.3 (691)	0.9 (46)
Transition out	10.8 (561)	1.0 (53)
Panel B: Homeownership with mortgage		
Overall	25.5 (1326)	7.7 (402)
Transition in	16.2 (840)	1.4 (72)
Transition out	17.1 (888)	1.7 (86)
Panel C: Homeownership without mortgage		
Overall	12.6 (654)	3.6 (188)
Transition in	9.7 (504)	1.0 (50)
Transition out	6.5 (338)	0.6 (30)
Panel D: Entrepreneur, dependent		
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 (excluding Scotland and Wales) who are either employed or self-employed. Total number of individuals: 5193. Panel is unbalanced.

Appendix Table 2: Summary statistics of individual characteristics – Time of transitions into and out of homeownership and entrepreneurship

	Time of transition into...	Time of transition out of...
Panel A: Homeownership with mortgage		
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)
Panel B: Homeownership without mortgage		
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)
Panel C: Entrepreneur		
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 (excluding Scotland and Wales) who are either employed or self-employed. Number of individuals: 5193. Panel is unbalanced. Figures are means and standard deviations (in parenthesis) of listed characteristics.

Appendix Table 3: First-stage coefficients

	(1)	(2)
Dependent variable:	*Loan-to-value ratio (LTV) of mortgage*	*House value*
National house prices (when bought) × % Developed land	0.010	1,060
	(0.001)***	(213)***
National house prices (when bought) × Refusal rate	0.002	-333
	(0.001)***	(241)
National house prices (current) × % Developed land	-0.132	16,927
	(0.030)***	(22,617)
National house prices (current) × Refusal rate	-0.054	121,917
	(0.031)	(18,142)***
Kleibergen-Paap F-Stat, First Stage	*41.30*	

Note: All instruments are divided by 100,000. 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 3 for more details. Standard errors clustered at the LA level. *: 10% significant; **: 5% significant; ***: 1% significant.

Online appendix, not for publication:

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 the interview are considered as starting on the date of the 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.

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 presented in Online Appendix Table 1. In Column (1) we

perform our analysis using yearly data. This approach relies only on the housing tenure, leverage 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%.

On-line Appendix: Further Results

On-Line appendix table 1: Robustness checks

	Dependent variable: entrepreneurship			
	(1)	(2)	(3)	(4)
	Yearly Data	Immobile Workers	Excluding London	Excl. Selected Sectors
LTV of mortgage	-0.014	-0.018	-0.015	-0.021
	(0.008)*	(0.009)**	(0.009)*	(0.009)**
Additional controls	*House Val. & Own*	*House Val. & Own*	*House Val. & Own*	*House Val. & Own*

Note: All regressions include year dummies; monthly dummies (except for Column 1); SIC92 1-digit sector dummies; and individual controls. See notes to Table 1 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 Colum (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.

On-line appendix table 2: Cumulative house prices gains

	(1) OLS Full Sample	(2) Ind. FE Full Sample	(3) Spell FE Owners Only	(4) Ind. FE + IV Full Sample
Loan-to-value (LTV)	-0.009	-0.018	-0.021	-0.024
of mortgage	(0.012)	(0.009)**	(0.010)**	(0.011)**
Cumulative house price	0.0098	-0.0023	-0.0015	-0.002
gains (× £100,000)	(0.0045)**	(0.0045)	(0.0057)	(0.008)
Homeowner	0.016	0.003		
	(0.009)*	(0.008)		
Kleibergen-Paap First Stage	--	--		*76.33*

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 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. Instrumental variable (IV) regression in Column (4) instruments (i) individual's LTV with national house prices at the moment of purchase interacted with local proxies for the elasticity of housing supply (LA-level percentage of developed land and LA-level refusal rates); and (ii) self-reported house values with cumulative national house prices 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.