The Housing Boom and Selection into Entrepreneurship*

João Galindo da Fonseca† Pierluca Pannella‡

March 11, 2021

Abstract

How does a housing boom affect the selection of individuals that open a firm? To answer this question, we merge MSA-level and individual-level data. First, we find that the early 2000s increase in house prices led to a larger creation of new businesses but also to higher exit rates of these startups. Second, the housing boom had a larger impact on the decision to become an entrepreneur for lower ability house-owners. We derive our results using IQ scores and an indirect measure of ability constructed from individuals' wage history. Our findings are consistent with a collateral financing model of entrepreneurship.

Keywords: Housing Boom, Collateral Finance, Entrepreneurship and Selection
JEL Classification: G3, L26, E23

*We would like to thank Andriana Bellou, Raphael Godefroy, Hugo Jales, Baris Kaymak, Mathieu Marcoux, Filippo Mezzanotti, Gabor Pinter, Cristine Pinto and Vladimir Ponczek for feedback and discussions.

†Université de Montréal and CIREQ. E-mail: ja.galindo.da.fonseca@gmail.com (corresponding author)

‡Sao Paulo School of Economics - FGV. E-mail: pierluca.pannella@fgv.br

1 Introduction

How does a housing price boom impact the selection of individuals into entrepreneurship? Policy makers and academics have long emphasized the importance of collateral and credit constraints for the creation of new firms (Evans and Jovanovic (1989), Holtz-Eakin, Joulfaian and Rosen (1994), Quadrini (2000), Gentry and Hubbard (2004), Cagetti and De Nardi (2006, 2009)). We know that young firms are important for job creation (Haltiwanger, Jarmin and Miranda (2013)), productivity (Clementi and Palazzo (2016) and Alon et al. (2018)), and business cycle fluctuations of employment (Pugsley and Şahin (2019)). Furthermore, ex-ante firm heterogeneity is key for firm outcomes (Pugsley, Sedlacek and Sterk (2021)). However, little is known about how the selection of individuals into entrepreneurship changes once we relax credit constraints and how it affects firm outcomes. The answer to this question is crucial for our understanding of the impact of the collateral channel on firm creation and destruction. In this paper, we investigate whether the housing price boom in the US during the early to mid 2000s had a differential impact on the entry into entrepreneurship among individuals of different abilities.

We start by documenting how the housing price boom affected firm creation and the survival of new firms created at the aggregate level. Consistent with previous literature[1], we find that cities that experienced larger house price increases had a larger share of startups (startup ratio, from hereafter). In addition, we document for the first time that the housing boom is associated with a larger exit rate among this new generation of startups in the same period.

Next, we leverage MSA-year level variation to verify these patterns are not driven by endogeneity concerns. Following Chaney, Sraer and Thesmar (2012), we use the interaction of housing supply elasticities by MSA, constructed in Saiz (2010), interacted with nation-wide long-term interest rates as our instrument for house price growth in a particular MSA (IV, from hereafter). We include dummies for MSAs and years as controls. As a result, our identification relies on how

[1]See Corradin and Popov (2015) and Schmalz, Sraer and Thesmar (2017)

house prices react to interest rate changes across cities of different housing supply elasticities.

Our results indicate that a 10 percentage point rise in house prices increases the startup ratio by 0.1 percentage points and the exit rate by 0.9 percentage points. To contextualize these results, consider that the nation-wide house price index grew 130 percentage points from the first quarter of 2001 to the first quarter of 2007. Given the average startup ratios and exit rates in the data, this implies an increase of 14.2% in startup ratios and 35% in exit rates during this period.

Following these results, we investigate to what extent did the composition of new entrepreneurs change. We use publicly available data from the Panel Study of Income Dynamics (PSID) and restricted access information on the Metropolitan Statistical Area (MSA) of residence of an individual. Using two different empirical strategies and two different measures of ability, we show that rising house prices induce a larger increase in entry rates into entrepreneurship among low ability house owners. To further connect this composition result with the exit patterns, we verify that both our ability measures predict lower exit rates out of entrepreneurship.

Our first empirical strategy uses individual-level home equity data. Our second strategy uses city-level house price indexes (HPI). To address endogeneity due to MSA level shocks, in our first strategy, we include dummies for each MSA-year pair, and in our second strategy, we use our IV for house prices.

Our first measure of ability is based on IQ scores available in the PSID. The advantage of this proxy is that it directly measures cognitive ability; however, it is only available for a limited portion of our sample. To increase power and sample size, we construct an alternative measure. We use the residual individual fixed effect component of a standard wage regression. This residual fixed effect component is estimated using years prior to the house price boom. To gain insight into what this ability measure is capturing, we verify it is positively correlated to our IQ score. One concern is that individuals with a higher wage residual experience larger wage responses following rising house prices. If that were the case, our measure would capture variation in outside options rather than ability. To exclude this explanation, we verify there is no direct and differential effect of house prices on wages. Our results show that a 10 percentage point increase in the house price index (HPI) increases the entry rate into entrepreneurship by 1.33 percentage points, and a one standard deviation increase in the IQ score decreases this effect by 23%.

One concern is that our results might be driven by the housing price boom inducing higher demand in the non-tradeable sector. This could induce higher entry into entrepreneurship among low ability individuals if these tend to operate firms in the non-tradeable sector. We verify this is not the case by excluding non-tradeable industries. Secondly, as a robustness check, we also exclude the creation of businesses in the real estate sector. Thirdly, we might worry that our measure of ability is actually capturing non-housing wealth of an individual. If this is the case, those we call low ability are actually individuals of low wealth. Then, house prices would have a stronger effect on these individuals because they are less wealthy before the housing boom. To guarantee our results are robust to this criticism, we show that our findings continue to hold once we control for wealth.

We investigate the economic mechanism behind these facts by proposing a tractable model of entrepreneurship entry and exit with a role for housing as collateral. Individuals are heterogeneous in their entrepreneurial ability which translates into heterogeneity in their firm productivity and their decision to exit. They choose to open a business if their expected profits are larger than their wage. All entrepreneurs require capital to start a firm. Loans are provided by a risk-neutral financial sector. In equilibrium, the expected return of lending to an entrepreneur equals the return to investing in an exogenous risk-free asset. Higher collateral induces a larger reduction in the financing costs of riskier entrepreneurs since they have a higher probability of repaying the loan with housing. Therefore, the model predicts that a housing boom increases business creation more for low ability house owners. As a result, rising house prices increase firm creation, decrease aggregate productivity and increase firm exit rates. It is important to highlight that our model predictions do not rely on a negative correlation between house prices and ability.

We contribute to the literature on selection into entrepreneurship (Blanchflower and Oswald (1998), Hamilton (2000), Hurst and Pugsley (2011), Poschke (2013, 2019), Galindo da Fonseca (2019), Berube and Galindo da Fonseca (2020)) by showing how a house price boom affects entry across individuals of different ability. Our paper also relates to the literature on how house prices influence firm creation and outcomes (Chaney, Sraer and Thesmar (2012), Adelino, Schoar and Severino (2015), Corradin and Popov (2015) and Bahaj, Foulis and Pinter (2017)). By analyzing how house prices affect the selection into entrepreneurship, we provide a new channel via which house prices affect firm outcomes.

Our paper relates to Pugsley, Sedlacek and Sterk (2021), who point to the importance of ex-ante firm heterogeneity in determining firm outcomes. We focus on a particular source of firm ex-ante heterogeneity, the ex-ante ability of the firm owner.

The paper is organized as follows. Section 2 describes the data being used. Section 3 presents aggregate patterns. Section 4 describes our main specifications, our identification strategies and our two measures of ability. In Section 5, we report our results. Section 6 presents our model. Section 7 concludes.

2 Data Description

In this Section, we describe the datasets used in our empirical analysis. For our analysis at the aggregate-level, we use data from the Business Dynamics Statistics (BDS). Table 1 reports summary statistics. Each observation corresponds to a MSA-year pair. Our empirical analysis uses years from 2001 to 2007. We define the startup ratio as the share of firms that are less than 1 year old. Table 1 shows an average startup ratio of 8.6% in our BDS sample. Row 2 of Table 1 reports statistics for the 2-year frequency exit rate of startups, defined as the share of firms born two years ago that no longer exist this year.

Table 1: Summary Statistics for our Business Dynamics Statistics (BDS) sample

	Mean	Std Deviation	Obs
Share of Startups	0.086	0.019	$1,695$
2-year frequency exit rate of startups	0.353	0.072	$1,695$

Notes: Summary Statistics for our BDS sample used in our regressions. Each observations corresponds to a MSA-year pair. The sample includes years $2001 - 2007$.

In order to study individual-level outcomes, we combine the publicly available variables of the Panel Study of Income Dynamics (PSID) with restricted access information on the MSA of residence of individuals across time. From hereafter, the term MSA and city are used interchangeably. We restrict our attention to household heads with 16 to 65 years old. We include both men and women.

Table 2 presents the summary statistics for the sample used in our individual-level analysis. On average, among all individuals that are not entrepreneurs in the previous period, 6.2% enter entrepreneurship. For our period of interest, data in the PSID is biannual. As a result, our entry rate into entrepreneurship is not directly comparable to studies using annual frequency data.

We define home owners as individuals that own the place of residence in year the 1999. In our data, they represent 58.8% of observations. In our sample, average home equity and non-home equity are respectively $\$52,638.79$ and $\$73,415.39$ (Table 2). Finally, the PSID also contains a measure of cognitive skills (IQ score) that ranges from 0 to 13. The average score in our sample is 9.181.

Table 2: Summary Statistics for our sample in the PSID

	Mean	Std Deviation	Obs
Woman (dummy)	0.321	0.467	$3,568$
Age	41.85	9.54	$3,568$
Home owner in 1999 (dummy)	0.588	0.492	$3,568$
Entry into entrepreneurship (dummy)	0.062	0.241	$3,568$
Log real wages	2.11	0.605	$3,568$
Home Equity	$\$78,289.28$	$\$107,878.3$	$2,099$
Non-home Equity	$\$106,038.3$	$\$356,760$	$2,099$
IQ score	9.181	2.45	$1,003$

Notes: Summary Statistics for our sample of individuals in the PSID used in our main regressions. The sample is restricted to heads of the household between 16 and 65 years of age, years $2001-2007$.

3 Aggregate Patterns

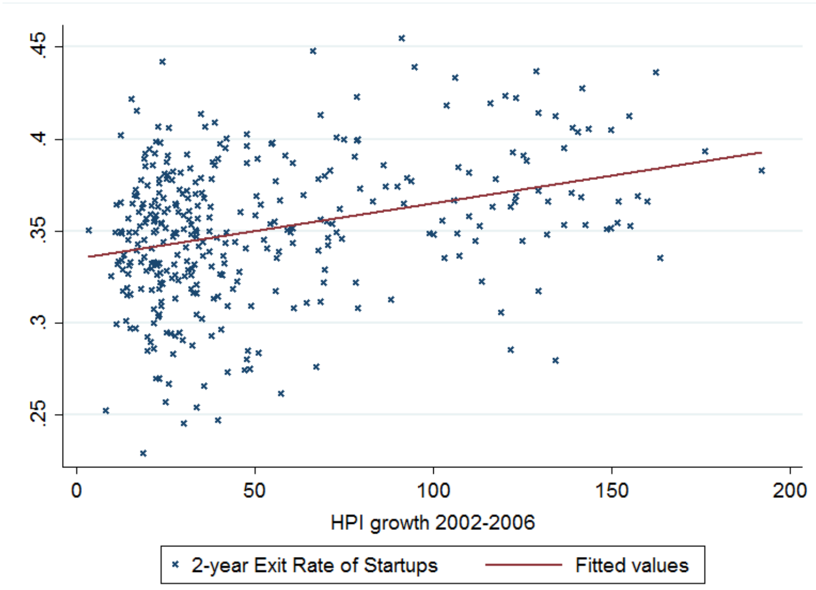
In this section, we describe the aggregate patterns regarding firm entry and exit. The first thing we verify is the relationship between startup ratio and house price growth. To do so, we use aggregate firm data from the Business Dynamics Statistics (BDS). Figure 1 illustrates the positive relationship between MSA level house price growth and the average startup ratio. We see that cities (MSAs) that experience higher house price growth exhibit a larger increase in the startup ratio.

Figure 1: HPI growth plotted against the average startup ratio. Each observation is a Metropolitan Statistical Area (MSA). Startup ratio is defined as the share of firms with less than 1 year old.

Given this pattern, we wonder to what extent these firms created during these house price increases are different than the rest. Figure 2 plots the relationship between MSA-level house price growth and the average exit rate among newly created firms.

We see a positive relationship suggesting larger house price increases are associated with larger exit rates among newly created firms. The patterns above are interesting, but they should not be interpreted as causal relationships. In particu-

Figure 2: HPI growth plotted against the average 2-year frequency exit rate of startups. Each observation is a Metropolitan Statistical Area (MSA).



lar, we are concerned that MSA-specific productivity shocks could bias our results. Positive productivity shocks could induce increasing house prices and larger entry, leading to a spurious correlation between the two. To address this endogeneity concern, we proceed to use an instrumental variable strategy for house prices (HPI).

After confirming these trends with the use of an instrumental strategy, we investigate one potential mechanism that could explain them. The increase in exit rate rates may be driven by a change in the composition of individuals that opened firms, changing firm outcomes. To test this hypothesis, we can use individual-level data from the Panel Study of Income Dynamics (PSID), augmented with restricted access information on MSA of residence.

4 Main Empirical Specifications

In this section, we present our main empirical specifications and identification strategies. The analysis can be divided into MSA-year level specifications, using BDS data and individual-year level specifications, using PSID data.

4.1 MSA-year level specifications

Let $SR_{c,t}$ and $ExitR_{c,t}$ represent the MSA-year startup ratio and exit rate of startups. Our main explanatory variable is $HPI_{c,t}$, the House Price Index in city c and year t. Consider individuals face shocks that may push them to enter or exit entrepreneurship. These shocks could represent the effect of city-specific productivity shocks. Let these be denoted by $\upsilon_{c,t}$. Secondly, consider there is some measurement error, ϵ, in $SR_{c,t}$ and $ExitR_{c,t}$. Then,

$$SR_{c,t} = \beta_{0,1} + \beta_{1,1}HPI_{c,t} + \mathbb{1}_c + \mathbb{1}_t + \upsilon_{c,t,1} + \epsilon_{c,t,1} \tag{1}$$

and

$$ExitR_{c,t} = \beta_{0,2} + \beta_{1,2}HPI_{c,t-2} + \mathbb{1}_c + \mathbb{1}_t + \upsilon_{c,t,2} + \epsilon_{c,t,2}. \tag{2}$$

Equations 1 and 2 represent our main specifications at the MSA-year level. They make clear that for unbiased estimates of the effect of house prices, we need an instrument for $HPI_{c,t}$ uncorrelated to $\upsilon_{c,t}$. We discuss our instrument (IV) strategy in subsection 4.3.

4.2 Individual level specifications

After documenting the positive relationship between entry, exit, and house prices, we are left wondering the possible mechanisms behind these patterns. One possibility is that the composition of individuals that open firms changed with higher house prices.

We expect the entrepreneurial probability of success to be correlated to the innate ability of an individual, μ_i. We think of μ_i as a latent ability variable determining outcomes both in the labor market and as an entrepreneur. Given a measure of ability, we can investigate whether the housing boom differently increased the entry of low or high ability individuals.

Let $Prob(\text{entry})$ denote the probability of entering entrepreneurship. Let $H_{i,c,t}$ be a measure of house prices. We consider two different measures: (1) a MSA-year level house price index, $HPI_{c,t}$, and (2) an individual-level home equity, $H_{i,t}$. Our main objects of interest are the direct effect of $H_{i,c,t}$ on the probability of entry and the interaction between $H_{i,c,t}$ and ability μ_i. The interaction allows us to evaluate the extent to which the effect of $H_{i,c,t}$ on entry changes with ability, μ_i.

As mentioned in the previous subsection, different city-specific productivity shocks, $\upsilon_{c,t}$, could push individuals into entrepreneurship. Secondly, consider there is some measurement error, $\upsilon_{i,t}$, in individual entry decisions in the data. We recognize that entry into entrepreneurship might be a function of individual observable characteristics $X_{i,t}$. Finally, entry into entrepreneurship might be affected by time invariant city characteristics, λ_c, or time effects, λ_t. Hence,

$$Prob(\text{entry})_{i,c,t} = Prob(\beta_0 + \beta_H H_{i,c,t} + \beta_{\mu,H}\mu_i \cdot H_{i,c,t} + \beta_\mu \mu_i + X_{i,c,t}\beta + \lambda_t + \lambda_c + \upsilon_{c,t} + \upsilon_{i,t}).$$

One open question is to what extent does the effect of the housing boom affect renters and home owners or only home owners. To test between these two possibilities, we also consider separate specifications for home owners and renters.

The expressions for the probability of entry among home owners and renters can be written respectively as

$$Prob(\text{entry}|\text{home owner})_{i,c,t} = Prob(\beta_0 + \beta^h_H H_{i,c,t} + \beta^h_{\mu,H}\mu_i \cdot H_{i,c,t} + \beta^h_\mu \mu_i + X_{i,c,t}\beta^h + \lambda^h_t + \lambda^h_c + \upsilon^h_{c,t} + \upsilon^h_{i,t})$$

and

$$Prob(\text{entry}|\text{renter})_{i,c,t} = Prob(\beta_0 + \beta^r_H H_{i,c,t} + \beta^r_{\mu,H}\mu_i \cdot H_{i,c,t} + \beta^r_\mu \mu_i + X_{i,c,t}\beta_r + \lambda^r_t + \lambda^r_c + \upsilon^r_{c,t} + \upsilon^r_{i,t}).$$

If the housing price change has no effect on renters, then we should expect $\beta^r_{\mu,H} = 0$ and $\beta^r_H = 0$. Furthermore, if the effect of housing on entry of home owners is larger among low ability individuals, we expect: $\beta^h_H > 0$ and $\beta^h_{\mu,H} < 0$.

In order to estimate these equations we need two things: (1) an identification strategy that addresses the endogeneity caused by $\upsilon_{c,t}$ and (2) a measure of ability

μ_i. In the next subsection, we describe our identification strategies given a measure for μ_i. In the subsection after, we describe our two measures of ability $\hat{\mu}_i$.

For all empirical specifications, we include as controls a quadratic polynomial in age, a quadratic in totals years of education, dummies for gender, year, metropolitan statistical area, and industries. We exclude from our individual-level analysis entries into entrepreneurship in the non-tradeable sector. This is done since firm creation in this sector may be driven by an increase in aggregate demand.[2][3]

4.3 Identification Strategies

In this section, we describe our identification strategies for a given measure $\hat{\mu}_i$ of latent ability μ_i.

We estimate our specifications at the individual level using two different identification strategies. The first strategy exploits individual level variation in home equity as our housing measure, $H_{i,c,t}$. Such analysis restricts our sample to home owners. Specifically, we estimate the following equation:

$$
\begin{aligned}
Prob(\text{entry}|\text{home owner})_{i,c,t} &= Prob(\beta_0 + \beta^h_H log(\text{home equity})_{i,t} \\
&+ \beta^h_{\mu,H}\hat{\mu}_i \cdot log(\text{home equity})_{i,t} + +\beta^h_{\mu}\hat{\mu}_i + \beta^h_{c,y}\mathbb{1}\{\text{city}X\text{year}\}_{c,t} + X_{i,c,t}\beta_h \\
&+ \upsilon^h_{i,t} > 0). \quad (3)
\end{aligned}
$$

Note that the inclusion of dummies for each MSA-year pair controls for variation in $\upsilon_{c,t}$. As a result we can estimate Equation (3) with simple probit specifications.

Our second strategy uses MSA-year level variation in the house price index, $HPI_{c,t}$. In the absence of city-specific productivity shocks ($\upsilon_{c,t}$), we could estimate

[2] Adelino, Schoar and Severino (2015) follow the same strategy to prove the importance of the collateral channel.

[3] Results continue to hold once we include the non-tradeable sector.

the MSA-year level specifications using a probit. However, the presence of $\upsilon_{c,t}$ in the error term creates a correlation between the error terms with the explanatory variable $HPI_{c,t}$.

To address this issue, we use an instrument for $HPI_{c,t}$. We follow the strategy used by Chaney, Sraer and Thesmar (2012). In order to exploit variation across metropolitan statistical areas and years, we instrument the growth in house prices with housing supply elasticity (e_c) interacted with the 30 year fixed mortgage rate (r_t). While a reduction in interest rate increases the price of houses, this effect is stronger for cities in which the supply of housing is less elastic. It follows that house price growth should be increasing in $e_c \cdot r_t$. Let $IV_{c,t}$ denote our instrument, then it can be written as

$$IV_{c,t} = e_c \cdot r_t. \tag{4}$$

Note that we control for city-specific and time-specific effects. Hence, the main identifying variation comes from the interaction. Specifically, we estimate the following equations:

$$\begin{aligned} Prob(\text{entry}|\text{home owner})_{i,c,t} = {} & Prob(\beta_0 + \beta_H^h HPI_{c,t} + \beta_{\mu,H}^h \hat{\mu}_i \cdot HPI_{c,t} + \beta_\mu^h \hat{\mu}_i \\ & + \mathbb{1}\{\text{year}\}_t^h + \mathbb{1}\{\text{city}\}_c^h + X_{i,c,t}\beta_h + \nu_{i,t}^h > 0) \end{aligned} \tag{5}$$

and

$$\begin{aligned} Prob(\text{entry}|\text{renter})_{i,c,t} = {} & Prob(\beta_0 + \beta_H^r HPI_{c,t} + \beta_{\mu,H}^r \hat{\mu}_i \cdot HPI_{c,t} + \beta_\mu^r \hat{\mu}_i \\ & + \mathbb{1}\{\text{year}\}_t^r + \mathbb{1}\{\text{city}\}_c^r + X_{i,c,t}\beta_r + \nu_{i,t}^r > 0). \end{aligned} \tag{6}$$

where $\mathbb{1}\{\text{year}\}$ are year dummies and $\mathbb{1}\{\text{city}\}$ are MSA dummies.

The error terms are given by

$$\nu_{i,t}^r = \upsilon_{i,t}^r + \upsilon_{c,t} \tag{7}$$

and

$$\nu_{i,t}^h = \upsilon_{i,t}^h + \upsilon_{c,t}. \tag{8}$$

4.4 Measures of Ability

In order to estimate how the house prices changed the ability composition of new entrepreneurs, we must have a measure for μ_i. In this section, we describe our two measures of μ_i. Our first measure comes directly from data on IQ scores available at the PSID. These scores are based on IQ tests available for the first years of the sample. We can use the individuals that took this test and were still in the sample in the 2000s to observe to what extent did the house price boom change the composition of people opening a firm. We denote this measure by IQ_i. Unfortunately, due to the limited number of observations, we are unable to consider separate specifications for home owners and renters and to include dummies for each MSA-year pair. As a result, our specification with individual home equity and IQ scores becomes

$$Prob(\text{entry}|\text{home owner})_{i,c,t} = Prob(\beta_0 + \beta_H^h log(\text{home equity})_{i,t} + \beta_{\mu,H}^h IQ_i \cdot log(\text{home equity})_{i,t} + \beta_\mu^h IQ_i + \mathbb{1}\{\text{year}\}_t^h + \mathbb{1}\{\text{city}\}_c^h + X_{i,c,t}\beta^h + \nu_{i,t}^h > 0). \quad (9)$$

Our empirical specification using IQ_i and the house price index (HPI) is

$$Prob(\text{entry})_{i,c,t} = Prob(\beta_0 + \beta_H HPI_{c,t} + \beta_{IQ,H} IQ_i \cdot HPI_{c,t} + \beta_{IQ} IQ_i + \mathbb{1}\{\text{year}\}_t + \mathbb{1}\{\text{city}\}_c + X_{i,c,t}\beta + \nu_{i,t} > 0). \quad (10)$$

If we want to use IQ_i as a proxy of entrepreneurial ability we need to know whether IQ_i is positively or negatively correlated to entrepreneurial outcomes. To verify the sign of this correlation we analyze the relationship between the exit probability of an entrepreneur and our proxy for ability IQ_i. We estimate the following specification:

$$Prob(\text{exit out of entrepreneurship})_{i,c,t} = Prob(\alpha IQ_i + \Psi_{i,t} > 0) \quad (11)$$

where $\Psi_{i,t}$ represents a luck component. If $\alpha < 0$, then our measure is negatively correlated to exit probability. Table 3 indicates that a high IQ score predicts a lower exit probability.

Table 3: Exit probability

Probability of exiting entrepreneurship		
IQ_i	-0.062^{**}	-0.064^{**}
	(0.031)	(0.030)
State of Residence dummies	Yes	Yes
Year dummies	No	Yes
Observations	323	323

Notes: Regressions of probability of exiting entrepreneurship on IQ score. Standard errors are clustered at the MSA level. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. We use years after 2000.

We construct a second measure of ability and validate it with IQ_i, in order to increase our sample size. We follow a two-step strategy where we first construct a proxy for ability and then use it in our main specifications.[4] Our strategy is to rely on the correlation between wage history and ability. Specifically, we estimate ability as a fixed effect component from wages. This strategy is close to the one followed by Fraga, Gonzaga and Soares (2017).

We assume that wages are a function of observable characteristics $X_{i,t}$ (composed of dummies in industry, gender, year and quadratics in school, and age), time-invariant city-specific characteristics, γ_c, aggregate factors, γ_t, and latent ability μ_i.

Let $\varepsilon_{i,t}$ be measurement error in $w_{i,c,t}$. Then the expression for log wages, $w_{i,c,t}$, is given by

$$w_{i,c,t} = X_{i,t}\beta + \gamma_c + \gamma_t + \mu_i + \varepsilon_{i,t}. \tag{12}$$

[4] All our standard errors are bootstrapped for these specifications.

From Equation (12) we can interpret latent ability, μ_i, as the individual fixed component of wages of each individual. Next, given our assumption that both worker and entrepreneurial outcomes are determined by μ_i we can proxy ability by $\hat{\mu}_i$. To make sure we are not confounding the effect of the housing boom on wage determination, we use only years prior to 2000 to estimate μ_i.

In Table 4 below, we show that $\hat{\mu}_i$ is positively correlated to IQ_i.[5] This is a useful exercise both as a validation of our proxy $\hat{\mu}_i$ and also to get a sense of what it represents.

Table 4: Ability $\hat{\mu}_i$ as a function of IQ_i

IQ_i	0.041^{***}
	(0.012)
Observations	755

Notes: Linear regressions of our ability measure μ_i as a function of IQ score measure available at the PSID.* represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped.

Next, we would like to verify if $\hat{\mu}_i$ predicts lower exit rates. Table 5 shows that the exit rate out of entrepreneurship is negatively correlated to our proxy $\hat{\mu}_i$.[6]

[5] In Table 12 of Section A of the Appendix we investigate if μ_i also captures non-cognitive skills.

[6] We run into small sample problem when considering these exit regressions with more controls.

Table 5: Probability of Exit as a function of ability $\hat{\mu}_{i,c}$

$\hat{\mu}_i$	-0.129^{***}	-0.122^{***}
	(0.035)	(0.039)
State of Residence dummies	Yes	Yes
Year dummies	No	Yes
Observations	814	814

Notes: Probit regressions of the exit rate out of entrepreneurship on our proxy for entrepreneurial ability μ_i. The proxy is obtained as the fixed effect component of individuals wages for all years prior to the years used in exit rate regressions. We use years after 2000. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped.

One concern with our estimation is that larger house prices could increase wages more for high $\hat{\mu}_i$ individuals. Under this alternative scenario, we would wrongly attribute this differential effect to entrepreneurial ability. If this is the case, then house prices, $H_{i,c,t}$, should have an impact on wages, and this effect should vary with $\hat{\mu}_i$ (significant $H_{i,c,t} \cdot \hat{\mu}_i$). From this logic, we construct a placebo test for house owners in which we consider

$$w_{i,c,t} = \gamma_0 + \gamma^h_{\mu,H}\hat{\mu}_i \cdot H_{i,c,t} + \gamma^h_H H_{i,c,t} + \gamma^h_\mu \hat{\mu}_i + X_{i,c,t}\beta_h + \mathbb{1}\{\text{year}\}^h_t + \mathbb{1}\{\text{city}\}^h_c + \varepsilon_{i,t}. \tag{13}$$

Appendix B shows the placebo test holds, $\gamma^h_{\mu,H}$ and γ^h_H are insignificant, for both our main identification strategies. These results are inconsistent with the hypothesis that housing has a significant effect on outside options via wages.

5 Empirical Results

5.1 Results on Startup Ratio and Exit Rate

In this section, we present our results for the MSA-year level analysis. Recall that our instrument for $HPI_{c,t}$ is the interaction between housing supply elasticity and the 30 year fixed mortgage rate. Since we include dummies for MSA and year, we expect $IV_{c,t}$ to predict a higher $HPI_{c,t}$. Column (1) of Table 6 confirms this prediction. Both 2nd stage specifications use the same sample; hence, the first stage is identical for both IV regressions. Columns 2 and 3 report results for our 2nd Stage regressions.

Table 6: IV Regressions - Startup Ratio and Exit Rates as a function of House prices (HPI)

	1st Stage	2nd Stage	2nd Stage
Dependant Variable in 2nd Stage		SR	$ExitR$
$IV_{c,t}$	6.15***	-	-
	(1.03)		
$HPI_{c,t}$	-	0.01*	0.09**
		(0.005)	(0.04)
MSA dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	1695	1695	1695

Notes: IV Regressions of Startup Ratio and Exit Rates on house prices (HPI). HPI is instrumented by the interaction between housing supply elasticity (e_c) and 30 year fixed mortgage rate (r_t) ($IV_{c,t} \equiv e_c r_t$). Standard errors are clustered at the MSA level. Coefficients and standard errors are multiplied by 100 for clarity. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are clustered at the msa level. We use years $2001 - 2007$.

The estimates indicate that a 10 percentage point rise in house prices increases the startup ratio by 0.1 percentage points and the exit rate by 0.9 percentage points. To contextualize these results, consider that the nation-wide house price index grew 130 percentage points from the first quarter of 2001 to the first quarter of 2007. Given the average startup ratios and exit rates in the data, this implies an increase of 14.2% in entry rates and 35% in exit rates during this period.

5.2 Results using the IQ score

In this section, we investigate whether higher house prices change the composition of entrepreneurs, using our first measure of ability, IQ_i. Our main dependent variable is a dummy that identifies the creation of a business. The data from the PSID is biannual during the period we consider ($2001 - 2007$). Table 7 presents the results. Column 1 of Table 7 presents results using our IQ score and individual level home equity. We define home equity as housing wealth minus the value of mortgage debt. Our estimates indicate that higher individual housing wealth predicts a larger probability of entering entrepreneurship. Furthermore, this effect is stronger for lower IQ_i individuals.

Column 2 shows that, consistent with our intuition, the instrument ($IV_{c,t}$) predicts a larger house price index ($HPI_{c,t,}$). Column 3 indicates that a larger house price index (HPI) increases entry into entrepreneurship by more for low IQ score individuals. The results indicate that a 10 percentage point increase in HPI increases the entry rate into entrepreneurship by 1.33 percentage points, and a one standard deviation increase in the IQ score decreases this effect by 23%. Finally, the results also indicate that entry rates into entrepreneurship are increasing in IQ score. It follows that during periods of rising house prices (HPI), entry into entrepreneurship is less correlated to high IQ scores. Our findings are consistent with the hypothesis that higher house prices during the 2000s induced a change in the composition of entrepreneurs towards lower ability individuals.

The results in Table 7 have the limitation of only including individuals that were in the sample when the IQ scores were administrated in 1974. As a result, using the IQ scores forces us to exclude young individuals. In the next two sections, we address this concern by using our second proposed measure of ability $\hat{\mu}_i$. The next section presents results using $\hat{\mu}$ and variation in individual-level home equity. Section 5.4 presents results using our second measure of ability and MSA-level variation in house prices, $HPI_{c,t}$, instrumented by $IV_{c,t}$.

Table 7: Probability of entering entrepreneurship

Housing measure	Individual home equity	$HPI_{c,t}$	$HPI_{c,t}$
		1st Stage	2nd Stage
$log(\text{home equity})_{i,t}$	0.747^{**}	-	-
	(0.304)		
$log(\text{home equity})_{i,t} \cdot IQ_i$	-0.065^{**}	-	-
	(0.029)		
$IV_{c,t}$	-	7.637^{***}	-
		(2.373)	
$HPI_{c,t}$	-	-	0.047^{*}
			(0.024)
$HPI_{c,t} \cdot IQ_i$	-	-	-0.003^{***}
			(0.001)
IQ_i	0.854^{**}	-	0.498^{***}
	(0.396)		(0.238)
MSA dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	1178	1003	1003

Notes: IV Regressions of probability of individual entering entrepreneurship on house price index (HPI) and house price index interacted with IQ score (IQ). HPI is instrumented by the interaction between housing supply elasticity (e_c) and 30 year fixed mortgage rate (r_t) ($IV_{c,t} \equiv e_c r_t$). Other controls include dummies in MSA of residence of the individual, quadratic in age, quadratic in total years of schooling, dummies in industry, dummies in year and a dummy for gender. Regressions includes only housing boom years ($2001 - 2007$). Standard errors are clustered at the MSA level. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are clustered at the msa-level.

5.3 Individual-Level Home Equity Results with $\hat{\mu}$

In this section, we report results using individual-level home equity and $\hat{\mu}_i$ as our measure of ability.[7] To test if the relationship between entry into entrepreneurship and home equity changes with $\hat{\mu}_i$ we estimate Equation (3). Column 1 shows that there is a positive relationship between entry into entrepreneurship and home equity. These findings validate our results from Section 5.1 concerning the startup ratio and house prices. Furthermore, Column 1 indicates that the positive effect of home equity on entry decreases for high ability individuals. Column 2 indicates that the results are unchanged once we control for the log of mortgage values. These results confirm our findings in Section 5.2. The housing boom induced a larger increase in entry into entrepreneurship among low ability home owners.

[7] As in Fraga et al. (2017) we rescale our ability measures within each MSA to have mean zero and standard deviation of one.

Table 8: Individual-Level Home Equity Regressions

Sample considered	Home Owners	Home Owners
$log(\text{home equity})_{i,t}$	3.42^{**}	3.35^{**}
	(1.52)	(1.61)
$\hat{\mu}_i \cdot log(\text{home equity})_{i,t}$	-1.26^{**}	-1.17^{**}
	(0.54)	(0.56)
$\hat{\mu}_i$	16.84^{**}	15.58^{**}
	(7.24)	(7.42)
Controlling for log(mortgage value)	No	Yes
Dummies for each MSA year pair	Yes	Yes
Observations	$1,312$	$1,299$

Notes: Probit regressions of entry into entrepreneurship on ability ($\hat{\mu}_i$), home equity of the individual ($log(\text{home equity})_{i,t}$) and the interaction of home equity and ability ($\hat{\mu}_i \cdot log(\text{home equity})_{i,t}$). Other controls quadratic in age, quadratic in total years of schooling, dummies in industry, dummies in yea, a dummy for gender and dummies for each MSA year pair. Regressions includes only housing boom years (2001 − 2007). House ownership status is based on house ownership status in 1999. Both regressions exclude entrepreneurship entry in the non-tradeable sector. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped and clustered at the MSA level.

5.4 House Price Index Results with $\hat{\mu}$

In this Section, we exploit variation in house prices across MSAs and use $\hat{\mu}_i$ as our measure of ability. In Table 9, we report our results for our Equations (5) and (6). Columns 1 and 3 indicate that our instrument $IV_{c,t}$ is positive and significant. First stages differ across renters and home owners due to a different sample. Column 3 shows that a larger house price index (HPI) produces a significant positive effect on the probability that a house owner opens a business. Column 4 indicates HPI has no effect on the entry probability of renters.

The results indicate that a 10 percentage point increase in house prices is associated with a 1.57 percentage points increase in the entry rate into entrepreneurship for house owners. Furthermore, a 10% increase in $\hat{\mu}_i$ is associated with a drop in the response of entry to house prices by 10%. Despite a different source of variation for identification, the results in this section confirm those in sections 5.2 and 5.3.[8]

Table 9: House Price Index Regressions

Sample	Home Owners	Home Owners	Renters	Renters
	1st Stage	2nd Stage	1st Stage	2nd Stage
$IV_{c,t}$	9.730***		12.131***	
	(2.404)		(2.952)	
$HPI_{c,t}$		0.018**		-0.001
		(0.009)		(0.0121)
$\hat{\mu}_i \cdot HPI_{c,t}$		-0.006**		-0.004
		(0.003)		(0.003)
$\hat{\mu}_i$		1.006**		0.818
		(0.389)		(0.562)
MSA dummies	Yes	Yes		Yes
Year dummies	Yes	Yes		Yes
Observations	2,099	2,099	1,469	1,469

Notes: Probit IV regressions of entry into entrepreneurship on ability ($\hat{\mu}_i$), House price index in the city of residence of the individual ($HPI_{c,t}$) and the interaction of House price and ability ($\hat{\mu}_i \cdot HPI_{c,t}$). HPI is instrumented by the interaction between housing supply elasticity (e_c) and 30 year fixed mortgage rate (r_t) ($IV_{c,t} \equiv e_c r_t$). Other controls include dummies in MSA of residence of the individual, quadratic in age, quadratic in total years of schooling, dummies in industry, dummies in year and a dummy for gender. Regressions includes only housing boom years ($2001 - 2007$). Regressions are run separately for house owners and renters. House ownership status is based on house ownership status in 1999. Both regressions exclude entrepreneurship entry in the non-tradeable sector. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped and clustered at the MSA level.

One alternative explanation for our main results is that our ability measure is highly correlated with individual wealth. In that case, we may wonder whether the housing boom simply helped individuals that started with lower wealth. In Table 10, we show that our results for home owners persist when we control for initial

[8]Our results are robust to including the non-tradeable sector (See Table C of the Appendix).

housing and non-housing wealth.

Table 10: Robustness : Controlling for initial wealth

$HPI_{c,t}$	0.02^{**}	0.053^{**}	0.022^{**}	0.036^{*}
	(0.01)	(0.025)	(0.011)	(0.021)
$\hat{\mu}_i \cdot HPI_{c,t}$	-0.007^{**}	-0.005^{*}	-0.005^{**}	-0.005^{*}
	(0.003)	(0.003)	(0.0024)	(0.003)
$\hat{\mu}_i$	1.051^{**}	0.859^{**}	0.883^{**}	0.769^{*}
	(0.422)	(0.43)	(0.366)	(0.415)
MSA dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Significance IV for $HPI_{c,t}$	Yes	Yes	Yes	Yes
Control for hw_{1999}	Yes	Yes	No	No
Control for $hw_{1999} \cdot HPI_{c,t}$	No	Yes	No	No
Control for nhw_{1999}	No	No	Yes	Yes
Control for $nhw_{1999} \cdot HPI_{c,t}$	No	No	No	Yes
Observations	$1,931$	$1,931$	$1,698$	$1,698$

Notes: Probit IV regressions of entry into entrepreneurship on ability ($\hat{\mu}_i$), House price growth in the city of residence of the individual ($HPI_{c,t}$) and the interaction of House price growth and ability ($\hat{\mu}_i \cdot HPI_{c,t}$). hw_{1999} is 1999 level of real housing wealth and nhw_{1999} is 1999 level of real non-housing wealth. Other controls include dummies in MSA of residence of the individual, quadratic in age, quadratic in total years of schooling, dummies in industry, dummies in year and a dummy for gender. Regressions includes only housing boom years ($2001-2007$). Regressions are run only for house owners. All regressions exclude entrepreneurship entry in the non-tradeable sector. House ownership status is based on house ownership status in 1999.* represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped and clustered at the MSA level.

In Column 1 we control for initial housing wealth, hw_{1999}. In Column 2 we also include the interaction between initial housing wealth and house prices. In Column 3 we control for non-housing wealth, nhw_{1999}. In Column 4 we also include the interaction between initial non-housing wealth and house prices. Our results are unchanged in both magnitude and significance.

Table 11: Robustness : Excluding entries in real estate

$HPI_{c,t}$	0.02^{**}	0.051^{**}	0.03
	(0.094)	(0.024)	(0.02)
$\hat{\mu}_i \cdot HPI_{c,t}$	-0.005^{**}	-0.005^{*}	-0.005^{*}
	(0.002)	(0.003)	(0.003)
$\hat{\mu}_i$	0.967^{**}	0.847^{**}	0.805^{**}
	(0.373)	(0.419)	(0.39)
MSA dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Significance IV for $HPI_{c,t}$	Yes	Yes	Yes
Control for hw_{1999}	No	Yes	No
Control for $hw_{1999} \cdot HPI_{c,t}$	No	Yes	No
Control for nhw_{1999}	No	No	Yes
Control for $nhw_{1999} \cdot HPI_{c,t}$	No	No	Yes
Observations	$2,099$	$1,931$	$1,698$

Notes: Probit IV regressions of entry into entrepreneurship on ability ($\hat{\mu}_i$), House price growth in the city of residence of the individual ($HPI_{c,t}$) and the interaction of House price growth and ability ($\hat{\mu}_i \cdot HPI_{c,t}$), assigning as 0 any entry into real estate. hw_{1999} is 1999 level of real housing wealth and nhw_{1999} is 1999 level of real non-housing wealth. Other controls include dummies in MSA of residence of the individual, quadratic in age, quadratic in total years of schooling, dummies in industry, dummies in year and a dummy for gender. Regressions includes only housing boom years ($2001 - 2007$). Regressions are run only for house owners. All regressions exclude entrepreneurship entry in the non-tradeable and real estate sectors. House ownership status is based on house ownership status in 1999.* represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped and clustered at the MSA level.

A second concern is that results are being driven by entry into the real estate sector. If we expect low ability individuals to self-select into real estate relative to other industries, this can potentially bias our results. To address this concern, Table 11 shows our results are robust to assigning as non-entry any entry into entrepreneurship in the real estate sector. Our main findings are validated in all these alternative specifications.

5.5 Concluding Remarks

Previous papers have shown the importance of collateral financing on the decision to open a firm. Our analysis confirms these previous findings. In addition, a housing boom alters the selection of individuals that open a business favoring people with lower ability. This channel is one of the possible factors behind the increase in firms' exit rates that started before the burst of the 2008 financial crisis.

In the next section, we present a model of entry and exit into entrepreneurship to rationalize our findings.

6 Model

In this section, we propose a tractable framework capable of delivering the empirical patterns discussed in the previous Sections.

Individuals differ in entrepreneurial ability a and housing wealth H. The model is composed of two periods. In the first period, the individual decides whether or not to enter entrepreneurship. The outside option to opening a firm is receiving wage w. In order to open a firm, an individual needs to borrow one unit of financing from the banking sector.

Upon entering, the second component of firm productivity, z, is realized. Firm production is given by $y = e^{z+a}n^{\alpha}$ where n is the firm's number of employees. Productivity z is drawn from an exponential distribution of shape β. At the end of the first period, individuals with enough profits pay off the interest rate, r. If they do not have enough profits, the banking sector takes a fraction of their housing wealth to fully pay for the interest rate. If profits and housing wealth are not enough to pay the interest rate, the banking sector recovers the maximum amount of housing wealth possible: ϕH, where $1 > \phi > 0$. In the second period, individuals decide whether to exit or not. If they exit, they receive wage w.

The banking sector has the outside option of investing in a risk free asset with return $\overline{r}$. In equilibrium, the banking sector is indifferent between lending to any given entrepreneur or investing in the safe asset.

Consistent with the empirical section, our focus in this section is on startups and the process of firm creation. In this context, the firms modeled here are unlikely to contribute to general equilibrium effects. Secondly, recall that our empirical results were robust to including control for each msa and year pair. With this in mind, we take wages w as given.[9]

6.1 Profit Maximization

Conditional on firm survival, at each period, business owners maximize their profits. The static profit maximization problem for a firm is

$$\pi(z) = \max_{n} e^{z+a} n^{\alpha} - wn \tag{14}$$

where w is the wage. The firm problem above implies

$$\pi(z) = (1-\alpha)(\frac{\alpha}{w})^{\frac{\alpha}{1-\alpha}} e^{\frac{z+a}{1-\alpha}} \tag{15}$$

For integrals to be well defined, we consider $\beta > \frac{1}{1-\alpha}$.

6.2 Optimal decision to exit

Conditional on entering, in the second period, the entrepreneur makes the optimal decision to exit or not. This decision is after payment of the loan and with full knowledge of z. It follows that the entrepreneur optimal exit decision is characterized by a threshold $\underline{z}_{\text{exit}}$ such that they exit if $z > \underline{z}_{\text{exit}}$ and $\underline{z}_{\text{exit}}$ is defined by

$$\pi(\underline{z}_{\text{exit}}) = w. \tag{16}$$

Solving for $\underline{z}_{\text{exit}}$ gives

$$\underline{z}_{\text{exit}} = -a + (1-\alpha) log((\frac{w}{1-\alpha})(\frac{w}{\alpha})^{\frac{\alpha}{1-\alpha}}). \tag{17}$$

[9]In order to have a positive well defined exit rate we consider $log(w) > 1 - (\alpha log(\alpha) + (1-\alpha) log(1-\alpha))$.

Next, Lemma 1 below states that the probability of exit is decreasing with ability a and does not change with r. The proofs for all Lemmas and Theorems are found in the Appendix.

Lemma 1. *Let* p *be the probability an entrepreneur chooses to exit. Then,*

$$p = Prob(z \leq \underline{z}_{exit}), \tag{18}$$

$$\frac{\partial p}{\partial a} < 0 \quad \textit{and} \quad \frac{\partial p}{\partial r} = 0. \tag{19}$$

6.3 Optimal decision to enter

In the first period, entrepreneurs know that as long as profits, $\pi(z)$, are higher than the interest rate r charged by the banking sector, their income is $\pi(z) - r$. Define $\overline{z}$ as the level of z such that $\pi(\overline{z}) = r$, then,

$$\overline{z} = -a + (1-\alpha)log((\frac{r}{1-\alpha})(\frac{w}{\alpha})^{\frac{\alpha}{1-\alpha}}). \tag{20}$$

For $z < \overline{z}$, individuals lose all their profits to pay for the interest rate. It follows that the sum of discounted expected profits of an entrepreneur conditional on entry is given by

$$\int_{\overline{z}} (\pi(z) - r) f(z) dz + \rho \int_{\underline{z}_{exit}} \pi(z) f(z) dz + \rho \int^{\underline{z}_{exit}} w f(z) dz, \tag{21}$$

where ρ is the discount factor. It follows that an entrepreneur of ability a and housing wealth H enters entrepreneurship if

$$\int_{\overline{z}} (\pi(z) - r) f(z) dz + \rho \int_{\underline{z}_{exit}} \pi(z) f(z) dz + \rho \int^{\underline{z}_{exit}} w f(z) dz > w + \rho w. \tag{22}$$

So far, we have not discussed the role of housing wealth H. As we shall see, the impact of H on individual decision making arises due to its impact on the interest rate charged by the bank r.

6.4 Banking Sector

The banking sector always has the option of investing in a risk-free asset with return $\overline{r}$. Now define $\underline{z}_{\text{bank}}$ as the minimum value of z such that the entrepreneur pays r in its entirety. Therefore, it is the value that satisfies $\pi(\underline{z}_{\text{bank}}) + \phi H = r$. Then,

$$\underline{z}_{\text{bank}} = -a + (1-\alpha)log((\frac{r-\phi H}{1-\alpha})(\frac{w}{\alpha})^{\frac{1}{1-\alpha}}). \tag{23}$$

It follows that the expected return of lending to an entrepreneur of ability a and housing wealth H at interest rate r is given by

$$\int_{\underline{z}_{\text{bank}}} rf(z)dz + \int^{\underline{z}_{\text{bank}}} (\phi H + \pi(z))f(z)dz. \tag{24}$$

In equilibrium, the banking sector is indifferent between lending to any entrepreneur and investing in the safe asset. As a result, for all a, H,

$$\overline{r} = \int_{\underline{z}_{\text{bank}}} rf(z)dz + \int^{\underline{z}_{\text{bank}}} (\phi H + \pi(z))f(z)dz, \quad \text{if } r \geq \overline{r} \tag{25}$$

otherwise,

$$r = \overline{r}. \tag{26}$$

The indifference condition for the bank defines an entrepreneur-specific interest rate r that depends on both ability a and housing wealth H. Next, in order to analyze how entry changes with housing wealth H we must verify how it affects r. Lemma 2 below states that interest rate r is decreasing in H, and this decrease is smaller for high ability a. Finally, it also states that interest rate r is decreasing in a.

Lemma 2.

$$\frac{\partial r}{\partial H} < 0, \frac{\partial^2 r}{\partial H \partial a} > 0 \quad \textit{and} \quad \frac{\partial r}{\partial a} < 0. \tag{27}$$

Intuitively, the interest rate of those individuals with higher probability of obtaining low profits is more sensitive to housing values.

6.5 Impact of Housing Wealth on Entry

We are now ready to analyze how an increase in housing wealth affects the decision of an individual to open a firm and their ex-post firm outcomes. Theorem 1 below states that entry increases in housing and that the increase is lower for high ability individuals.

Theorem 1. *Define*

$$L = \int_{\overline{z}} (\pi(z) - r) f(z) dz + \rho \int_{\underline{z}_{exit}} \pi(z) f(z) dz + \int^{z_{exit}} w f(z) dz \tag{28}$$

Then,

$$\frac{\partial L}{\partial H} > 0, \frac{\partial^2 L}{\partial H \partial a} < 0 \quad \textit{and} \quad \frac{\partial L}{\partial a} > 0. \tag{29}$$

It follows that the probability of entering into entrepreneurship is increasing in H, and the increase is smaller for high ability, a, individuals.

Theorem 1 is the theoretical counterpart to our main empirical results concerning the differential effect of housing on entry based on ability. Since the interest rate decreases more for a lower a, low ability individuals experience a higher increase in entry.

Let $\underline{a}(H)$ be the ability level that makes the individual with housing wealth H indifferent between opening a firm or not. Lemma 3 below states that an increases in housing wealth decreases $\underline{a}$.

Lemma 3. *The entry decision of an individual with housing wealth H is characterized by a threshold rule $\underline{a}(H)$ such that the individual enters if $a > \underline{a}(H)$. The threshold is characterized by*

$$\frac{\partial \underline{a}(H)}{\partial H} < 0. \tag{30}$$

Next, we can verify whether a larger housing boom increases exit rates like what we observe in the data. Theorem 2 below shows that it does.

Theorem 2. *Let Q denote the aggregate exit probability of firms in the economy. Then,*

$$\frac{\partial Q}{\partial H} > 0. \tag{31}$$

Finally, Theorem 3 below indicates that both average productivity $E[\varphi]$ and aggregate productivity Φ decrease with higher H.

Theorem 3. *Let Φ denote aggregate productivity and $E[\varphi]$ denote average productivity, then*

$$\frac{\partial \Phi}{\partial H} < 0 \quad \textit{and} \quad \frac{\partial E[\varphi]}{\partial H} < 0. \tag{32}$$

We conclude that while rising house prices increase firm creation, it does so by worsening aggregate productivity and increasing exit among new firms.

6.6 An Alternative Model with Positive Selection

We have seen our model is able to reproduce the empirical results from the previous sections. A housing boom increases the creation of new firms. However, it also increases their exit rate by reducing average ability of new entrepreneurs. In this section, we show that the way financial constraints are modeled is relevant to obtain this outcome. We present as an example an alternative stylized model in which higher housing prices may actually improve the selection of individuals into entrepreneurship. Let us keep the same production function for entrepreneurs, but assume that an individual of ability a must pay a fixed cost $K(a) = \kappa a$, where $\kappa > 0$. The fixed cost must be financed by banks, so the total expected profits of an entrepreneur are

$$\pi = e^{z+a} n^{\alpha} - wn - r\kappa a = (1-\alpha)(\frac{\alpha}{w})^{\frac{\alpha}{1-\alpha}} e^{\frac{z}{1-\alpha}} e^{\frac{a}{1-\alpha}} - r\kappa a. \tag{33}$$

With respect to our previous model, we assume that the interest rate r is fixed, but the quantity to be borrowed is limited by a housing collateral constraint of the form:

$$r\kappa a \leq \phi H. \tag{34}$$

Therefore, an individual would enter entrepreneurship if both (34) and the following entry condition are respected:

$$\int \pi(z) f(z) dz + \rho \int_{\underline{z}_{exit}} \pi(z) f(z) dz + \rho \int^{\underline{z}_{exit}} w f(z) dz \geq w + \rho w. \tag{35}$$

Note that for a given H, the collateral constraint now imposes that only those individuals with a lower a are able to get financing to open a firm. At the same time, higher ability individuals expect larger profits and have a lower chance of exiting. In such an environment, an increase in housing prices would help high ability individuals to become entrepreneurs and increase the quality of new businesses.

7 Conclusion

The role of financial frictions as a barrier to firm entry has been emphasized in both theoretical and empirical work. In particular, recent papers have revealed the positive effect of an increase in house prices on the creation of new firms. This has been widely interpreted as evidence for the existence of a collateral channel. However, these papers have usually neglected the effect that a change in the collateral value can produce on the selection of new entrepreneurs.

In this paper, we analyze the effect of the US housing boom of the early 2000s on the selection of individuals that entered entrepreneurship. In line with the existing evidence, we find that house owners are positively affected by the change in prices in the decision to open a firm. In order to explore how this effect differs across individuals, we use two alternative ability measures. We provide evidence that the positive incentive to create a firm was higher for individuals with lower ability.

This result is easily explained in a model of collateral financing. An increase in the value of housing wealth is more important for individuals that have a lower probability of success. These individuals face a higher probability of having to repay their debt with collateral. Our analysis reveals one possible channel explaining the increase in exit rates during the boom in housing prices.

References

Adelino, Manuel, Antoinette Schoar, and Felipe Severino, "House prices, collateral, and self-employment," *Journal of Financial Economics*, 2015, *117* (2), 288–306.

Alon, Titan, David Berger, Robert Dent, and Benjamin Pugsley, "Older and slower: The startup deficit's lasting effects on aggregate productivity growth," *Journal of Monetary Economics*, 2018, *93*, 68–85.

Bahaj, Saleem, Angus Foulis, and Gabor Pinter, "Home Values and Firm Behaviour," 2017.

Berube, Charles and Joao Galindo da Fonseca, "Spouses, Children and Entrepreneurship," *Working Paper*, 2020.

Blanchflower, David G and Andrew J Oswald, "What makes an entrepreneur?," *Journal of Labor Economics*, 1998, *16* (1).

Cagetti, Marco and Mariacristina De Nardi, "Entrepreneurship, frictions, and wealth," *Journal of political Economy*, 2006, *114* (5), 835–870.

_ **and** _ , "Estate taxation, entrepreneurship, and wealth," *American Economic Review*, 2009, *99* (1), 85–111.

Chaney, Thomas, David Sraer, and David Thesmar, "The collateral channel: How real estate shocks affect corporate investment," *American Economic Review*, 2012, *102* (6), 2381–2409.

Clementi, Gian Luca and Berardino Palazzo, "Entry, exit, firm dynamics, and aggregate fluctuations," *American Economic Journal: Macroeconomics*, 2016, *8* (3), 1–41.

Corradin, Stefano and Alexander Popov, "House prices, home equity borrowing, and entrepreneurship," *The Review of Financial Studies*, 2015, *28* (8), 2399–2428.

Evans, David S and Boyan Jovanovic, "An estimated model of entrepreneurial choice under liquidity constraints," *Journal of Political Economy*, 1989, pp. 808–827.

Fraga, Eduardo, Gustavo Gonzaga, and Rodrigo R Soares, "Selection on Ability and the Early Career Growth in the Gender Wage Gap," 2017.

Galindo da Fonseca, Joao, "Unemployment, entrepreneurship and firm outcomes," *Working Paper*, 2019.

Gentry, William M and R Glenn Hubbard, """ Success Taxes," Entrepreneurial Entry, and Innovation," Technical Report, National Bureau of Economic Research 2004.

Haltiwanger, John, Ron S Jarmin, and Javier Miranda, "Who creates jobs? Small versus large versus young," *Review of Economics and Statistics*, 2013, *95* (2), 347–361.

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

Holtz-Eakin, Douglas, David Joulfaian, and Harvey S Rosen, "Sticking it Out: Entrepreneurial Survival and Liquidity Constraints," *Journal of Political Economy*, 1994, pp. 53–75.

Hurst, Erik and Benjamin Wild Pugsley, "What do small businesses do?," Technical Report, National Bureau of Economic Research 2011.

Poschke, Markus, "Who becomes an entrepreneur? Labor market prospects and occupational choice," *Journal of Economic Dynamics and Control*, 2013, *37* (3), 693–710.

_ , "Wage employment, unemployment and self-employment across countries," 2019.

Pugsley, Benjamin W, Petr Sedlacek, and Vincent Sterk, "The nature of firm growth," *American Economic Review*, 2021, *111* (2), 547–79.

Pugsley, Benjamin Wild and Ayşegül Şahin, "Grown-up business cycles," *The Review of Financial Studies*, 2019, *32* (3), 1102–1147.

Quadrini, Vincenzo, "Entrepreneurship, saving, and social mobility," *Review of Economic Dynamics*, 2000, *3* (1), 1–40.

Saiz, Albert, "The geographic determinants of housing supply," *The Quarterly Journal of Economics*, 2010, *125* (3), 1253–1296.

Schmalz, Martin C, David A Sraer, and David Thesmar, "Housing collateral and entrepreneurship," *The Journal of Finance*, 2017, *72* (1), 99–132.

A Relationship μ_i and non-cognitive skills

In this section we investigate whether our measure of ability μ_i also captures non-cognitive skills.

Table 12: Ability $\hat{\mu}_i$ as a function of cognitive and non-cognitive measures

Locus of Control	0.136^{**}	-	-
	(0.062)		
Values challenge	-	0.137^{**}	-
		(0.059)	
Achievement-Motivation Index	-	-	0.022^{**}
			(0.010)
Observations	822	737	755

Notes: Linear regressions of our ability measure as a function of cognitive and non cognitive measures available at the PSID. Locus of control is a dummy taking value 1 if the individual reports believing they have control over their own life. Values challenge is a dummy taking value 1 if the individual reports liking challenges in life. Achievement-Motivation Index is an index measuring if the individual is highely motivated/high achiever in life. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped.

B Placebo test for 2nd measure of ability, μ_i

In this section, we verify whether house prices had a differential effect on wages of lower ability individuals. If our measure of ability μ_i is note correlated to changes in outside options, then we should expect no effect of housing on wages.

Table 13: Placebo tests : House Price Index ($H_{c,t}$) Regressions

Dependant Variable	$w_{i,c,t}$	
$H_{c,t}$	-0.002	-0.002
	(0.004)	(0.004)
$\hat{\mu}_i \cdot H_{c,t}$	$-$	0.001
		(0.003)
$\hat{\mu}_i$	0.426^{***}	0.275
	(0.003)	(0.517)
MSA dummies	Yes	Yes
Year dummies	Yes	Yes
Significance IV for $HPI_{c,t}$	Yes	Yes
Significance $\hat{\mu}_i \cdot IV$ for $\hat{\mu}_i \cdot HPI_{c,t}$	-	Yes
Observations	$1,847$	$1,847$

Notes: Iv regressions of log real wages on ability ($\hat{\mu}_i$), House price index $H_{c,t}$ and the interaction of house price index and ability ($\hat{\mu}_i \cdot H_{c,t}$). $HPI_{c,t}$ is instrumented by the interaction between housing supply elasticity (e_c) and 30 year fixed mortgage rate (r_t) ($IV_{c,t} \equiv e_c r_t$). Other controls include dummies in MSA of residence of the individual, quadratic in age, quadratic in total years of schooling, dummies in industry, dummies in yea, a dummy for gender. Regressions includes only housing boom years ($2001 - 2007$). House ownership status is based on house ownership status in 1999. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped and clustered at the MSA level.

This corresponds to coefficients for housing ($H_{c,t}$ or $log(\text{home equity})_{i,t}$) and for the interaction of housing and ability ($\hat{\mu}_i \cdot H_{c,t}$ or $\hat{\mu}_i \cdot log(\text{home equity})_{i,t}$) being insignificant.

Table 14: Placebo tests : Individual-Level Home Equity Regressions

Dependant Variable	$w_{i,c,t}$	
$log(\text{home equity})_{i,t}$	0.686	0.415
	(0.61)	(0.667)
$\hat{\mu}_i \cdot log(\text{home equity})_{i,t}$	–	0.533
		(0.532)
$\hat{\mu}_i$	0.454^{***}	-6.641
	(0.032)	(7.089)
Dummies for each MSA year pair	Yes	Yes
Observations	1,595	1,595

Notes: IV regressions of log of real wages on ability ($\hat{\mu}_i$), home equity of the individual ($log(\text{home equity})_{i,t}$) and the interaction of home equity and ability ($\hat{\mu}_i \cdot log(\text{home equity})_{i,t}$). Other controls include dummies in MSA of residence of the individual, quadratic in age, quadratic in total years of schooling, dummies in industry, dummies in yea, a dummy for gender and dummies for each MSA year pair. Regressions includes only housing boom years ($2001-2007$). House ownership status is based on house ownership status in 1999.* represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped and clustered at the MSA level.

C Results including entries into non-tradeable sector

Table 15: Main specifications

Sample considered	Home Owners	Renters
$HPI_{c,t}$	0.019^{**}	-0.01
	(0.009)	(0.012)
$\hat{\mu}_i \cdot HPI_{c,t}$	-0.004^{*}	-0.004
	(0.002)	(0.003)
$\hat{\mu}_i$	0.757^{**}	0.879^{*}
	(0.385)	(0.531)
MSA dummies	Yes	Yes
Year dummies	Yes	Yes
Significance IV for $HPI_{c,t}$	Yes	Yes
Significance IV for $\hat{\mu}_i \cdot HPI_{c,t}$	Yes	Yes
Observations	$2,140$	$1,534$

Notes: Probit IV regressions of entry into entrepreneurship on ability ($\hat{\mu}_i$), House price index in the city of residence of the individual ($HPI_{c,t}$) and the interaction of House price and ability ($\hat{\mu}_i \cdot HPI_{c,t}$) including entries into non-tradeable sector. Other controls include dummies in MSA of residence of the individual, quadratic in age, quadratic in total years of schooling, dummies in industry, dummies in year and a dummy for gender. Regressions includes only housing boom years ($2001-2007$). Regressions are run separately for house owners and renters. House ownership status is based on house ownership status in 1999. Both regressions exclude entrepreneurship entry in the non-tradeable sector. * represents 10% significance, ** represents 5% significance and *** represents 1% significance. Standard errors are bootstrapped and clustered at the MSA level.

D Proofs

In this section, we present the proofs to the lemmas and theorems in the model section.

Proof of Lemma 1.

Given our assumption of $F(z)$ being exponential of shape β, then,

$$p = Prob(z \leq \underline{z}_{\text{exit}}) = 1 - e^{-\beta \underline{z}_{\text{exit}}}. \tag{36}$$

Differentiating gives

$$\frac{\partial p}{\partial a} = -\beta e^{-\beta \underline{z}_{\text{exit}}} < 0 \quad \text{and} \quad \frac{\partial p}{\partial r} = 0 \tag{37}$$

where the last term follows from

$$\frac{\partial \underline{z}_{\text{exit}}}{\partial r} = 0. \tag{38}$$

Proof of Lemma 2.

Consider the derivative of the interest rate r with respect to housing wealth. Differentiating the indifference condition for the banking sector with respect to r and H and reorganizing we get

$$\frac{\partial r}{\partial H} = -\frac{\phi F(\underline{z}_{\text{bank}})}{1 - F(\underline{z}_{\text{bank}})} < 0. \tag{39}$$

Next, we totally differentiate the indifference condition for the banking sector with respect to r and a to get

$$\frac{\partial r}{\partial a} = -\frac{\int^{\underline{z}_{\text{bank}}} \frac{\partial \pi(z)}{\partial a} f(z) dz}{1 - F(\underline{z}_{\text{bank}})} < 0. \tag{40}$$

Now using 39 and differentiating gives

$$\frac{\partial^2 r}{\partial H \partial a} = -\frac{\phi f(\underline{z}_{\text{bank}})}{(1 - F(\underline{z}_{\text{bank}}))^2} \frac{\partial \underline{z}_{\text{bank}}}{\partial a} - \frac{\phi f(\underline{z}_{\text{bank}})}{(1 - F(\underline{z}_{\text{bank}}))^2} \frac{\partial \underline{z}_{\text{bank}}}{\partial r} \frac{\partial r}{\partial a} > 0. \tag{41}$$

For the result above, we used the fact that

$$\frac{\partial \underline{z}_{\text{bank}}}{\partial a} < 0, \frac{\partial \underline{z}_{\text{bank}}}{\partial r} > 0 \quad \text{and} \quad \frac{\partial r}{\partial a} > 0. \tag{42}$$

Proof of Theorem 1. Using the definition of L and differentiating, we obtain

$$\frac{\partial L}{\partial H} = -\frac{\partial r}{\partial H}\int_{\overline{z}} f(z)dz + (\pi(\overline{z}) - r)f(\overline{z})\frac{\partial \overline{z}}{\partial r}\frac{\partial r}{\partial H} = -\frac{\partial r}{\partial H}\int_{\overline{z}} f(z)dz > 0. \quad (43)$$

The last equality follows from the definition of $\overline{z}$: $\pi(\overline{z}) = r$. Now take the derivative of $\frac{\partial L}{\partial H}$ with respect to a to obtain

$$-\frac{\partial^2 r}{\partial H \partial a}\int_{\overline{z}} -\frac{\partial r}{\partial H}(-f(\overline{z}))\frac{\partial \overline{z}}{\partial a} - \frac{\partial r}{\partial H}(-f(\overline{z}))\frac{\partial \overline{z}}{\partial r}\frac{\partial r}{\partial a}. \quad (44)$$

Then, writing the terms explicitly:

$$-\frac{\phi f(\underline{z}_{\text{bank}})}{(1-F(\underline{z}_{\text{bank}}))^2}(1-F(\overline{z})) + \frac{\phi f(\underline{z}_{\text{bank}})}{(1-F(\underline{z}_{\text{bank}}))^2}\frac{\partial \underline{z}_{\text{bank}}}{\partial r}\frac{\partial r}{\partial a}(1-F(\overline{z}))$$
$$+\frac{f(\overline{z})\phi F(\underline{z}_{\text{bank}})}{(1-F(\underline{z}_{\text{bank}}))} - \frac{(1-\alpha)\phi F(\underline{z}_{\text{bank}})f(\overline{z})}{r(1-F(\underline{z}_{\text{bank}}))}\frac{\partial r}{\partial a}$$

$$= -\frac{\phi f(\underline{z}_{\text{bank}})(1-F(\overline{z}))}{(1-F(\underline{z}_{\text{bank}}))^2} + \frac{\partial r}{\partial a}\Big(\frac{\phi f(\underline{z}_{\text{bank}})(1-\alpha)(1-F(\overline{z}))}{(1-F(\underline{z}_{\text{bank}}))^2(r-\phi H)}$$
$$-\frac{(1-\alpha)\phi F(\underline{z}_{\text{bank}})f(\overline{z})}{r(1-F(\underline{z}_{\text{bank}}))}\Big) + \frac{f(\overline{z})\phi F(\underline{z}_{\text{bank}})}{(1-F(\underline{z}_{\text{bank}}))}. \quad (45)$$

Given $\frac{\partial r}{\partial a} < 0$, to get

$$\frac{\partial r}{\partial a}\Big(\frac{\phi f(\underline{z}_{\text{bank}})(1-\alpha)(1-F(\overline{z}))}{(1-F(\underline{z}_{\text{bank}}))^2(r-\phi H)} - \frac{(1-\alpha)\phi F(\underline{z}_{\text{bank}})f(\overline{z})}{r(1-F(\underline{z}_{\text{bank}}))}\Big) < 0, \quad (46)$$

we need

$$\frac{\phi f(\underline{z}_{\text{bank}})(1-\alpha)(1-F(\overline{z}))}{(1-F(\underline{z}_{\text{bank}}))^2(r-\phi H)} - \frac{(1-\alpha)\phi F(\underline{z}_{\text{bank}})f(\overline{z})}{r(1-F(\underline{z}_{\text{bank}}))} > 0. \quad (47)$$

which is true if

$$\frac{f(\underline{z}_{\text{bank}})(1-F(\overline{z}))}{(r-\phi H)(1-F(\underline{z}_{\text{bank}}))} > \frac{F(\underline{z}_{\text{bank}})f(\overline{z})}{r} \quad (48)$$

Now using the fact that F is exponential of shape β. The above condition becomes

$$\frac{r}{r-\phi H}e^{-\beta \underline{z}_{\text{bank}}}e^{-\beta \overline{z}} > e^{-\beta \underline{z}_{\text{bank}}}e^{-\beta \overline{z}}(1-e^{-\beta \underline{z}_{\text{bank}}}) \tag{49}$$

which implies

$$\frac{r}{r-\phi H} > 1 > 1-e^{-\beta \underline{z}_{\text{bank}}}. \tag{50}$$

Hence, as long as $H > 0$,

$$\frac{\partial r}{\partial a}\Big(\frac{\phi f(\underline{z}_{\text{bank}})(1-\alpha)(1-F(\overline{z}))}{(1-F(\underline{z}_{\text{bank}}))^2(r-\phi H)} - \frac{(1-\alpha)\phi F(\underline{z}_{\text{bank}})f(\overline{z})}{r(1-F(\underline{z}_{\text{bank}}))}\Big) < 0. \tag{51}$$

Now to finish the proof all we need is

$$-\frac{\phi f(\underline{z}_{\text{bank}})(1-F(\overline{z}))}{(1-F(\underline{z}_{\text{bank}}))^2} + \frac{f(\overline{z})\phi F(\underline{z}_{\text{bank}})}{(1-F(\underline{z}_{\text{bank}}))} < 0 \tag{52}$$

which happens if

$$\frac{f(\underline{z}_{\text{bank}})(1-F(\overline{z}))}{1-F(\underline{z}_{\text{bank}})} > f(\overline{z})F(\underline{z}_{\text{bank}}). \tag{53}$$

Now using the fact that F is exponential of shape β. The above condition becomes

$$e^{-\beta \underline{z}_{\text{bank}}}e^{-\beta \overline{z}} > e^{-\beta \overline{z}}e^{-\beta \underline{z}_{\text{bank}}}(1-e^{-\beta \underline{z}_{\text{bank}}}) \Rightarrow 1 > 1-e^{-\beta \underline{z}_{\text{bank}}} \equiv 1 > F(\underline{z}_{\text{bank}}). \tag{54}$$

The condition above always holds. This completes the proof for

$$\frac{\partial^2 L}{\partial H \partial a} < 0. \tag{55}$$

In order to prove $\frac{\partial L}{\partial a} > 0$ we use the expression for L and differentiate with respect to a to get

$$\frac{\partial L}{\partial a} = \int_{\overline{z}} \Big(\frac{\partial \pi(z)}{\partial a} - \frac{\partial r}{\partial a}\Big) f(z)dz > 0. \tag{56}$$

For the above result we used the fact that

$$\frac{\partial \pi(z)}{\partial a} > 0 \quad \text{and} \quad \frac{\partial r}{\partial a} < 0. \tag{57}$$

Proof of Lemma 3.

Let us define

$$A = \frac{1}{\beta(1-\alpha)-1}[\frac{1}{1-\alpha}(\frac{w}{\alpha})^{\frac{\alpha}{1-\alpha}}]^{-\beta(1-\alpha)} \tag{58}$$

and

$$B = \frac{\beta(1-\alpha)}{\beta(1-\alpha)-1}(1-\alpha)(\frac{\alpha}{w})^{\frac{\alpha}{1-\alpha}} \tag{59}$$

From the bank indifference condition, we find the following implicit solution of the equilibrium interest rate r for a given a and H:

$$A(r-\phi H)^{-(\beta(1-\alpha)-1)} = Be^{-\frac{\beta(1-\alpha)-1}{1-\alpha}a} - (\overline{r}-\phi H)e^{-\beta a} \tag{60}$$

From the entry condition of the individual, we obtain the following equation defind-ing threshold $\underline{a}$:

$$e^{-\beta\underline{a}} = \frac{A}{w}r(\underline{a})^{-(\beta(1-\alpha)-1)} + \rho A w^{-\beta(1-\alpha)}. \tag{61}$$

Note that

$$\frac{d\underline{a}}{dH} = \frac{d\underline{a}}{dr(\underline{a})}\frac{dr(\underline{a})}{dH}. \tag{62}$$

By totally differentiating Equation 61 with respect to $\underline{a}$ and $r(\underline{a})$, we obtain

$$\frac{d\underline{a}}{dr(\underline{a})} > 0. \tag{63}$$

By combining the Equations 61 and 60, we get the implicit solution for $r(\underline{a})$:

$$\left(\frac{1}{\frac{A}{w}r(\underline{a})^{-(\beta(1-\alpha)-1)} + \rho A w^{-\beta(1-\alpha)}}\right)^{\frac{1}{\beta(1-\alpha)}} =$$

$$\frac{A}{B}\frac{1}{\frac{A}{w}\left(\frac{r(\underline{a})-\phi H)}{r(\underline{a})}\right)^{\beta(1-\alpha)-1} + \rho A w^{-\beta(1-\alpha)}(r(\underline{a})-\phi H)^{\beta(1-\alpha)-1}} + \frac{\overline{r}-\phi H}{B}. \tag{64}$$

Note that the left hand side is increasing in $r(\underline{a})$, while the right hand side is decreasing in r(a̲).

Now, let us define

$$C \equiv \frac{1}{\beta(1-\alpha)} \left(\frac{A}{w} r(\underline{a})^{-(\beta(1-\alpha)-1)}\right)^{-\frac{1+\beta(1-\alpha)}{\beta(1-\alpha)}} \frac{A}{w} \left[\beta(1-\alpha)-1\right] w r(\underline{a})^{-\beta(1-\alpha)} +$$
$$\frac{A(\beta(1-\alpha)-1)\left[\frac{A}{w}\left(\frac{r(\underline{a})-\phi H)}{r(\underline{a})}\right)^{\beta(1-\alpha)-2} \frac{\phi H}{r(\underline{a})^2} + \rho A w^{-\beta(1-\alpha)}(r(\underline{a})-\phi H)^{\beta(1-\alpha)-2}\right]}{B\left[\frac{A}{w}\left(\frac{r(\underline{a})-\phi H)}{r(\underline{a})}\right)^{\beta(1-\alpha)-1} + \rho A w^{-\beta(1-\alpha)}(r(\underline{a})-\phi H)^{\beta(1-\alpha)-1}\right]^2} > 0.$$

By totally differentiating Equation 64 with respect to $r(\underline{a})$ and ϕH we obtain:

$$\frac{dr(\underline{a})}{d\phi H} =$$
$$\frac{A}{C(r(\underline{a})-\phi H)B} \frac{(\beta(1-\alpha)-1) - \left[\frac{r(\underline{a})}{w}\left(\frac{r(\underline{a})-\phi H)}{r(\underline{a})}\right)^{\beta(1-\alpha)} + \rho\left(\frac{r(\underline{a})-\phi H)}{w}\right)^{\beta(1-\alpha)}\right]}{\frac{A}{w}\left(\frac{r(\underline{a})-\phi H)}{r(\underline{a})}\right)^{\beta(1-\alpha)-1} + \rho A w^{-\beta(1-\alpha)}(r(\underline{a})-\phi H)^{\beta(1-\alpha)-1}}. \tag{65}$$

Now recall that in our model the indifference condition for the bank holds if $r \geq \overline{r}$ and otherwise $r = \overline{r}$, for all a, H. It follows that $r(\overline{a}) \geq \overline{r}$. If $r(\overline{a}) > \overline{r}$, the indifference condition of the bank must hold. As a result, it must be that $r > \phi H + \pi(z, \underline{a})$, for all $z < \underline{z}_{\text{bank}}$, which in turn implies $r > \phi H + \pi(0, \underline{a})$. Furthermore,

$$r(\underline{a}) > \phi H + \pi(0,\underline{a}) = \phi H + (1-\alpha)(\frac{\alpha}{w})^{\frac{\alpha}{1-\alpha}} e^{\underline{a}} \rightarrow r(\underline{a}) - \phi H$$
$$> (1-\alpha)(\frac{\alpha}{w})^{\frac{\alpha}{1-\alpha}} e^{\frac{\underline{a}}{1-\alpha}} \tag{66}$$

$$\rightarrow e^{-\beta\underline{a}} > \frac{[\frac{1}{1-\alpha}(\frac{w}{\alpha})^{\frac{\alpha}{1-\alpha}}]^{-\beta(1-\alpha)}}{(r(\underline{a})-\phi H)^{\beta(1-\alpha)}}$$

$$\rightarrow \frac{r(\underline{a})^{-(\beta(1-\alpha)-1)}}{w} + \rho w^{-\beta(1-\alpha)} > \frac{(\beta(1-\alpha)-1)}{(r(\underline{a})-\phi H)^{\beta(1-\alpha)}}$$

$$\rightarrow (\beta(1-\alpha)-1) - \left[\frac{r(\underline{a})}{w}\left(\frac{r(\underline{a})-\phi H}{r(\underline{a})}\right)^{\beta(1-\alpha)} + \rho\left(\frac{r(\underline{a})-\phi H}{w}\right)^{\beta(1-\alpha)}\right] < 0, \tag{67}$$

which implies

$$\frac{dr(\underline{a})}{dH} < 0. \tag{68}$$

On the other hand, if $r(\underline{a}) = \overline{r}$, any increase in H has no effect on $r(\underline{a})$, such that

$$\frac{dr(\underline{a})}{dH} = 0. \tag{69}$$

It follows that

$$\frac{dr(\underline{a})}{dH} \leq 0. \tag{70}$$

We conclude that that

$$\frac{d\underline{a}}{dH} = \frac{d\underline{a}}{dr(\underline{a})}\frac{dr(\underline{a})}{dH} \leq 0. \tag{71}$$

Proof of Theorem 2. The exit probability for an individual of ability a is given by

$$Prob(\text{exit}) = 1 - e^{\beta a}((\frac{w}{1-\alpha})(\frac{w}{\alpha})^{\frac{\alpha}{1-\alpha}})^{-\beta(1-\alpha)} \tag{72}$$

$$= 1 - \frac{e^{a\beta}w^{-\beta}}{\alpha^{\alpha\beta}(1-\alpha)^{\beta(1-\alpha)}}. \tag{73}$$

Let $g(a)$ denote the distribution of a, then, the aggregate exit rate is given by

$$Q = \int_{\underline{a}} (1 - \frac{e^{a\beta}w^{-\beta}}{\alpha^{\alpha\beta}(1-\alpha)^{\beta(1-\alpha)}})\frac{g(a)}{1-G(\underline{a})}da. \tag{74}$$

Differentiating gives

$$\frac{\partial Q}{\partial H} = (\frac{w^{-\beta}}{\alpha^{\alpha\beta}(1-\alpha)^{\beta(1-\alpha)}}) \int_{\underline{a}} (e^{\underline{a}\beta} - e^{a\beta}) \frac{g(\underline{a})g(a)}{(1-G(\underline{a}))^2} da \frac{\partial \underline{a}}{\partial H} > 0 \tag{75}$$

where we used the fact that

$$\frac{\partial \underline{a}}{\partial H} < 0. \tag{76}$$

Proof of Theorem 3.

Define aggregate productivity as

$$\Phi = \frac{\int_{\underline{a}} \int y(z,a) f(z) g(a) dz da}{\int_{\underline{a}} \int n(z,a)^{\alpha} f(z) g(a) dz da} \tag{77}$$

where $y(z,a)$ is the production and $n(z,a)$ is the number of employees of a firm of productivity $z+a$. Then,

$$\Phi = (\frac{\beta(1-\alpha)-\alpha}{\beta(1-\alpha)-1}) \frac{\int_{\underline{a}} e^{\frac{a}{1-\alpha}} g(a) da}{\int_{\underline{a}} e^{\frac{\alpha a}{1-\alpha}} g(a) da}. \tag{78}$$

Now differentiating, we obtain

$$\frac{\partial \Phi}{\partial H} = \frac{\partial \underline{a}}{\partial H} (\frac{\beta(1-\alpha)-\alpha}{\beta(1-\alpha)-1}) [\frac{\int_{\underline{a}} e^{\frac{\alpha \underline{a}}{1-\alpha}} e^{\frac{a}{1-\alpha}} g(a) g(\underline{a}) da - \int_{\underline{a}} e^{\frac{\alpha a}{1-\alpha}} e^{\frac{\underline{a}}{1-\alpha}} g(a) g(\underline{a}) da}{(\int_{\underline{a}} e^{\frac{\alpha a}{1-\alpha}} g(a) da)^2}] < 0. \tag{79}$$

Define average productivity as

$$E[\varphi] = \int_{\underline{a}} \int e^{a+z} f(z) \frac{g(a)}{1-G(\underline{a})} dz da. \tag{80}$$

Differentiating, we get

$$\frac{\partial E[\varphi]}{\partial H} = (\frac{\beta(1-\alpha)}{\beta(1-\alpha)-1}) [\frac{\int_{\underline{a}} (e^{a} - e^{\underline{a}}) g(\underline{a}) g(a) da}{(1-G(\underline{a}))^2}] \frac{\partial \underline{a}}{\partial H} < 0, \tag{81}$$

where we used the fact that

$$\frac{\partial \underline{a}}{\partial H} < 0. \tag{82}$$