Housing Bubbles and Misallocation: Evidence from Spain*

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April 2017
PRELIMINARY AND INCOMPLETE
DO NOT CIRCULATE

Abstract

During the 2000s, several developed economies experienced a housing bubble. At the same time, productivity growth started to decline. Spain is a paradigmatic example. We use unique matched firm- and bank-level data to empirically analyze the effects of the housing bubble on the allocation of capital and credit across firms. We employ housing supply elasticity at the municipality level (based on land availability) as an instrument for house price growth between 2004 and 2007. We find empirical evidence that the housing bubble generated misallocation and reduced total factor productivity (TFP). The reason behind this misallocation is that firms with a large initial share of housing (over total assets) increased their investment, whereas firms without housing decreased their investment. This difference was higher in municipalities with lower housing supply elasticity (higher house price growth). We also provide evidence of the credit supply channel. Firms with a larger initial share of housing received more credit and had lower denial rates. These differential effects are also exacerbated in municipalities with lower housing supply elasticity.

Keywords: Bubbles, Housing, Misallocation, Credit.
JEL Classification: E22, E44, O16, O47.

*We thank Pol Antràs for useful comments and suggestions. Any views expressed in this paper are only those of the authors and should not be attributed to the Banco de España or the Eurosystem. Basco acknowledges financial support from the Banco de España and the Ministerio de Economía y Competitividad (Spain), grant MDM 2014-0431. Contact: sergi.basco@gmail.com, david.lopezr@bde.es, enrique.moral@bde.es.

1 Introduction

Starting in the early-2000s, several developed economies experienced a large increase in house prices followed by a sudden bust. The growing consensus is that these economies had a housing bubble. Before the onset of the global financial crisis, productivity growth started to decline in different countries[1]. The coincidence of both facts aroused a suspicion among economists and policymakers that housing bubbles could be responsible of the misallocation of factors.

In this paper, we provide a first empirical attempt to identify the effect of housing bubbles on the misallocation of capital and credit. We perform this exercise for Spain, which is a paradigmatic example. House prices increased by 114% between 2000 and 2007 before they suddenly collapsed. Total factor productivity (TFP) declined by 3.6% between those years.[2]

An empirical challenge in investigating the effect of the housing bubble on the allocation of factors is that house price growth may be endogenous. To address this concern, we instrument house price growth at the municipality level with the housing supply elasticity. Our instrument is based on land availability and it is analogous to the one used in Glaeser et al. (2008) or Mian and Sufi (2011) for the United States. Housing bubbles cannot appear if the housing supply is infinitely elastic. Therefore, we exploit within-country differences in housing supply elasticity to identify the effect of the housing bubble.

We show that the housing bubble generated misallocation of capital and reduced TFP. First, we document that the increase in house prices had a differential effect on investment depending on the initial share of housing (over total assets) of the firm. Then, we uncover the credit supply channel behind the misallocation on investment. Finally, we show that this misallocation at municipality level generated a decline in aggregate TFP.

Our paper contributes to the empirical literature on misallocation and financial frictions. In the model, which we use to guide the empirical evidence, entrepreneurs are financially constrained. They can borrow only a fraction of their collateral (as in, for example, Kiyotaki and Moore, 1997). The only difference across entrepreneurs is the distribution of housing ownership. Rational bubbles appear when there is a shortage of assets. In the model, it happens when the borrowing constraint is very tight and/or savings are high. If the bubble is attached to houses, it increases the price of the house, which raises the value of the collateral of the entrepreneurs with houses. These entrepreneurs receive more credit, which allows them to increase their investment. Since entrepreneurs are otherwise identical, this differential effect on investment implies that the housing bubble reduces TFP. We are the first to empirically investigate this channel.

We use unique matched firm- and bank-level data from Banco de España between 2004 and 2007.[3] The firm-level dataset comes from the reported financial statements that all firms

[1] See, for example, Fabina and Wright (2013) or Fernald (2015).

[2] We obtain TFP data from Feenstra et al. (2015). House prices come from Bank of Spain.

[3] There is no house price data at municipality level before 2004. This precludes to extend our analysis before

are required to yearly submit to the Commercial Registry (Registro Mercantil Central). This dataset is representative and covers around 90% of registered business in Spain. The firm-level credit data come from the loan level Central Credit Register (Central de Información de Riesgos – CIR) owned/collected by Banco de España in its role of supervisor of the Spanish banking system. By having access to these data, we can both investigate the effect of the housing bubble on investment and document the credit supply channel.

We start providing aggregate suggestive evidence consistent with the mechanism of the model. First, as argued in, for example, Hsieh and Klenow (2009), the variance of the capital-labor ratio is a measure of misallocation of capital. We document that the increase in the variance of the capital-labor ratio between 2000 and 2007 was heterogenous across municipalities. Indeed, the increase in housing supply elastic municipalities were 12.4%, whereas it was 57.5% in housing supply inelastic municipalities. Second, we show that even though interest rates were low in other eurozone countries, the increase in debt was much larger in Spain, which had a large housing bubble. Third, we show that the interest rate spread between collateralized and uncollateralized loans was much smaller in Spain than other eurozone countries. Once the bubble burst, the interest rate spread increased in Spain, which reduced the wedge wih other countries. This evidence paints a picture consistent with the view that the housing bubble generated a misallocation of capital driven by the credit supply channel.

After the suggestive evidence, we formally test the effect of the housing bubble on investment. Our baseline specifications are a the firm level and include both industry and size fixed effects. All standard errors are clustered at municipality level. The main variable of interest is the interaction between house price growth and initial share of housing (over total assets). We run this regression both using OLS and instrumenting house price growth with the housing supply elasticity of the municipality. The coefficients of our 2SLS specification imply that one percent increase in house prices decreases investment by .650 percentual points if the firm has no housing and it increases investment by .746 percentual points if the housing share is one. This differential effect on investment across firms is higher in municipalities with lower housing supply elasticity. Thus, it is evidence that the housing bubble generated misallocation of capital.

In our baseline specification we include all sectors in the economy. However, we also run the same regressions only with manufacturing firms. The reasons are twofold. First, the manufacturing sector is an important driver of total factor productivity. Second, firms in the manufacturing sector are more intensive in housing than in the average sector. We find that the coefficient on the interaction between house price growth and housing share remains positive and statistically significant. The magnitude of the coefficients are larger (in absolute value), which implies that the misallocation generated by the housing bubble was exacerbated in the manufacturing sector.

2004, when presumably the housing bubble had already begun.

Our working assumption is that the housing bubble affected the relative investment of firms through the credit channel. The housing bubble raised the price of houses, which increased the value of the collateral of firms with a larger share of initial housing. Thus, these firms were able to borrow more. Our dataset allows us to test this credit channel. We run the same type of specification and show that credit was also misallocated. The coefficients imply that one percent increase in house prices translates into a not significant effect on credit if the firm has no housing but to an increase in .335 percentual points in credit if the firm has a housing share of one. We find a similar qualitative effect on the extensive margin. In housing supply inelastic municipalities (high house price growth), firms with housing had higher loan acceptance rates than firms without housing. We conduct the same set of robustness checks to these results.

Then, we provide evidence that the misallocation of capital had aggregate effects. First, we show that the housing bubble increased the dispersion of the capital-labor ratio. In particular, the dispersion of capital increased more in housing supply inelastic municipalities. Moreover, this effect increases with the variance of housing ownership in the municipality. The intuition is that if all firms have the same share of housing, an increase in house prices will not have a differential effect on investment across firms. Lastly, we perform a back-of-the-envelope exercise to quantify, through the lenses of the model, the effect of the housing bubble on the aggregate TFP. Between 2004 and 2007, aggregate TFP declined .81% in Spain. According to our model, in the absence of the housing bubble, TFP would have declined only .68%. Thus, the housing bubble explains the 16.2% of the fall in TFP. These numbers should be taken with a grain of salt. First, we make the conservative assumption that not having bubble means that the housing supply elasticity is in the 75th percentile of the distribution. Second, we use a model developed to illustrate the qualitative effects of the housing bubble on the misallocation of capital.

Finally, we conduct additional robustness checks to our main results. One may argue that the differential effect on investment was due to low interest rates that allowed small firms to borrow and invest more. This is the narrative in, for example, Gopinath et al. (2017). The mechanism in our paper is different. We emphasize that firms located in housing supply inelastic municipalities were able to borrow and invest more because the value of their collateral increased with the housing bubble. Moreover, we make use of the large raise in interest rates during 2006 to show that we obtain the same differential effect on investment between 2006 and 2007, when house prices were still growing in Spain. In addition, we show that our results also apply to large firms.

Related literature. This paper relates to different strands of the literature. Following the seminal paper of Hsieh and Klenow (2009) on misallocation, there has been a large number of empirical investigations on the reasons why the actual allocation of inputs may depart from the optimal one (see Jones, 2016). In this paper we study how housing bubbles affect the allocation of inputs. In this sense, our paper is related to Banerjee and Duflo (2014) and Midrigan and Yi Xu (2014), who analyze how financial frictions may generate misallocation of inputs. One departure from this literature is to document how the relaxation of financial frictions may exacerbate the misallocation of capital. That is, we show that, in bubbly municipalities, the increase in credit was biased toward firms with a larger initial share of housing (over total assets), which increased the within-industry dispersion of investment.

The credit boom in Spain in the late 2000s has aroused a great interest in the academia. For example, Garcia-Santana et al. (2015) show that the economic growth in GDP was not driven by improvement in total factor productivity (TFP). A closer paper is Gopinath et al. (2017). Their goal is to analyze whether a fall in interest rate may increase misallocation of inputs. They employ Spanish firm-data level and argue that low-interest rates were the cause that capital was misallocated towards firms with more net worth. One first difference is that we exploit within-country variation. In particular, we use housing supply elasticity at municipality level as an exogenous source of variation. We show that the channel driving the misallocation of capital in Spain was that firms with a larger share of housing (over total assets) increased their investment and received more credit than firms with a lower share of housing. Moreover, this effect was larger in more housing supply inelastic municipalities.

There have been other papers that have studied how the recent real estate boom has affected the investment of firms. For example, for the United States, Chakraborty et al. (2016) show that firms that borrowed from banks active in strong housing markets invested less. Similarly, Chaney et al. (2012) shows that the collateral channel was stronger for real state owners than renters during the housing boom in the United States. An important departure from this literature is that we analyze how the housing bubble generated misallocation of capital. We show that the dispersion of the capital labor ratio was larger in more bubbly municipalities and this effect was exacerbated in municipalities with a larger dispersion on the share of housing ownership across firms. The other findings of our paper can be see as complementary to these papers. We show that, in Spain, consistent with Chaney et al. (2012), the effect of house price growth depends on the share of housing over total assets. Moreover, consistent with Chakraborty et al. (2016), we find that investment of firms without housing may fall in bubbly municipalities.

Finally, even though our model is only to guide the empirical evidence, we also contribute to the rational bubbles literature by showing how housing bubbles may generate misallocation and reduce TFP. Rational bubbles appear in our model because there is a shortage of assets, as in the seminal papers of Samuelson (1958) and Tirole (1985). In particular, the shortage of assets arises because of a financial friction as in, for example, Martin and Ventura (2012). However, the bubble will be attached to houses like in Arce and López-Salido (2011) and Basco (2014, 2016). The main difference is that none of these papers have studied how the emergence of rational housing bubbles generates misallocation. We show that housing bubbles tilt the distribution of capital towards firms with more housing and reduces TFP.[4]

2 Macroeconomic Background and Suggestive Evidence

Before developing a simple model to guide the empirical analysis, we provide some suggestive evidence on the effect and mechanism through which the housing bubble generated misallocation.

The first thing to notice is that the housing bubble in Spain was very large by international standards. Figure 1 reports (nominal) house price indexes for the United States and Spain. Note that while the 2000-to-peak house price growth was 114% in Spain, the corresponding number for the United States was 72%. Therefore, the housing boom in Spain was much larger than in the United States.

However, this increase in house prices was heterogeneous across municipalities. Following Saiz (2010), we compute a housing supply elasticity based on land availability (see Section 5 for further details).We define housing supply inelastic municipalities those with a housing supply elasticity below the 25th percentile of the housing supply elasticity distribution. Analogously, we define housing supply elastic municipalities those above the 75th percentile. We find that the average house price between 2004 and 2007 in housing supply inelastic municipalities was 32% higher than in elastic ones.

Then, Figure 2 provides suggestive evidence of the effect of the housing bubble on the misallocation of capital. It reports the evolution of the variance of the capital-labor ratio for three groups of municipalities. The variance of the capital-labor ratio is a measure of misallocation and it has the advantage that, as opposed to TFP, it is model free. The blue line reports the variance of the capital-labor ratio for all municipalities in Spain. As it can be seen, the variance of the capital-labor ratio increased by 26.9% between 2000 and 2007. This is evidence of increasing misallocation of capital in Spain. This fact has also been emphasized in, for example, Gopinath et al. (2015). However, this aggregate figure hides the differential increase across municipalities. Indeed, the green (red) line reports the evolution of the variance of the capital-labor ratio in housing supply elastic (inelastic) municipalities. Note that the two lines grow apart during the housing bubble and start converge after the bubble burst. The increase in the variance was 12.4% in housing supply elastic municipalities and it was more than four times larger (57.5%) in housing supply inelastic municipalities. Therefore, this figure suggests that the housing bubble exacerbated the misallocation of capital in Spain.

During those years, the interest rates were low throughout the eurozone. However, these

[4] In our model, we consider an overlapping generation economy. However, as shown in, Santos and Woodford (1997), the distinction between an infinitely lived agent and an overlapping generation is not crucial for the existence of rational bubbles. Rational bubble are possible because of the borrowing constraint.

low interest rates did not translate into an increase in credit (debt) in all the economies. Figure 4 reports the evolution of private debt of firms (over GDP) for Spain and two eurozone countries with similar size: France and Italy. Note that between 2000 and 2007, private debt almost doubled in Spain, it increased from 64.34% to 124.40%. In contrast, private debt remained fairly stable in France. In Italy, private debt also raised but the increase was much lower than in Spain (from 55.58% to 77.74%). Moreover, as documented in, for example, Basco and Lopez-Rodriguez (2017), Spanish private debt started to accelerate in 2004. This evidence suggests that low interest rates are not a sufficient condition to generate an increase in credit. In Spain, low interest rate were also associated with a large housing bubble.

Finally, Figure 5 reports the evolution of monthly interest rates on new loans given to firms for different maturity. Loans with a maturity of more than five years are not given to firms without some type of collateral, generally housing. Therefore, the interest rate spread between loans of maturity of one year and more than five years can be interpreted as housing premium. The lower is the difference, the higher is the discount for having housing. The left-hand side reports the evolution of these interest rates for Spain and the right-hand side for Italy. We want to emphasize two things. First, during the housing boom (2003-2007), the average monthly interest rate spread was very small in Spain (.30), compared to Italy (.53). It implies that the discount to own houses was larger in Spain. Second, after the bust of the housing bubble, the spread in Spain increased more than in Italy. Between 2008 and 2012, the average monthly interest rate spread was .83 in Spain and 1.33 in Italy, which reduced the wedge between both countries. These figures hint to a differential effect of the housing bubble on the lending conditions of entrepreneurs depending on their housing ownership.

To sum up, this evidence suggests that the housing bubble generated misallocation of capital. In addition, it seems that the credit supply was the mechanism behind this misallocation of capital. In the next section, we develop a simple rational housing bubble model that can rationalize the facts described in this section.

3 Housing Bubbles and Misallocation: A Model

This section develops a model to guide the empirical analysis. We consider an overlapping generation economy with two agents: savers and entrepreneurs. There is a mass one of savers who live for two periods. In the first period, they receive and endowment e, which they invest to consume in the next period. In the second period, they consume final good and housing services. We assume that both population and endowment growth are zero. The problem of a saver born at time t can be written as

$$\begin{aligned} Max_{\{c_{t+1},h_{t+1}\}}\, U_t &= u(c_{t+1}) + u(h_{t+1}) \\ s.t. \quad e &= a_t, \\ R_{t+1}a_t &= p_{t+1}h_{t+1} + c_{t+1}, \end{aligned} \tag{1}$$

where a_t are savings, c_{t+1} is final good consumption, h_{t+1} are houses and e is the endowment.

We assume that there is a continuum of entrepreneurs, with mass M, indexed by i. Entrepreneurs live for two periods. Entrepreneurs are born with an endowment of houses h_t^i and intangible capital η_t^i. These assets are not used in production but can be collateralized. In the first period, entrepreneurs borrow d_t to invest in their firm. In the second period, they produce output, they sell the endowments and repay the debt.

We assume that financial markets are not perfect. Borrowers could avoid repayment by paying a fraction θ of the value of their assets. Since savers anticipate this possibility, they will lend to the borrower only up to the point where $R_{t+1}d_t \leq \theta \left[p_{t+1}h_t^i + \eta_t^i\right]$.[5]

Thus, the problem of an entrepreneur born at time t is

$$\begin{aligned} & Max_{\{c_{t+1},k_{t+1}\}}\, U_t = u\left(c_{t+1}\right) \\ s.t.\ k_{t+1}^i &\leq d_t, \\ c_{t+1} &\leq f(k_{t+1}^i) - R_{t+1}d_t + p_{t_{+1}}h_t^i + \eta_t^i, \\ R_{t+1}d_t &\leq \theta\left[p_{t+1}s_h^i H_t + \eta_t^i\right], \end{aligned} \tag{2}$$

where $s_h^i = \frac{h_t^i}{H_t}$ is the share of housing owned by firm i.

In our empirical section, we compare municipalities with different housing supply elasticity. Thus, we assume that the supply of housing is given by $H_t^S = h(p_t, \varepsilon) = p_t^{\varepsilon}$, where ε is the housing supply elasticity.

Finally, we assume that the only difference between entrepreneurs is the composition of their assets. For simplicity, we consider that *low-i* firms have houses but not intangible assets and *high-i* firms have intangible assets but not houses. In particular,

$$\begin{aligned} s_h^i &= \begin{cases} \frac{1}{\kappa} \text{ if } i < \kappa \\ 0 \text{ if } i > \kappa \end{cases} \\ \eta_t^i &= \begin{cases} 0 \text{ if } i < \kappa \\ \eta \text{ if } i > \kappa \end{cases} \end{aligned}$$

[5]This borrowing constraint is the same as in Monacelli (2009). It is also similar to Kiyotaki and Moore (1997) with the difference that they assume θ=1.

The next assumption implies that, in the absence of bubbles, the value of the endowment is the same for all firms.

Assumption 1 *(initial condition)* $\eta = \frac{1}{\kappa}\left(\frac{e}{2}\right)^{\frac{2+\varepsilon}{1+\varepsilon}}$

It is well known in the rational bubbles literature that bubbles can emerge in equilibrium when the financial friction is very tight. To guarantee the existence of bubbles in equilibrium, we make the following assumption

Assumption 2 *(shortage of assets)* $\theta < \theta^* = \frac{e}{(M-\kappa)\eta + \left(\frac{e}{2}\right)^{\frac{2+\varepsilon}{1+\varepsilon}}}$

This assumption implies that there is a shortage of assets and rational bubbles may appear in equilibrium. Note that this condition is more likely to hold when the demand of assets (numerator) is high and the amount of collateralizable assets (denominator) is low.[6] For ease of exposition, we have considered a closed economy model. However, it would be straightforward to consider an open economy model and show, like in Basco (2014), how financial integration makes bubbles possible by increasing the demand of assets (capital inflows). Intuitively, financial integration would increase the numerator of θ^*.

As the seminal paper of Tirole (1985) shows, there are two conditions for the existence of rational bubbles in equilibrium:

$$\frac{B_{t+1}}{B_t} \geq R_{t+1} \tag{3}$$

$$B_t(R_t) \leq A - D_t(R_t) \tag{4}$$

where $A_t = \int a_t di$ and $D_t(R_t) = \int d_t^i(R_r)di$.

Equation 3 is the arbitrage condition. It states that the return on holding the bubble must be higher (or equal) than the alternative (lending money to entrepreneurs). Equation 4 is the shortage of assets condition, it implies that the supply of assets (bubble plus borrowing of entrepreneurs) cannot exceed the demand of assets (savings).

We are now ready to derive the steady-state market clearing conditions. There are three markets in this economy: capital, housing and final good. By Walras' Law, I can focus on only the first two. Noting that there is no growth in the economy, it follows that the capital and housing market clearing conditions are

$$A = D(1) + B(1) \tag{5}$$

$$H^S = \int h^i di + \frac{B}{p} \tag{6}$$

Equation 5 is the capital market clearing condition. It states that the supply of assets

[6] We derive the fundamental (bubbleless) equilibrium in the Appendix.

(borrowing of entrepreneurs plus the bubble) must equal the demand of assets (savings of savers). Equation 6 is the housing market clearing condition. The supply of houses must equal the demand of houses. Notice that there are two components of housing demand. The first part is the demand of old savers and the second part is the bubble. Young savers purchase the bubble, which is attached to housing and, thus, raises housing demand. This notion of housing bubble is the same as in Arce and López-Salido (2011) or Basco (2014, 2016).

Definition *An steady-state housing bubble equilibrium is an interest rate (R), house price (p), size of the bubble (B), final good consumption (c) and housing (h) such that: (i) savers maximize utility given prices (1), (ii) entrepreneurs maximize utility given prices (2), (iii) all markets clear (5 and 6) and (iv) $B > 0$.*

In the appendix we fully derive the steady-state equilibrium. For ease of exposition, the next section states the most salient empirical predictions of the model.

3.1 Empirical Predictions

In this section we describe the effects of the housing bubble on the misallocation of credit and capital across firms. First, we state the empirical predictions on the relative investment of firms. Then, we discuss how the housing bubble has a differential effect on the value of the collateral. Finally, we show how the housing bubble may distort the allocation of capital and reduce TFP.

Prediction 1 *With a housing bubble, the investment of firm increases with the share of housing. This effect is larger, the lower is the housing supply elasticity*

The relative investment of firms with housing ($i < \kappa$) in the bubbly equilibrium is[7]

$$\frac{k^{\text{with houses}}}{k^{\text{without houses}}} = \frac{\frac{1}{\kappa}\left(\frac{\varepsilon}{2} + B\right)^{\frac{2+\varepsilon}{1+\varepsilon}}}{\eta} = \Phi(B, \varepsilon) > 1.$$

The intuition for this result is that the housing bubble raises the value of the collateral of the firms who own houses. This effect is exacerbated when ε is small because the increase in house prices is decreasing with the housing supply elasticity. Note that in the absence of bubbles the two types of firms would invest the same amount.

[7]It is straightforward, given assumption 1, that $\Phi(B, \varepsilon) > 1$. Moreover, $\frac{\partial \Phi(B,\varepsilon)}{\partial \varepsilon} < 0$ because both $\frac{2+\varepsilon}{1+\varepsilon}$ and B decrease with ε.

Prediction 2 *With a housing bubble, firms with housing receive more credit. In addition, if there is rationing, firms with less houses are more likely to be denied credit. Both effects are exacerbated in housing supply inelastic municipalities.*

These predictions are a corollary of the previous one. In the model, investment is equivalent to credit ($D = K$). Thus, firms with housing invest more because they can also borrow more. There is no credit rationing in the model. However, if we assumed that the likelihood of receiving credit depends on the value of the collateral, we would find that firms with houses are more likely to receive credit. Moreover, these effects are larger, the lower is the housing supply elasticity.

Prediction 3 *With a housing bubble, the dispersion in k is larger. Moreover, this effect is larger, the lower is the housing supply elasticity and the larger is the dispersion in housing ownership.*

Given the equilibrium investment of firms, the standard deviation of capital is

$$st.d(k)^{Bubbles} = (\Phi - 1)\frac{[(M-\kappa)M\kappa]^{\frac{1}{2}}}{\Phi\kappa + M - \kappa} \tag{7}$$

The first thing to notice is that without a housing bubble, $\Phi = 1$, the standard deviation of capital is zero. In addition, if all firms had housing ($\kappa = M$) or no firm had housing ($\kappa = 0$), the standard deviation would also be zero. When there is a bubble, $\Phi > 1$, the standard deviation is positive. In addition, the increase is larger, the lower is housing supply elasticity.[8]

This prediction implies that the allocation of capital is less efficient when there is a housing bubble. The reason is that firms with more housing can invest more than other firms. Moreover, this effect is larger, the larger is the dispersion in the distribution of housing across firms. The next prediction relates this misallocation of capital to lower TFP.

Prediction 4: *The TFP with housing bubbles is lower. Moreover, TFP is lower in housing supply inelastic municipalities and when the dispersion in share of houses between firms is higher..*

In order to compute a measure of TFP, we assume that $f(k) = k^{\alpha}$. Given that we have two types of firms, it follows that aggregate output is $Y = [k_1^{\alpha}]^{\frac{\kappa}{M}} [k_2^{\alpha}]^{\frac{M-\kappa}{M}}$,where 1(2) stands for firms with low(high) i index.

[8] This is the case because $\frac{\partial st.d(k)^{Bubbles}}{\partial \varepsilon} < 0$ given $\frac{\partial \Phi}{\partial \varepsilon} < 0$.

$$TFP^{Bubble} = \left[\frac{\Phi\kappa}{\Phi\kappa + M - \kappa}\right]^{\alpha\frac{\kappa}{M}} \left(\frac{M-\kappa}{\Phi\kappa + M - \kappa}\right)^{\alpha\frac{M-\kappa}{M}} \tag{8}$$

It is straightforward to see that TFP^{Bubble} has an inverse-U shape with maximum at $\Phi = 1$. When there is no bubble, $\Phi = 1$. Thus, $TFP^{Bubble} < TFP^{Without\ Bubble}$. Moreover, note that if all firms were identical, TFP would be independent of Φ. Lastly, remember that the lower is the housing supply elasticity, the higher is Φ.

Finally, note that, as in, e.g., Hsieh and Klenow (2009), the variance of the capital-labor ratio is a sufficient statistic for TFP. In order to obtain closed form solutions, we assume that $M = 1$ and $\kappa = 1/2$. In that case, by plugging equation 7 into equation 8, we find that

$$TFP = \left[\frac{1 - var(k)}{4}\right]^{\frac{\alpha}{2}} \tag{9}$$

This equation means that the higher is the variance of capital, the lower is the level of TFP. In our case, in the absence of the housing bubble, the variance of capital would be zero. Similarly, as we discussed in Prediction 3, the variance of capital is higher, the larger is the housing bubble (or the lower is the housing supply elasticity).

Discussion of the Model: Housing vs Asset Price Bubbles Since we want to empirically analyze the effect of the housing bubble on the misallocation of capital, we assumed that the bubble appeared in housing. Needless to say, the predictions of the model would be different if the bubble were not attached to houses. For example, if young savers, instead of using the "bubble money" to purchase houses, they chose to give it equally to all entrepreneurs, the bubble would not create misallocation of credit.[9] In other words, the housing bubble creates misallocation because it artificially raises the value of the collateral of entrepreneurs with housing, who receive more credit and, thus, invest more.

4 Data

In this section, we describe the data that we are going to use in section 5. We test the empirical predictions of the model using a rich firm-level dataset with exhaustive information on administrative credit records and financial statements of Spanish firms. This micro dataset is complemented with (aggregated local) data on both residential housing prices and housing supply elasticity at municipality level. These local datasets are matched with the firm-level dataset according to the geographic location reported by business in their financial statements.

[9] See, for example, Basco (2016) for a discussion on the differential effect of housing and asset price bubbles.

4.1 Firm Data

The empirical strategy to identify the misallocation mechanism crucially relies on having exhaustive firm-level information on business' activity in terms of both flows and stocks matched with their credit records with the banking system. The firm-level dataset has an administrative nature because comes from the reported financial statements that all firms are required to yearly submit by law to the Commercial Registry (Registro Mercantil Central). Banco de España has processed, digitalized and statistically treated this raw data resulting in an exhaustive dataset covering around 90% of registered business in Spain from 2000-2013. This dataset is representative of the non-financial productive sector of the economy given that it replicates the firm-size distribution of firms in terms of both sales and employment, and also the dynamics of production and full-time employment according to official census statistics provided by the National Institute of Statistics of Spain and Spanish Tax Agency.[10]

The resulting firm-level dataset has a panel structure from 2000 to 2013 and includes the following information for each firm: business name, fiscal identifier, zipcode location, sector of activity (4-digit CNAE-2009 code), number of employees and the complete information contained in their financial statements composed by the Balance Sheet and the Profit & Loss Account. The main variables used in our empirical analysis included in the reported financial statements are: (i) the annual net operating revenue; (ii) material expenditures, i.e. the cost of all raw materials and services purchased by the firm in the production process; (iii) labor expenditures, which accounts for the total wage bill of a firm, excluding social security contributions; (iv) total assets; (v) stock of capital; (vi) value-added; and (vii) accounting profit. Table A1 presents summary statistics on these variables for the firms included in our analysis.

The firm-level credit data come from the loan level Central Credit Register (Central de Información de Riesgos – CIR) owned/collected by Banco de España in its role of supervisor of the Spanish banking system. This credit register contains detailed monthly information on granted credit and drawn down credit from all new and outstanding loans over 6000 euros to non-financial firms granted by all banks operating in Spain since 1984.[11] We process the information recorded in outstanding loans' data in order to obtain aggregate measures of average drawable and drawn down credit at the firm-year level from 2000 to 2013. We also create these firm-level measures of credit by type of lender separating the sample in loans granted by either commercial or savings banks. Besides of information on granted loans, CIR also compiles since 2002 monthly requests lodged by banks to obtain information on

[10] See Almunia, Lopez-Rodriguez and Moral-Benito (2017) for a detailed description on the construction and representativeness of this firm-level dataset.

[11] The significantly low reporting threshold implies that virtually all firms with outstanding bank debt are included in the CIR database. See, for instance, Jiménez et al. (2012) for a detailed discussion on the CIR database.

outstanding loans of potential borrowers when the latter give their consent. Lenders receive monthly information on the default status and outstanding debts with all banks of their current borrowers, thus these requests reveal information on borrowers' applications to banks without outstanding debt. We match firm-year level data on loans granted by banks and the set of loan applications in order to infer both loans' denial rates and the new loans granted by banks to nonconcurrent borrowers.

In order to analyze the credit channel of the misallocation mechanism, we merge firm-level data contained in the financial statements database with the yearly aggregated firm-level information on loan applications and credit exposures from the Central Credit Register. The matching process is feasible given the common fiscal identification number associated to each firm that is available in both datasets. Table A2 presents summary statistics on credit and loan applications for the firms included in the analysis.

4.2 Housing Supply Elasticity

In order to capture the real-estate market dynamics, we build housing price indexes at municipality level considering that these local indexes capture valuations of real-estate assets hold by firms located in a given town. Price indexes are built using the census micro-data on real-estate transactions provided by the Spanish Ownership Registry (Registro de la Propiedad) to the Banco de España since 2004. This dataset contains daily frequency information on the market value of transacted real-estate assets, size of the assets measured in square meters and the geographic location of each transaction (i.e. local registers that report transactions can be associated to municipality identifiers). We calculate the market value price per square meter for each transaction and then aggregate those prices for all transactions made in a town during a natural year to create yearly average prices per square meter from 2004 to 2012 in towns with more than 1000 inhabitants.[12] We also calculate the same average price indexes for towns that exceed 5000 inhabitants in 2004 to undertake the sensitivity analysis discussed in section 6.

According to our empirical predictions, the dynamics of housing prices affects firms' investment and credit decisions but housing prices are endogenous to these decisions. To address the endogeneity problem, in our empirical strategy we instrument housing price growth with a measure of the housing supply elasticity in the geographic area of analysis, in line with the empirical strategy followed by Mian and Sufi (2011). Indeed, we construct a measure of housing supply elasticity for Spanish towns following the insights provided by Glaeser et al. (2008) and adapting the elasticity measure created by Saiz (2010) for metropolitan areas in the US. This measure aims to capture the housing supply geographic fundamentals that

[12]We exclude tiny towns to avoid small yearly sample sizes that present high volatility and thus could introduce biases in our estimates. This exclusion does not affect the aggregate results because these towns represent less than 5% of population being rural areas without a significant share of economic activity.

should explain the evolution of housing prices in the long-run. In particular, Saiz (2008) proposes a geographic measure of land availability that cleans undevelopable land (e.g. water areas, mountains) from total surface, and then correct/adjust it by land's slope to measure potential land for urban development. Using census data on land categories at municipal level registered by the Spanish Cadastre (Catastro), we calculate the ratio of potential plot surface over the built urban surface in a year previous to the housing boom. Within potential plot surface we consider undevelopable total land once excluded protected non-urban areas (e.g. rivers or natural parks), plot classified as of rural use and public goods land (e.g. local surface occupied/covered by transport and utilities infrastructure). We measure this variable as of 1997/1998 to avoid feedback effects of booming prices on the availability of undevelopable urban land during the housing bubble. We select 1997/1998 given that it precedes the housing prices-credit boom of 2000s and also because in 1998 the Spanish government passes an ambitious soil liberalization law to ease the use of potential plot surface. Before that reform, developable urban land was very rigid because of political constraints being the pre-reform year a good year to measure towns' potential urban land conditional on geographic constraints.[13] The constructed measure is a good proxy of the (physical) relative capacity to build new real-estate assets in a municipality as showed by its predictive power on differential housing prices' dynamics during the housing boom (see the first-stage regressions in the Online Appendix).

5 Empirical Evidence

This section reports the main empirical results of the paper. First, we show that the housing bubble generated misallocation of capital at the firm level. Second, we provide evidence on the mechanism behind this misallocation of capital. Finally, we document how this misallocation of capital at the firm level translated at the municipality and country level.

5.1 Housing Bubble and Investment

In this section we test the first prediction of the model. According to our model, the housing bubble allowed firms with a larger share of housing to invest more than firms with less housing. In order to test this prediction, we start with the next simple regression,

[13] Before the Spanish Soil Liberalization Law was passed, the process to obtain licenses to construct in plot urban surface in Spain was costly and required time. Indeed, the town hall had to provide an urban plan to create new developable urban land and this plan had to be approved by the Spanish Parliament. In practice this implied that developable urban land was rigid and almost fixed in the short-term. The liberalization law empowered town halls to easily and quickly do all this process resulting in a huge increase in new urban built land across the country.

$$Investment_{04-07,f} = \beta_0 + \beta_1 * HP_{04-07,c} + \beta_2 * HP_{04-07.c} * \text{Share Housing}_f + \epsilon_{cf},$$

where $Investment_{04-07,f}$ is the increase in the capital stock between 2004 and 2007 of firm f, $HP_{04-07,c}$ is house price growth between 2004 and 2007, Share Housing$_f$ is the ratio of housing on total assets. Prediction 1 of the model implies that $\beta_1 < 0$ and $\beta_2 > 0$.

Column 1 of Table 1 reports this regression with standard errors clustered at municipality level. Consistent with the prediction of the model, the coefficient on house prices is negative and the interaction is positive. It means that when house prices increase, firms without houses reduce investment. However, investment of firms with a large share of housing will increase with house prices. Note that we are controlling for the total assets of the firms. Thus, it means that the composition of total assets affect the investment of firms when there is growth in house prices. This result implies that during the housing bubble there was misallocation of capital. Moreover, this misallocation was larger in municipalities with higher house price growth. In other words, if there was no growth in house prices, the composition of total assets would not affect the investment of firms.

A possible concern in the above regression is that the increase in house prices may be endogenous. In order to address this concern, we use housing supply elasticity of the municipality as an instrument for house price growth. The intuition behind this regression is that the housing supply elasticity only affects investment through house price growth. A similar instrument has been used in, for example, Mian and Sufi (2011) for the U.S. housing market. Thus, we run the following two-stage least squares,

$$\begin{aligned} Investment_{04-07,f} &= \beta_0 + \beta_1 * HP_{04-07,c} + \beta_2 * HP_{04-07.c} * \text{Share Housing}_f + \epsilon_{cf,} \quad (10) \\ HP_{04-07,c} &= \gamma_0 + \gamma_1 * HSE_c + u_c, \end{aligned}$$

where, in the first-stage, HSE_c is housing supply elasticity of the municipality.

Column 2 reports the coefficient of running equation (10) without the interaction term. Note that the coefficient on house price is negative and significant at 10 percent. This coefficient implies that for the average firm, house price growth reduces investment. In other words, for a firm with the average composition of assets, an increase in house prices will reduce investment.

Column 3 includes the interaction between housing share and house price growth, which is the main prediction of the model. As predicted by the model, the interaction is positive and statistically significant. It implies that firms with more housing invested more than firms without housing. Importantly, this effect is higher in municipalities with low housing supply elasticity (high house price growth).

The quantitative effects of this misallocation are also significant. The coefficients of column 3 imply that one percent increase in house prices decreases investment by .65 percentual point if the firm has no housing. However, if the firm had an initial housing share equal to one, investment would increase by .746 percentual point. Note that the differential investment between these two types of firms will be higher in housing supply inelastic municipalities, where house price growth is higher. Therefore, it implies that the housing bubble increases the dispersion in investment and it generates misallocation of capital.

One possible concern with these results is that, even though we are including industry fixed effects, there may be some industry driving the results. A related concern is that empirical studies on misallocation tend to focus only on manufacturing. In order to address both concerns, we run the same baseline regression for the subsample of manufacturing firms. Column 4 reports the coefficients of running this regression. Note that the coefficients on both house prices and the interaction term are significant and larger (in absolute terms) than the coefficients for all firms (column 3). Therefore, the misallocation of investment generated by the housing bubble is exacerbated in manufacturing.

Finally, one may think that our result only applies to small firms because large firms have other sources of credit (e.g., equity or bond markets). This argument is, a priori, less relevant for the Spanish case because Spanish firms obtain most of their credit from banks. Nonetheless, we test this alternative hypothesis by running the same regression only for large firms. Column 5 reports the coefficients of running this regression. Note that the coefficients are statistically significant and the magnitudes are larger. A possible interpretation of these results is that large firms have more assets and, given the same increase in prices, they will be able to invest more.

To sum up, the evidence reported in Table 1 illustrates that the housing bubble generated misallocation of capital. For a given distribution of share of housing across municipalities, investment increased more in municipalities with a lower housing supply elasticity (large increase in house prices). Put it differently, for a given increase in house prices, firms with a larger share of housing invested more.

5.2 Credit Channel: Housing Bubble and Credit Supply

In the previous section we have shown that the housing bubble generated misallocation of capital in Spain. In this section we provide evidence on the mechanism behind this misallocation of capital. According to our model, firms are financially constrained and their borrowing is linked to the value of their collateral. In other words, we should observe the same effects on credit than on investment.

In order to test this prediction, we run regressions of the following type,

$$\Delta Credit_{04-07,f} = \beta_0 + \beta_1 * HP_{04-07,c} + \beta_2 * HP_{04-07.c} * \text{Share Housing}_f + \epsilon_{cf}, \quad (11)$$
$$HP_{04-07,c} = \gamma_0 + \gamma_1 * HSE_c + u_c,$$

where $\Delta Credit_{04-07,f}$ is the change in credit of firm f between 2004 and 2007. Note that this is the same specification as equation 10. The only difference is the dependent variable. Prediction 2 of our model implies that $\beta_2 > 0$.

Table 2 reports the coefficients of running equation 11. Column 1 reports the OLS coefficients. Note that the coefficient of interest, the interaction term, is positive and statistically significant. This coefficient implies that, for a given level of housing share, firms in municipalities with higher house price growth received more credit. Therefore, this is evidence that the housing bubble generated misallocation of credit. Ceteris paribus, a firm in a bubbly municipality received more credit.

Columns 2 to 4 report the coefficients of using housing supply elasticity as an instrument for house price growth. Note that the interaction term is positive and statistically significant. The coefficients in column 2 imply that a one percent increase in house prices has no significant effect on credit if the firm has no housing. However, if the housing share of the firm were equal to one, the credit of the firm would increase by .335 percentual points. This differential effect across firms is larger in municipalities with a low housing supply elasticity (high house price growth). Therefore, these coefficients imply that the housing bubble also generated a misallocation of credit, which explains the misallocation of capital.

A similar concern on particular industries driving the results discussed in the previous section may apply now. In order to address this concern, we run equation 11 only for firms in the manufacturing industry. Note that the interaction term is positive and statistically significant. Moreover, the coefficient is larger, which implies that the effects of the housing bubble on the misallocation of credit were higher in the manufacturing industry.

It may also be argued that large firms had access to other sources to obtain credit and, thus, our mechanism is not relevant for large firms. To address this concern, we run the same regression only for large firms. Column 4 reports the coefficients. Note that the coefficient on the interaction term is, as predicted by the model, positive and statistically significant. Therefore, we can conclude that the credit supply channel also applies to large firms.

To conclude this section, we provide additional evidence on the credit supply channel. In our simple model we did not allow for rationing. However, we do know that in reality some firms are not granted credit. That is, in Table 2 we reported evidence on the intensive margin and we can complement this evidence by analyzing the extensive margin. If the decision of granting a loan depends on the value of the collateral, we would expect that, given a housing share, firms in low housing supply elasticities are more likely to receive credit. Our database includes information on whether the loan was approved or declined and, thus, we can test this hypothesis.

Table 3 reports the coefficient of running equation 11 with acceptance rate as dependent variable. The prediction is that the coefficient on the interaction between the share of housing and house price growth is positive. Column 1 reports the OLS estimates. The coefficient on the interaction term is positive and statistically significant. It implies that, given a share of housing, firms in municipalities with high house price growth were less denied credit than firms in low house price growth municipalities. Similarly, given house price growth, firms with a larger share of housing were more likely to have access to credit.

Finally, columns 2 to 4 of Table 3 report the coefficients of running equation 11 with housing supply elasticity as an instrument of house price growth. Analogously to Table 2, in column 2 we have all firms, column 3 focusses on manufacturing firms and column 4 restricts the sample to large firms. The first thing to notice is that the coefficient on the interaction is positive in all subsamples. It is significant at 1 percent in all but column 4 (large firms). When we restrict the sample to large firms, the coefficient is significant only at 10 percent. These coefficients imply that firms with a large share of housing had more access to credit and this effect was larger in municipalities with low housing supply (high price growth). However, for large firms, this effect was less significant. Thus, given Table 2 and 3, we conclude that the housing bubble affected both the intensive and extensive margin for small and medium firms; but for large firms the main effect was through the intensive margin.

To summarize, the evidence presented in this section paints a picture consistent with the view that the housing bubble generated a misallocation of credit, which explains the misallocation of capital. That is, given the same distribution of housing ownership across municipalities, the dispersion in credit was higher in municipalities with low housing supply elasticity (high house price growth). Note that if there were no housing bubble, the dispersion in credit would be the same in all municipalities.

5.3 Misallocation of Capital at Municipality Level

In this last subsection we provide evidence on the aggregate effects of the housing bubble. The unit of analysis in our previous analysis was the firm. We showed that, given a share of housing ownership, firms in municipalities with low housing supply elasticity (high house price growth) received more credit and invested more. This is already evidence of misallocation of capital because it implies that the housing bubble, by distorting house prices, favored (hurt) firms with a large (small) share of housing. In other words, given the same distribution of housing ownership across municipalities, the dispersion of investment and credit was larger in bubbly municipalities.

In this section we go one step further and investigate whether the variance in capital-labor ratio was larger in bubbly municipalities. As we theoretically showed in Section 2, the distribution of housing is key to understand the effects of the housing bubble. Imagine that all firms in the municipality have the same share of housing. In this case, an increase in house prices will not change the dispersion in the capital-labor ratio. However, imagine that there are two groups of firms. The first group has only housing, and the second group does not have housing. In this case, an increase in house prices will increase investment of the first group and will decline investment of the second. Therefore, the prediction of the model, Prediction 3, is that the dispersion of capital-labor ratio will be higher when both the dispersion of housing share in the municipality and house price growth are high.

In order to test this prediction, we run the following regression,

$$\begin{aligned} Var(K/L)_{2007,c,s} &= \beta_0 + \beta_1 * HP_{04-07,c} + \beta_2 * HP_{04-07.c} * Var(Housing)_{c,s} + \epsilon_{cf}, \quad (12) \\ HP_{04-07,c} &= \gamma_0 + \gamma_1 * HSE_c + u_c, \end{aligned}$$

where $Var(K/L)_{2007}$ is the variance in the capital-labor ratio in 2007 in municipality c, industry s, $Var(Housing)_{c,s}$ is the variance of the housing ownership across firms in city c and industry s. The prediction of the model is $\beta_2 > 0$.

Table 4 reports the coefficient of running equation 12. Column 1 reports the OLS coefficients. Note that the interaction between variance of housing share and house price growth is positive and statistically significant. This coefficient implies that, given a distribution of housing ownership, the variance of the capital-labor ratio is higher in municipalities with high house price growth. Column 2 reports the same regression with house price growth instrumented by housing supply elasticity. Note that the coefficient on the interaction term is positive and statistically significant.

In columns 3 and 4 we run the same regressions for the change in the variance between 2004 and 2007. Note that the prediction of the model is the same. The increase in the variance should be larger in municipalities with both low housing supply elasticity (high house price growth). Column 3 reports the coefficients of the OLS estimation and column 4 the 2SLS. Note that, consistent with the model, the coefficient on the interaction term is positive in both columns. Note this coefficient also implies that the effect of the housing bubble on the variance of capital increases with the variance of housing ownership in the municipality. The intuition is that if all firms have the same share of housing, an increase in house prices will not generate a differential change in investment. However, the larger is the dispersion on housing ownership in the municipalities, the larger will be the dispersion created by an increase in house prices.

To conclude, the evidence in this section has shown that the housing bubble created misallocation of capital. In the absence of the housing bubble, the dispersion in the capital-labor ratio would have been lower between municipalities.

5.4 Aggregate Implications

We have provided evidence that the housing bubble generated a dispersion in the variance of capital. As we discussed in the theoretical model and it is well known in the literature, this increase in the variance of capital is associated with a decline in TFP. In this section we perform a simple exercise to illustrate, through the lenses of our model, the aggregate effect of the housing bubble.

We compute the effect of the housing bubble on aggregate TFP in the following way. First, we assume that the housing supply of Spain is one half inelastic (25th percentile) and the other half elastic (75th percentile). Second, we use equation 9 to match the decline of TFP implied by this composition of the housing supply with the actual decline in TFP. TFP declined by .81% in Spain between 2004 and 2007 according to Feenstra et al. (2015). Third, we assume that if there were no bubble, the variance of capital in Spain would be like in a housing supply elastic municipality (75th percentile).

Equation 9 implies that, without the bubble, the decline in TFP would have been .68% instead of .81%.[14] Therefore, the decline in TFP with the bubble were 19.21% higher than if there had been no housing bubble. Another way to interpret these numbers is that the housing bubble explains the 16.2% of the total decline in TFP. The housing bubble reduced aggregate TFP because it increased the variance of capital across firms.

We want to emphasize that this is a back-of-the-envelope exercise and, thus, these numbers should be taken with a grain of salt. A precise quantification of the effect of the housing bubble is outside the scope of the paper. An important challenge is that we do not know the actual size of the bubble. We made the conservative assumption that municipalities in the 75th percentile of housing supply elasticity distribution had no bubble. However, one may argue that the housing bubble was present, in different size according to their housing supply elasticity, throughout Spain. Moreover, our model was developed to illustrate the qualitative effects of the housing bubble, which make it ill suited to perform quantitative exercises.

6 Robustness

In this section we conduct a series of robustness checks of our main empirical predictions.

6.1 Large Municipalities

In our baseline regression we have considered municipalities with more than 1000 people. One may be concerned that our results may be driven by some small municipalities. In order to

[14] To compute these numbers we assume that the capital share is .7. We also use the fact that the variance of capital in the 25th (75th) percentile of the housing suppy elasticity increased by 8.62% (6.07%) between 2004 and 2007.

address this concern, we replicate Table 1 for the subsample of large municipalities (more than 5000 people).

Table 5 reports the coefficients of running this regression. The coefficient of the interaction between house price growth and share of housing is positive and statistically significant in all columns. This is the case for the OLS estimate (column 1) and the 2SLS (columns 2 to 4). If we compare the coefficients for the main specification (IV with all firms) for large and small municipalities we see that they are almost identical. In column 2 of Table 5, the coefficient of interest is 1.400 and in column 3 of Table 1 is 1.396.

Therefore, from comparing these tables, we conclude that our results are robust to consider only large municipalities.

6.2 The Role of Savings Banks

A popular story in Spain is that political-oriented savings banks created the housing bubble. This political economy narrative has also been embraced in academic circles (see, for example, Santos, 2014). According to this narrative, the mismanagement of savings banks explains the build up and bust of the housing bubble. Therefore, one could argue that what we are finding is not that the housing bubble allowed firms with more housing to invest more. Instead, what we find could be driven by savings banks that wanted to expand and lend more during the housing boom.

In order to analyze the different behavior of saving and commercial banks, Table 6 reports the coefficient of replicating the main specifications of Tables 2 and 3 for both types of banks. In particular, the dependant variable of columns 1 and 2 is the increase in credit between 2004 and 2007. Column 1 restricts the sample to commercial banks and column 2 to saving banks. The coefficients are .345 for commercial banks (column 1) and .314 for saving banks (column 2). The coefficient in commercial banks is statistically larger than the coefficient for saving banks. This means that, given house price growth, the amount of credit that was granted by commercial banks was slightly larger than by savings banks. Moreover, this effect is larger, the larger is the share of housing.

To analyze the extensive margin, columns 3 and 4 consider the effect of the housing bubble on acceptance rates. The coefficient on the interaction term is larger for commercial banks (.384) than for savings banks (.186). This differential effect implies that, given house price growth, the dispersion in acceptance rate is larger in commercial banks than savings banks.

In sum, the evidence reported in the Table challenges the view that saving banks were responsible for the misallocation of credit in Spain. Indeed, our results hint to a larger misallocation of credit to firms dealings with commercial banks than saving banks.

6.3 Low Interest Rates

One of the established explanations on the misallocation of capital in Spain is that low interest rates allowed small firms to overinvest (see, for example, Gopinath et al., 2015). A first reply to this narrative is that interest rates were the same in all municipalities in Spain and, yet, we find a differential effect across municipalities. That is, the allocation of capital was more distorted in housing supply inelastic municipalities. A second reply is to analyze how these effects changed between 2006 and 2007 when the ECB raised interest rates but house prices were still increasing..

Figure 3 reports the evolution of ECB interest rate between 2001 and 2009. As it can be seen, from 2001 until December 2005, the interest rate steadily declined. However, from the rate increase in December 2005, the interest rate sharply raised from 2.25% to 4% at the end of 2007. However, house prices still increased between 2006 and 2007 (see Figure 2). Therefore, this increase in interest rate in 2006 offers an opportunity to test whether house price growth had an effect on misallocation of capital beyond low interest rates. To test this hypothesis, we run the same baseline regression as Table 1 but with investment between 2006 and 2007 as dependent variable.

Table 6 reports the coefficient of running this regression. Column 1 reports the OLS coefficients. Column 2-4 reports the 2SLS coefficients for all the sample (column 2), only manufacturing (column 3) and only large firms (column 4). Note that the coefficient of the interaction term is positive and statistically significant in all four columns. Moreover, if we compare, for example, the coefficient in column 2 of Table 5 (1.145) with the coefficient in column 3 of Table 1 (1.396), they are not statistically different. Therefore, even though interest rates increased from 2.25% to 4% during 2006, the differential effect of house prices on investment was roughly the same.

In this section we have shown that the effect of the housing bubble on misallocation of capital is independent of the evolution of interest rates. Indeed, between 2006 and 2007, house prices were booming and interest rates rising. We have seen that if we restrict the analysis to this period we obtain the same qualitative and quantitative effects.

7 Concluding Remarks

Spain experienced a large housing bubble in the late 2000s. Even though bubbles are often associated with misallocation of resources, there has not been any empirical investigation of the effects of a housing bubble on allocation of capital and credit. In this paper we fill this paper by using matched firm- and bank-level data for Spain.

In order to guide the empirical evidence, we developed a model to analyze the effects of a housing bubble in the investment, credit and TFP of the economy. In the model, firms are financial constraint and differ only on the share of housing. First, we derived conditions under which rational housing bubbles can emerge. Then, we showed that, with a housing bubble, firms with housing increased their investment and credit. Finally, we showed that, with the housing bubble, the variance in the capital increases with the dispersion of housing across firms.

Our main contribution is the empirical analysis. We studied the effect of housing boom between 2004 and 2007 on the investment and credit of firms. We used housing supply elasticity as an instrument for house price growth of the municipality. We show that, given a share of housing, investment of firms in housing supply inelastic (high house price growth) municipalities increased more than in housing supply elastic (low house price growth) municipalities. In all regressions we controlled for total assets and size and industry fixed effects. We also showed that this result was robust to consider only manufacturing and large firms.

Then, we provided evidence on the mechanism behind this misallocation of capital. We found that there was a misallocation of credit. Given a share of housing, firms in housing supply inelastic municipalities were able to increase more their credit between 2004 and 2007 than firms in more elastic municipalities. As complementary evidence, we also documented an effect of the housing bubble on the extensive margin. Given the share of housing, firms in housing supply inelastic municipalities had higher acceptance rates.

Finally, we documented that this misallocation at the firm level can also be observed at the municipality level. We showed that both the variance in 2007 and the change of variance between 2004 and 2007 of the capital-labor ratio was higher in housing supply elastic municipalities. Moreover, this differential effect on the variance of capital implies that the housing bubble reduced aggregate TFP. Indeed, our back-of-the-envelope exercise implies that, with the bubble, the decline in TFP was 19.21% higher than if there had been no bubble.

To conclude, asset price bubbles are often attached to houses (Kindleberger and Aliber, 2011). However, we do not have a good understanding of why this is the case. In a related paper, Basco and Lopez-Rodriguez (2017) analyze the origins of the residential mortgage debt boom in Spain and hint to a possible feedback between financial regulation, housing bubbles and mortgage debt. In future work, we plan to further work on this idea to investigate the origin of housing bubbles.

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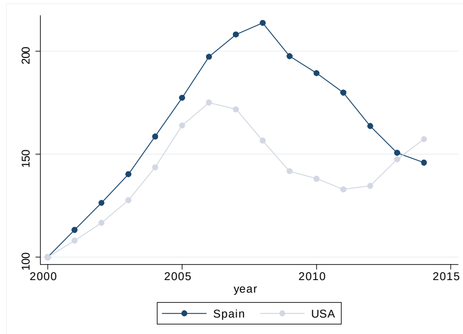
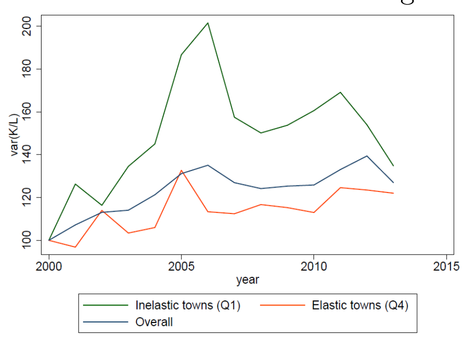
9 Figures and Tables

Figure 1: Housing Bubble in Spain.



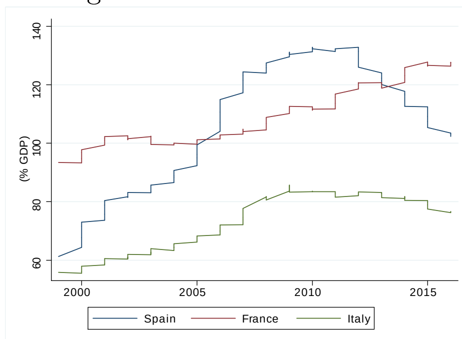
Note: House price index in Spain computed as median across CCAA (yearly data). For the United States it is the national home price Cass-Shiler index.

Figure 2: Misallocation and Housing Bubble



Notes: The green (red) is the variance of the capital-labor ratio for municipalities in the first (fourth) quartile of the housing supply elasticity. The blue line is the variance of the capital-labor ratio for all municipalities. See Section 4 for a data discussion.

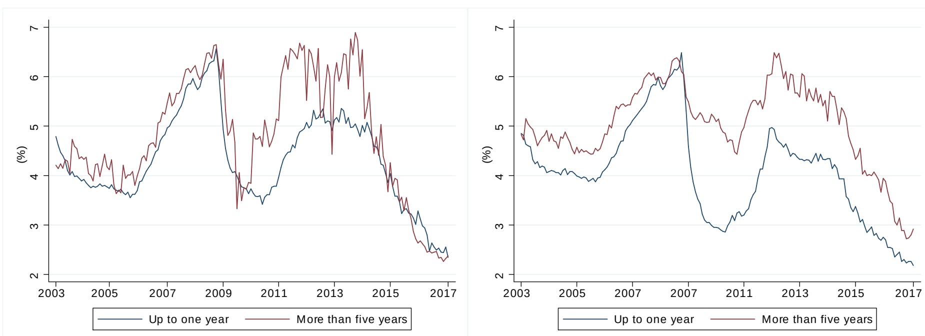
Figure 3: Non-Financial Debt



Note: Debt of non-financial institutions (over GDP). Data from Banco de España.

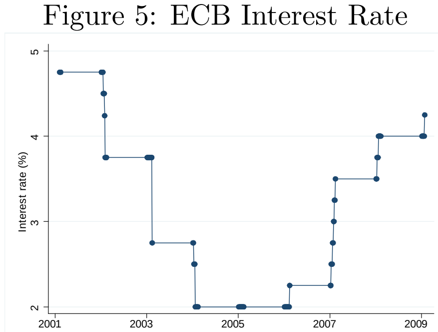
Figure 4: Interest Rate Spread

Spain | Italy



Note: interest rate on new loans of up to one million euros. Blue (red) line with maturity of up to one year (more than five years). Data from Banco de España.

Figure 5: ECB Interest Rate



Notes: ECB rate on the marginal lending facility.

Table 1: Housing Bubbles and Investment

	(1)OLS	(2)IV	(3)IV	(4)$IV-M$	(5)$IV-LF$
		$Dep.Var.:$	$Investment$		
House Prices$_c$	-.286***	-.114*	-.650***	-.814***	-1.684**
	(.012)	(.0676)	(.054)	(.157)	(.704)
Share Housing$_f$House Prices$_c$	.771***		1.396***	1.713***	4.769***
	(.0317)		(.0617)	(.0748)	(.469)
Total Assets$_f$	.002***	.002**	.002***	.003***	.001**
	(.0007)	(.0009)	(.0009)	(.0008)	(.0004)
Share Housing$_f$	-.257***		-4.373***	-.570***	-1.45***
	(.009)		(.0170)	(.0229)	(.131)
Size FE	Y	Y	Y	Y	N
Industry FE	Y	Y	Y	N	Y
No. Observations	136394	126170	122430	24032	4858

Notes: Dependent variable is investment of the firm between 2004 and 2007. Column 1 reports the coefficient of a OLS regression. Columns 2 to 5 report the coefficient of running 2SLS. In the first stage, house price growth is instrumentalized by housing supply elasticity. Column 4 constraints the sample to manufacturing firms. Column 5 constraints the sample to large firms. Clustered standard errors at municipality level. *, **,*** denote significant at 10, 5 and 1 percent, respectively.

Table 2: Housing Bubbles and Credit

	(1)OLS	(2)IV	(3)$IV-M$	(4)$IV-LF$
		$Dep.Var.:$	Increase	Credit
House Prices$_c$	-.050***	-.035	.149	-.446
	(.009)	(.147)	(.281)	(.588)
Share Housing$_f$House Prices$_c$	.161***	.335***	.580***	.709***
	(.017)	(.053)	(.078)	(.192)
Total Assets$_f$	-.001***	-.001**	-.002***	-.000
	(.0003)	(.0003)	(.0007)	(.000)
Share Housing$_f$	-.097***	-.143***	-.266***	-.199***
	(.008)	(.016)	(.027)	(.069)
Size FE	Y	Y	Y	N
Industry FE	Y	Y	N	Y
No. Observations	125972	113052	22804	4832

Notes: Dependent variable is increase in credit of the firm between 2004 and 2007. Clustered standard errors at municipality level in parentheses. *, **,*** denote significant at 10, 5 and 1 percent, respectively.

Table 3: Housing Bubbles and Credit

	(1)OLS	(2)IV	(3)$IV-M$	(4)$IV-LF$
		$Dep.Var.:$	Acceptance	Rate
House Prices_c	-.044***	-.251*	-.406	-.826
	(.012)	(.133)	(.328)	(.880)
Share Housing_fHouse Prices_c	.207***	.343***	.615***	.665*
	(.016)	(.036)	(.105)	(.399)
Total Assets_f	-.000	-.000	-.001**	-.000*
	(.0002)	(.0003)	(.0007)	(.0002)
Share Housing_f	-.066***	-.110***	-.174	-.153
	(.007)	(.011)	(.033)	(.030)
Size FE	Y	Y	Y	N
Industry FE	Y	Y	N	Y
No. Observations	136526	122549	24047	4893

Notes: Dependent variable is increase in credit of the firm between 2004 and 2007. Clustered standard errors at municipality level in parentheses. *, **,*** denote significant at 10, 5 and 1 percent, respectively.

Table 4: Housing Bubbles and Misallocation of Capital

	(1)OLS	(2)IV	(3)OLS	(4)IV
	$Dep.Var.:$	$Var(k)_{07}$	$Dep.Var.:$	$\Delta Var(k)_{04-07}$
House Prices_c	-2.19***	-2.59	-1.75***	-1.209
	(.388)	(2.97)	(.329)	(2.212)
$\text{Var(Hous.)}_{c,s}\text{HP}_c$	25.17***	34.36***	20.75***	27.13***
	(4.57)	(4.44)	(3.72)	(5.30)
$\text{Var(K/L)}_{2004,c,s}$			-.831***	-.811***
			(.117)	(.136)
Sector FE	Y	Y	Y	Y
No.Observations	6990	6257	6990	6257

Notes: Dependent variable is variance of k in 2007 for municipality and sector (column 1 and 2) and change in the variance between 2004 and 2007. Clustered standard errors at municipality level in parentheses. *, **,*** denote significant at 10, 5 and 1 percent, respectively.

Table 5: Robustness Check: Housing Bubbles and Investment - Large Municipalities

	(1)OLS	(2)IV	(3)$IV-M$	(4)$IV-LF$
	$Dep.Var.:$	$Investment$		
House $Prices_c$	-.309***	-.680***	-.849***	-2.41***
	(.016)	(1.40)	(.211)	(.905)
Share $Housing_f$House $Prices_c$	.850***	1.400***	1.645***	4.64***
	(.042)	(.070)	(.074)	(.458)
Total $Assets_f$	.002***	.003***	.003***	.001**
	(.001)	(.001)	(.001)	(.000)
Share $Housing_f$	-.276***	-.432***	-.550***	-1.40
	(.012)	(.019)	(.022)	(.128)
Size FE	Y	Y	Y	N
Industry FE	Y	Y	N	Y
No. Observations	115039	105725	19880	4303

Notes: Dependent variable is increase in credit of the firm between 2004 and 2007. We consider only municipalities with more than 5000people. Clustered standard errors at municipality level in parentheses. *, **,*** denote significant at 10, 5 and 1 percent, respectively.

Table 6: Robustness Check: Housing Bubbles and Credit - The Role of Savings Banks

	(1)$Banks$	(2)$Savings$	(3)$Banks$	(4)$Savings$
	$Dep.Var.:$	Credit Growth	$Dep.Var.:$	Acceptance
House $Prices_c$	-.015	-.077	-2.07**	.073
	(.158)	(.204)	(.360)	(.159)
Share $Housing_f$House $Prices_c$	.345***	.314***	.384***	.186***
	(.050)	(.076)	(.055)	(.050)
Total $Assets_f$	-.001**	-.008***	-.0004*	.001
	(.0003)	(.002)	(.0002)	(.001)
Share $Housing_f$	-.143***	-.127***	-.130***	-.077***
	(.016)	(.025)	(.018)	(.017)
Size FE	Y	Y	Y	N
Industry FE	Y	Y	N	Y
No. Observations	113359	43185	70008	52703

Notes: Dependent variable in columns 1 and 2 is increase in credit of the firm between 2004 and 2007. The dependent variable in columns 3 and 4 is acceptance rate. Column 1 and 3 consider commercial banks and columns 2 and 4 saving banks. These are 2SLS regressions. Clustered standard errors at municipality level in parentheses. *, **,*** denote significant at 10, 5 and 1 percent, respectively.

Table 7: Robustness Check: Housing Bubbles and Investment - Increase in interest rates

	(1)OLS	(2)IV	(3)$IV-M$	(4)$IV-LF$
	$Dep.Var.:$	$Investment$		
House Prices$_c$	-.154***	-.505***	-.611***	-1.54***
	(.008)	(.036)	(.092)	(.393)
Share Housing$_f$House Prices$_c$	.405***	1.145***	1.304***	3.901***
	(.021)	(.094)	(.087)	(.625)
Total Assets$_f$	.001***	.001***	.001**	.0001
	(.0002)	(.0002)	(.0004)	(.0002)
Share Housing$_f$	-.156***	-.414***	-.494***	-1.423***
	(.007)	(.032)	(.031)	(.220)
Size FE	Y	Y	Y	N
Industry FE	Y	Y	N	Y
No. Observations	173449	156181	27410	5375

Notes: Dependent variable is increase in investment of the firm between 2006 and 2007. Clustered standard errors at municipality level in parentheses. *, **,*** denote significant at 10, 5 and 1 percent, respectively.

10 Appendix A: The Model

This Appendix solves the fundamental (without bubble) equilibrium of the model described in Section 2 and derives the bubbly equilibrium.

Fundamental Equilibrium We start with the problem of the savers, which is to

$$\begin{aligned} Max\ U_t &= u(c_{t+1}) + u(h_{t+1}) \\ s.t. \quad e_t &= s_t \\ R_{t+1}s_t &= p_{t+1}h_{t+1} + c_{t+1} \end{aligned}$$

It then follows that the optimal choices are

$$\begin{aligned} s_t &= e_t, \\ h_{t+1} &= \frac{1}{2}\frac{R_{t+1}e_t}{p_{t+1}}, \\ c_{t+1} &= \frac{1}{2}R_{t+1}e_t. \end{aligned}$$

The solution to the problem of the entrepreneur is to choose the maximum amount of capital possible,[15]

$$k^i_{t+1} = \frac{\theta\left[p_{t+1}s^i_h H_t + \eta^i_t\right]}{R_{t+1}}.$$

We have only three markets in our economy, thus, we only need two market clearing conditions. In steady-state, the capital and housing market clearing conditions are

$$\begin{aligned} \int s^i di &= \int k^i di, \\ \int h^i di &= H^S. \end{aligned}$$

It then follows that the solution is given by the next two equations.

$$\begin{aligned} Re &= \theta\left[(M-\kappa)\eta + \left(\frac{Re}{2}\right)^{\frac{2+\varepsilon}{1+\varepsilon}}\right], \\ p &= \left[\frac{1}{2}Re\right]^{\frac{1}{1+\varepsilon}}. \end{aligned}$$

[15] Note that we are assuming that the borrowing constraint is binding, i.e., $F'\left(\frac{\theta\left[s^i_h p_t H + \eta^i_t\right]}{R}\right) > R$.

Equilibrium with Bubbles In order to guarantee that rational bubbles can emerge in equilibrium, we need to assume that

$$\theta < \theta^* = \frac{e}{(M-\kappa)\eta + \left(\frac{e}{2}\right)^{\frac{2+\varepsilon}{1+\varepsilon}}}.$$

We find the threshold θ^* by imposing $R(\theta^*) = 1$.As it is standard in the rational bubbles literature, the interest rate with the bubble is equal to one because in our economy there is no economic growth (see, for example, Basco, 2016).

As we explained in the text, the market clearing conditions with bubbles become,

$$\begin{aligned} \int s^i di &= \int k^i di + B(1) \\ \int h^i di + \frac{B}{P} &= H^S \end{aligned}$$

The two equations imply that the size of the bubble and house prices are given by

$$p = \left[\frac{e}{2} + B\right]^{\frac{1}{1+\varepsilon}}, \tag{13}$$

$$B = e - \theta\left[(M-\kappa)\eta + \left[\frac{e}{2} + B\right]^{\frac{2+\epsilon}{1+\varepsilon}}\right]. \tag{14}$$

From equation 14, it is straightforward to see that when $\theta = \theta^*$, the size of the bubble is zero. Thus, the size of the bubble will be positive when $\theta < \theta^*$. Moreover, note that the size of the bubble decreases with the housing supply elasticity (ε). Finally, from equation 13, we can see that house prices increase with the size of the bubble.

To conclude the derivation of equilibrium outcomes, note that the allocation of capital across firms is given by

$$k_i = \begin{cases} \frac{\theta(e+B)^{\frac{2+\varepsilon}{1+\varepsilon}}}{\kappa} & \text{if } i < \kappa, \\ \theta\eta & \text{if } i > \kappa. \end{cases}$$