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The financial transmission of housing bubbles: evidence from Spain

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Abstract

How do housing bubbles affect other economic sectors? We show that in the presence of collateral constraints, a bubble initially raises housing credit demand and crowds out credit to non-housing firms. If the bubble lasts, however, housing credit repayments raise banks' net worth and expand credit supply, so that crowding-out eventually gives way to crowding-in. This is consistent with evidence from the recent Spanish housing bubble. Initially, credit growth of non-housing firms was lower at banks with higher bubble exposure, and firms relying on these banks exhibited lower credit and output growth. During the bubble's last years, these effects reversed.

Keywords: Housing bubble, Credit, Investment, Financial Frictions, Financial Transmission, Spain.

JEL Codes: E32, E44, G21.

Non-technical summary

During the last decades, many countries experienced massive boom-bust cycles in house prices. Spain provides a good illustration for these episodes and their consequences. The spectacular 1995-2008 boom and 2008-2015 bust in Spanish house prices went hand in hand with an equally spectacular boom-bust cycle in real GDP. This suggests that bubbles have spillovers to the rest of the economy, for instance through the credit market. Indeed, Spain experienced a credit boom, and the share of construction and real estate in total firm credit increased from 22% in 1995 to 48% in 2007. However, it is not clear whether the massive expansion of housing firms reduced or increased the availability of credit for non-housing firms.

A priori, there are good reasons for both sides of the argument. On the one hand, the massive credit demand for housing may have crowded out credit from other sectors. On the other hand, higher house prices might also have stimulated credit in other sectors by providing collateral or attractive assets for securitization. In a recent paper with Alberto Martín and Enrique Moral-Benito, we argue that these views are not mutually exclusive, but describe two phases of the same phenomenon: housing bubbles initially crowd out credit from other sectors, but eventually – if they last long enough – crowd it in.

Our argument relies on a simple macroeconomic model in which banks and firms face financial constraints, meaning that the amount they can borrow depends on their current wealth. When a housing bubble appears, housing firms get wealthier and demand more bank credit. Banks cannot increase their credit supply, as the bubble does not immediately affect their wealth. Therefore, the bubble initially lowers credit to non-housing firms.

As long as the bubble lasts, however, housing firms repay their loans. This increases the banks' wealth, enabling them to borrow more from abroad and to expand credit supply. This reverses the initial decline in non-housing credit and eventually even leads to its expansion. Finally, the collapse of the bubble lowers loan repayments to banks, triggering a general credit crunch.

To show that these effects were at work in Spain, we use a dataset from the Spanish Central Bank that contains essentially all bank loans to firms. We note that some banks were more exposed to the bubble, having business models focused on housing or being located in regions with greater house price increases. Then, non-housing credit should initially grow less at more exposed banks than at less exposed ones, but this pattern should reverse later. This is indeed what we find in the data.

These findings persist when controlling for systematic differences between clients of different banks, and extend to the firm level: firms borrowing from more exposed banks had initially lower credit growth, higher credit growth in the last years of the bubble, and lower credit growth during the crisis. The same results hold for value added.

Summing up, our research suggests that concerns about housing bubbles absorbing credit needed in other sectors is likely to be temporary. However, the crowding-in effect of bubbles is also fragile, as bubbles can burst. Finally, our results generalize to other sector-specific shocks beyond bubbles, highlighting the role of the financial system as a transmission mechanism between sectors.

1 Introduction

During the last two decades, many economies experienced massive boom-bust cycles in house prices. These housing "bubbles", which occurred in the United States, the United Kingdom, Spain and Ireland, and may be ongoing in China, are widely believed to have important effects not only for the housing sector, but also for the broader economy (see Zhu, 2014 and Jordà et al., 2015a). Thus, understanding the channels through which they affect other economic sectors has become a key concern for economists and policymakers.

In this paper, we analyze the transmission of housing bubbles through the credit market. Despite its importance, the role of this market is a priori unclear. On the one hand, it has been argued that housing bubbles raise the demand for mortgages and credit to real estate and construction firms, reallocating credit towards housing at the expense of non-housing firms (e.g., Chakraborty et al., 2018). On the other hand, housing bubbles have also been identified as a source of credit booms extending to all sectors of the economy, including non-housing ones (e.g. Jimenez et al., 2014).

Our paper makes two main contributions. First, we construct a macroeconomic model of housing bubbles and show that they have conflicting crowding-out and crowding-in effects through the credit market. Crucially, these effects play out at different moments in time. While a housing bubble initially crowds out non-housing credit and investment by reallocating credit to the housing sector, it eventually crowds them in by raising the net worth of the banking sector and thus credit supply. Second, we use a detailed bank and firm-level database to show that these theoretical predictions are in line with the Spanish experience during the recent housing boom and bust. These findings imply that the contrasting views outlined above are not mutually exclusive, but instead describe two phases of the same phenomenon.

Our theoretical analysis is based on an overlapping-generations, small-open economy that produces two goods, housing and non-housing. The economy is populated by housing entrepreneurs, non-housing entrepreneurs, and bankers. In order to invest in capital, entrepreneurs from both sectors borrow from bankers, which in turn borrow from an international financial market. Crucially, we assume that the borrowing of entrepreneurs and bankers is limited by a collateral constraint, as they cannot credibly promise to repay more than a fraction of their future income to their creditors.

Housing entrepreneurs are endowed with land, which is used in housing production and traded in a competitive market. At any point in time, the fundamental value of land is the present value of its future marginal products. The market value of land, however, may exceed this value if it contains rational bubbles: in certain periods, housing entrepreneurs may be willing to buy land at a price exceeding its fundamental value because they expect to resell it at a high price in the future. We refer to such episodes as housing bubbles.

When a housing bubble starts, we find that it at first crowds out credit and investment in the non-housing sector. Indeed, the bubble raises the collateral of housing entrepreneurs and enables them to expand their credit demand. As credit supply is unaffected, this increases the domestic interest rate and reallocates credit (and investment) from the non-housing to the housing sector. As time passes and the bubble continues, however, crowding-out gives way to crowding-in. The reason is that the repayment of housing credit eventually raises the net worth of bankers, which enables them to borrow more from the international financial market and to expand the domestic credit supply. Thus, the rise in the interest rate is reversed, and credit and investment in the non-housing sector start to increase. If the bubble lasts long enough, we show that this crowding-in effect outweighs the initial crowding-out effect: the housing bubble ends up raising credit to all sectors, including the non-housing one.

However, a rational bubble is only sustained by the expectation that land prices continue to be high in the future. When these expectations change, the bubble bursts and land prices collapse. This wipes out the collateral of housing entrepreneurs and lowers their credit demand. It also reduces loan repayments received by bankers, thereby reducing their net worth and contracting their credit supply. Jointly considered, these effects trigger a sudden stop in borrowing from the international financial market, an increase in the domestic interest rate, and a fall in credit and investment both in the housing and non-housing sectors.

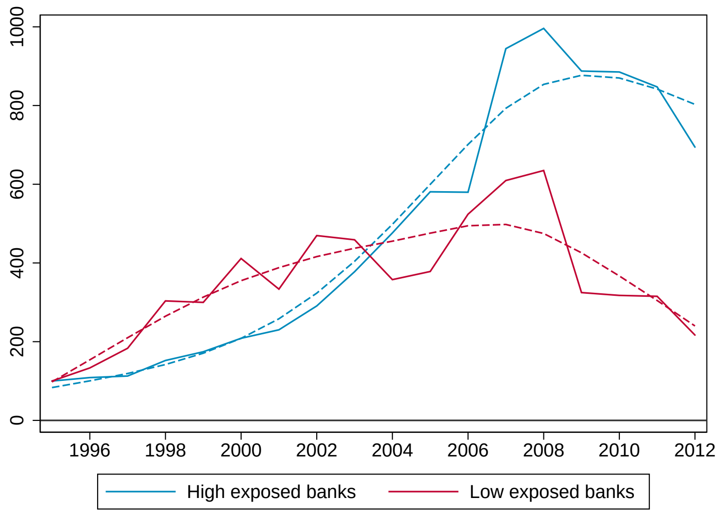
The main prediction of our model is the non-monotonic pattern of credit in non-housing sectors: a housing bubble first lowers non-housing credit, but eventually raises it again. In order to test this prediction, we use data from the massive boom-bust cycle in Spanish housing prices between 1995 and 2015. This cycle is generally interpreted as the result of a housing bubble, and therefore provides an ideal laboratory for our model. However, it is important to stress that our main theoretical prediction is not specific to bubbles: the same pattern of crowding-in and crowding-out effects could arise in housing cycles driven by productivity shocks or financial innovations (e.g., changes in the extent to which income can be pledged to bankers). Thus, our empirical analysis is not designed to establish whether the housing cycle in Spain was driven by a bubble, but rather to understand the financial transmission of that cycle to the non-housing sector.

The boom-bust cycle in Spanish housing was spectacular. Between 1995 and 2008, Spain experienced a threefold increase in housing prices and in the number of new houses built. In 2008, this boom gave way to a prolonged bust: by 2015, house prices had fallen by a third from the 2008 peak, and there were essentially no new houses being built.[1] The housing bubble was accompanied by a credit and investment boom, and a surge in capital inflows. Its burst coincided with a long and deep recession (Baldwin et al., 2015).

[1]These developments are discussed in greater detail in Section 2.

While our model is consistent with most of these aggregate developments, we aim to test it more directly, by confronting its main predictions with micro-level data from the Spanish Credit Registry (which contains information on virtually all loans to commercial firms). Our empirical strategy relies on the fact that not all banks were equally exposed to the bubble, as their business models did not assign the same importance to housing. Using a simple extension of our model with heterogeneous banks, we show that the crowding-out and crowding-in effects should then be observed at the bank level. Credit to non-housing firms should initially grow less at highly exposed banks relative to less exposed ones, but this pattern should reverse in later years and credit to non-housing firms should actually grow more at more exposed banks. Figure 1 shows that this prediction is in line with the evidence, by plotting the evolution of total credit to non-housing firms for the Spanish banks in the highest and lowest deciles of our baseline measure of exposure to the housing bubble.[2] In the first years after the start of the housing bubble in the late 1990s, credit to non-housing firms grew less in the most exposed banks. However, this pattern eventually reversed and towards the end of the bubble, credit to non-housing firms had actually grown more in the most exposed banks.

Figure 1: Credit to non-housing firms in different banks



Source: CIR and authors' calculations (see Section 5 for details). High (low) exposed banks are above (below) the 90th (10th) percentile of the exposure measure. Both series are normalized to 100 in 1995. Dashed lines are HP trends of the original series.

While the pattern shown in Figure 1 is suggestive, it may be due to systematic differences between the clients of high and low-exposure banks. To control for these factors, we regress annual credit growth of non-housing firms at the loan level (that is, for any bank-firm pair) on bank exposure to the housing bubble and firm-time

[2]Throughout, we define non-housing firms as firms which do not belong to the construction or real estate sectors. Our baseline measure of exposure to the housing bubble is the bank's ratio of mortgage-backed credit to total credit between 1992 and 1995, before the beginning of the bubble (dated by most observers, such as for instance Fernández-Villaverde et al. (2013), in the second half of the 1990s). This measure captures a bank's ability to assess real estate collateral. We consider two alternative measures of exposure in our empirical analysis, and results are unchanged.

fixed effects, following Khwaja and Mian (2008). Firm-time fixed effects control for firm-level shocks to credit demand. Coefficients are thus identified by differences in the credit growth of the same firm with more or less exposed banks, and only reflect changes at the bank-level. These regressions confirm the model's predictions: for the same firm, annual credit growth is significantly lower at more exposed banks during the first years of the bubble, but then becomes significantly higher at these banks. We also provide evidence that the eventual crowding-in is driven by changes in bank net worth, as predicted by the model. Finally, during the crisis, we show that credit growth at more exposed banks again becomes significantly lower.

To conclude, we extend our empirical analysis to firm-level outcomes. If non-housing firms could freely switch across banks, crowding-out and crowding-in should be aggregate phenomena affecting all non-housing firms in the same way. If frictions prevent firms from switching banks easily, however, the credit growth of a specific firm is likely to depend on its pre-existing bank relationships. To test whether these frictions are empirically relevant, we regress annual credit growth at the firm-level on a weighted average of housing bubble exposure of all banks from which the firm borrows. We find that indeed, firms that borrow more from more exposed banks experienced lower credit growth during the first years of the bubble, higher credit growth in its last years, and lower credit growth during the crisis. These results are confirmed when we consider value added growth instead of credit growth, showing that the differences in credit growth had real effects.

Our paper is related to several strands of literature. First, it relates to a growing body of work studying the role of housing for macroeconomic fluctuations (see Iacoviello (2010) and Piazzesi and Schneider (2016) for two recent surveys). Most of this literature analyzes consumption dynamics. For instance, Kaplan et al. (2017) recently showed that belief-driven changes in house prices account for a large part of aggregate fluctuations in the United States, mainly through wealth effects in consumption (the empirical importance of which is also underlined by Mian and Sufi, 2011). Guerrieri and Uhlig (2016) analyze the general relationship between housing and credit booms. We complement this work by focusing on the transmission of housing booms to the rest of the economy through the credit market.

Several empirical papers have studied the effect of house prices on credit and investment. Some provide evidence for a positive effect through a collateral channel, with higher house prices increasing the value of corporate headquarters for listed firms (Chaney et al., 2012) and of private homes for entrepreneurs (Adelino et al., 2015; Bahaj et al., 2017). Jimenez et al. (2014) argue for a positive effect of housing on banks' credit supply during the Spanish boom, driven by mortgage securitization. On the other hand, Chakraborty et al. (2018) show that banks which were more exposed to the US housing boom reduced their loans to firms, as mortgages crowded out corporate credit. Finally, Hernando and Villanueva (2014) and Cuñat et al.

(2016) show that banks that were exposed to housing reduced their lending across the board when housing prices fell, both in the United States and in Spain. Our paper shows that these findings are not mutually incompatible, but capture different phases of the transmission of a housing bubble through the credit market. Most importantly, we show that the crowding-out of non-housing credit documented by Chakraborty et al. (2018) eventually gives way to crowding-in. While the latter finding is in line with Jimenez et al. (2014), we argue that crowding-in is driven by an increase in bank net worth rather than by access to securitization, and provide some suggestive evidence in this direction.

More generally, our paper relates to a small but growing literature emphasizing the role of the financial system for the transmission of sectoral shocks. For instance, Bigio and La'O (2016) use a network model to study how sectoral financial shocks propagate through the economy. Bustos et al. (2017) show that Brazilian banks that are more exposed to regions experiencing an increase in agricultural profits expand their lending to non-agricultural firms elsewhere in the country. This finding is somewhat reminiscent of our crowding-in effect, by which banks that are more exposed to the housing bubble eventually expand their lending to non-housing firms.

The theoretical model in this paper builds on Martín and Ventura (2012), who develop a framework for analyzing the interaction between rational bubbles and credit when the former provide collateral. Martín and Ventura (2015) extend this model to an open-economy setting, and use it to study the relationship between bubbles, credit and capital flows. With respect to their work, our model adds financial intermediaries, multiple sectors and bank heterogeneity, enabling us to study the role of bank net worth in the propagation of sectoral (bubble) shocks.[3] In this regard, our model is the first to study the transmission of sectoral bubbles through financial intermediaries.

Finally, our paper adds to the large literature on credit booms and busts (including Jordà et al., 2015b; Mendoza and Terrones, 2008, 2012; Reinhart and Rogoff, 2009, 2014). These studies document that credit booms tend to be accompanied by capital inflows and rising house prices, and increase the risk of financial crises. Our paper is consistent with these stylized facts, and provides additional details on Spain. The Spanish experience itself has also been the focus of extensive research (see, for instance, Fernández-Villaverde et al., 2013; Akin et al., 2014; Santos, 2017a, 2017b), investigating the origins of the housing bubble, the drivers of capital inflows and the flaws of the Spanish banking system. While we build on some of the insights of these studies, we do not aim to provide a unified narrative for Spain's economic development during the

[3]Other related models include Arce and López-Salido (2011), who study the interaction of housing bubbles with collateral constraints, and Basco (2014), who studies the relationship of bubbles with financial liberalization. Ventura (2012) studies the interaction between bubbles and capital flows, but in his setting, bubbles affect the cost of capital and not the stock of credit. Den Haan et al. (2003) propose a model of macroeconomic fluctuations in which lenders are financially constrained.

period. For instance, we do not investigate whether the housing bubble was caused by the fall in Spanish real interest rates after the creation of the Euro, or decompose aggregate dynamics to see which part is explained by movements in the real interest rate and by the housing bubble.[4] Instead, we take the housing bubble as given and focus on its transmission to the rest of the economy through the credit market.

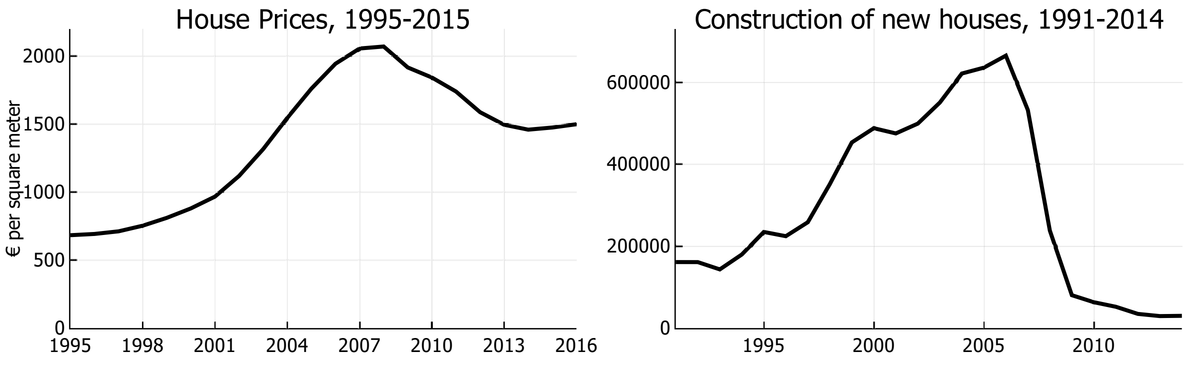
The remainder of the paper is structured as follows. Section 2 provides some background information about the Spanish boom and bust. Section 3 sets out our model of housing bubbles, and Section 4 illustrates its results and predictions. Section 5 tests the theoretical predictions with micro data, and Section 6 concludes.

2 The Spanish boom and bust

2.1 The housing bubble

In the middle of the 1990s, according to Jimeno and Santos (2014, P. 128), "*the Spanish economy [had] developed some characteristics that made it especially prone for a housing bubble*": the banking sector was able to attract capital inflows, construction firms had built up large capacities during earlier infrastructure projects, and the Spanish population was young and growing fast. Rising house prices were sustained by changes in zoning and land use regulations in 1997 and 1998 (which decentralized and liberalized the granting of housing permits), and weak lending standards, especially in regional banks subject to capture by local political elites (Fernández-Villaverde et al., 2013; Akin et al., 2014). As a result, both nominal house prices and the construction of new houses tripled between 1995 and 2008, as shown in Figure 2.

Figure 2: House Prices and Housing Construction



Source: Ministry of Construction. See Appendix B for further details.

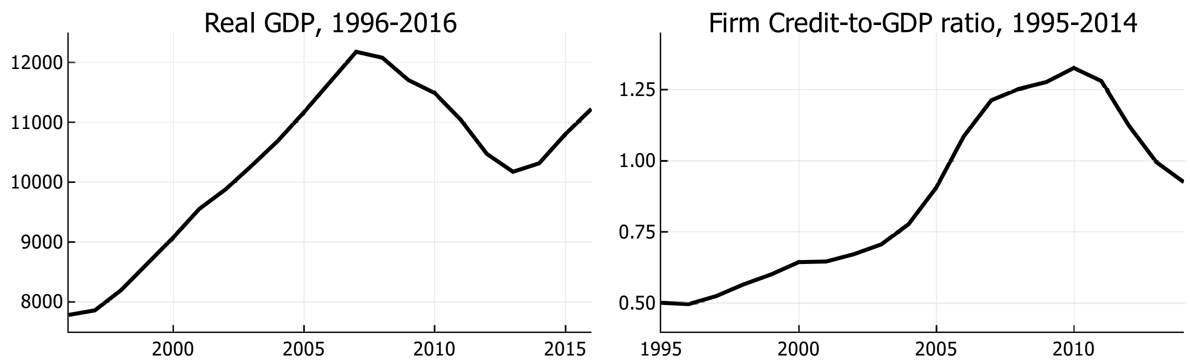
[4]We also abstract from the rising misallocation of capital during the period, documented by García-Santana et al. (2016) and Gopinath et al. (2017), and potentially responsible for Spain's low aggregate productivity growth. Basco et al. (2017) argue that the housing bubble was partly responsible for the increase in capital misallocation, as too many resources were channeled to unproductive firms with high real estate collateral, especially in municipalities with fast-growing housing prices.

The boom was followed by a spectacular collapse. Prices fell six years in a row, and in the years between 2010 and 2014, yearly housing construction represented only 6% of the pre-crisis peak. In the next section, we provide some further details on the macroeconomic context of this housing cycle.

2.2 GDP, credit, and capital inflows

Between 1995 and 2008, Spain experienced an economic boom, with the real GDP of the business economy increasing on average by 3.8% per year (see the left panel of Figure 3). This was followed by a deep crisis during which real GDP fell five years in a row. The expansion saw a credit boom, both in mortgage credit to households and in credit to firms.[5] The right panel of Figure 3 illustrates the latter point by plotting the ratio of firm credit to business-economy GDP, showing that this leverage ratio doubled between 1995 and 2008. Leverage continued to rise until 2010 (as credit fell more slowly than GDP), before deleveraging set in. The credit boom was financed by banks, which channeled capital inflows to firms and households. As a consequence, the external debt of Spanish banks almost tripled between 2002 and 2007.[6]

Figure 3: Real GDP and leverage of the Spanish business economy, 1995-2014



Source: INE and Bank of Spain. The right panel plots the ratio between credit to productive activities and business economy GDP (including all sectors except public administration, defense, social security, health, education, arts and entertainment).

A simple accounting decomposition shows that housing sector dynamics contributed substantially to these aggregate developments, most of all for credit. Figure 4 shows that the share of housing (construction and real estate firms) in business economy GDP increased substantially during the boom, from 18% in 1997 to 25% in 2007. The composition change for credit, however, was much more extreme: while housing made up 22% of firm credit in 1995, that share had increased to 48% in 2007. Had the GDP share of housing

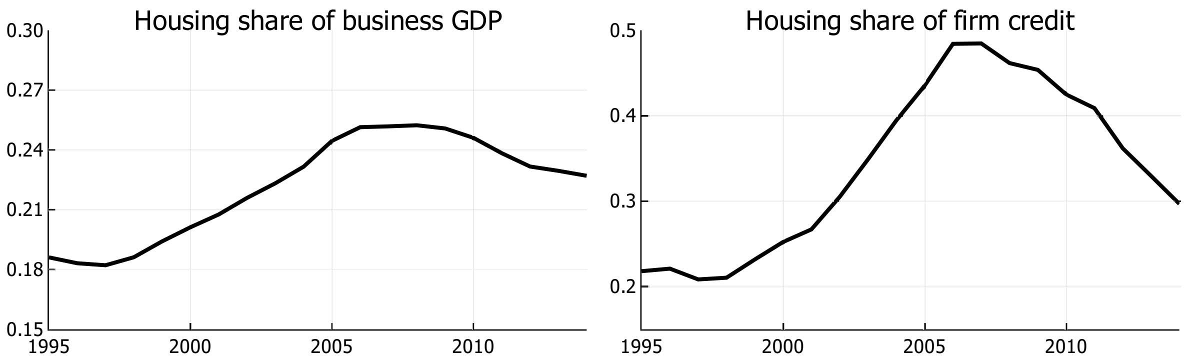
[5]This fact differentiates Spain from the contemporaneous experience of the United States, where firm leverage did not increase during the housing boom (Mian and Sufi, 2011).

[6]Statistical bulletin of the Bank of Spain, Series 17.31 (https://www.bde.es/webbde/es/estadis/infoest/bolest17.html).

remained constant between 1995 and 2007, and had leverage increased by the same rate than in the rest of the economy, the overall increase in the Spanish firm leverage ratio shown in Figure 3 would only have been half as large (37 instead of 71 percentage points). Furthermore, the large increase in household credit during the boom was almost entirely driven by mortgage lending.

The drivers of Spain's extraordinary boom-bust cycle have been widely debated. Clearly, productivity was not one of them, as Spain actually experienced negative growth in total factor productivity (TFP) throughout, particularly so in the housing sector.[7] Instead, the fall in real interest rates after the creation of the Euro and the housing bubble itself are generally regarded as the key drivers of aggregate dynamics.

Figure 4: Composition of business GDP and firm credit, 1995-2014



Source: INE and Bank of Spain. See Appendix B for details.

These explanations are of course not mutually exclusive. Our aim in this paper is not to judge their relative importance in accounting for Spain's boom-bust cycle, or to provide an exhaustive picture of all channels through which they may have affected the rest of the economy. Instead, we start from the premise that Spain experienced a housing bubble, and then study its spillover effects to the rest of the economy through the credit market. In particular, we are interested in analyzing whether the massive credit growth for housing firms shown in Figure 4 slowed down credit and investment growth in other sectors, or whether it actually stimulated them. In the next section, we present a simple model to address these questions in a systematic and rigorous manner.

[7] According to the EU KLEMS database (`http://www.euklems.net/`), construction sector TFP declined by 24% between 1995 and 2007. However, the popular conception that misallocation of capital inflows to the low-productivity construction sector caused the aggregate TFP decline is inconsistent with the data. Indeed, housing accounts only for a small part of the aggregate decline, which was observed in virtually all sectors (Fernández-Villaverde et al., 2013; García-Santana et al., 2016). Gopinath et al. (2017) argue instead that capital inflows were misallocated within manufacturing industries, helping only financially unconstrained firms (rather than the most productive ones) to expand.

3 A two-sector model of bubbles and financial intermediation

This section develops a model of a small open economy with two sectors, housing and non-housing. In both sectors, entrepreneurs borrow from domestic banks to finance capital accumulation. Banks, in turn, borrow from international financial markets. Crucially, all lending relationships are subject to collateral constraints. We model the housing bubble by introducing an additional asset, land. Land is used in housing production and held by housing entrepreneurs, who can use the income it generates as collateral. Importantly, land prices are prone to fluctuations driven by rational bubbles. When land prices increase, so does the value of housing entrepreneurs' collateral and thus their credit demand. However, the loan repayments sustained by this collateral eventually also raise the net worth of banks, allowing them to increase credit supply. This interplay between credit demand and credit supply is at the heart of our theoretical results.

In the model, boom-bust cycles are therefore driven by rational bubbles: land prices may rise because agents expect them to rise even more in the future, and may collapse because expectations change. This modeling choice provides a simple way of introducing price fluctuations that are fully consistent with rational expectations. However, our results would not change if land prices were driven by other factors (for instance, by belief and preference shocks, as in Kaplan et al., 2017). Note, moreover, that housing booms in the model are driven by the price of land and not of structures. This is in line with the empirical evidence. Indeed, Piazzesi and Schneider (2016, P. 1560) note that in the United States, "*movements in the value of the residential housing stock are mostly due to movements in the value of land*".

3.1 Agents, preferences and technologies

Agents and preferences Time is discrete ($t \in \mathbb{N}$). We consider a small open economy populated by generations of agents that live for two periods. Agents are risk-neutral and derive utility from their old-age consumption of the economy's final good. Thus, for agent i born in period t, utility is given by

$$U_{i,t} = E_t \left(C_{i,t+1} \right), \tag{1}$$

where $C_{i,t+1}$ denotes the consumption of agent i in period $t+1$. Each generation of agents consists of three types: housing entrepreneurs, non-housing entrepreneurs, and bankers. We consider throughout symmetric equilibria in which all agents of a certain type are identical. This allows us to focus, without loss of generality, on the representative agent for each type and generation.

Agents derive their income either from their participation in the production process or from their role in credit intermediation. Therefore, we next describe the production structure.

Production The final good is assembled by competitive firms from two intermediate goods, housing (H) and non-housing (N), according to the Cobb-Douglas production function

$$Y_t = (Y_{N,t})^{\tau} (Y_{H,t})^{1-\tau}, \quad \text{with } \tau \in (0,1). \tag{2}$$

The final good is tradable, and we normalize its price to 1. Intermediate goods, on the other hand, are not tradable. Letting $P_{N,t}$ and $P_{H,t}$ denote the prices of the intermediate goods in period t, cost minimization by final goods producers implies

$$\frac{Y_{N,t}}{Y_{H,t}} = \frac{\tau}{1-\tau} \frac{P_{H,t}}{P_{N,t}}. \tag{3}$$

Furthermore, perfect competition implies that the price of the final good is equal to its marginal cost, so that

$$\left(\frac{P_{N,t}}{\tau}\right)^{\tau} \left(\frac{P_{H,t}}{1-\tau}\right)^{1-\tau} = 1. \tag{4}$$

Intermediate goods are also produced by perfectly competitive firms. These firms use a Cobb-Douglas production function combining capital, labor and land, given by

$$Y_{j,t} = (L_{j,t})^{1-\alpha_j-\beta_j} (K_{j,t})^{\alpha_j} (T_{j,t})^{\beta_j} \text{ for } j \in \{N, H\}, \tag{5}$$

where $L_{j,t}$ stands for the labor employed by sector j in period t, $K_{j,t}$ for its capital stock and $T_{j,t}$ for its land use. α_j and β_j are two positive parameters satisfying $\alpha_j + \beta_j < 1$. For simplicity, we assume that $\beta_N = 0$, implying that land is only used in housing production.

Factor supply All three production factors are supplied by entrepreneurs. Each generation of j-sector entrepreneurs inelastically supplies one unit of sector-specific labor when young. Furthermore, young entrepreneurs have access to a sector-specific investment technology, which allows them to convert one unit of the final good in period t into one unit of their sector's capital in period $t+1$.

Finally, young housing entrepreneurs are also endowed with one unit of land, which can be used in production when they are old. This implies that the aggregate stock of land grows over time, as a new land "vintage" is added in every period. We interpret this growth in the stock of land as capturing the granting of construction permits to housing entrepreneurs. As shown by Fernández-Villaverde et al. (2013), this was a key feature of the Spanish housing boom, and it plays an important role in our model as well.

Our assumptions entail that all production factors are sector-specific. This is convenient because it eliminates all direct spillovers of a housing bubble through factor markets, and thus enables us to isolate its transmission through the credit market. However, factor specificity is not necessary for our results.[8]

We assume throughout that capital depreciates fully, and that land is productive for just one period. This last assumption simplifies the model by ensuring that the stock of productive land at any given point is constant and equal to one. As we show in Appendix A.1, none of our main results relies on this assumption.

Factor markets and equilibrium production of intermediate and final goods As land and labor are specific factors, Equation (5) pins down the output of each sector for a given level of the capital stocks. Factor markets being competitive, the wage for each type of labor $j \in \{N, H\}$ equals its marginal product,

$$w_{j,t} = (1 - \alpha_j - \beta_j) \cdot P_{j,t} \cdot (K_{j,t})^{\alpha_j} \,, \tag{6}$$

where we have already used the fact that in equilibrium, $L_{N,t} = L_{H,t} = T_{H,t} = 1$. Likewise, the rental rates of capital and land are also equal to their marginal products,

$$r_{j,t} = \alpha_j \cdot P_{j,t} \cdot (K_{j,t})^{\alpha_j - 1} \,, \tag{7}$$

where $r_{j,t}$ denotes the rental rate of capital in sector j, and

$$m_t = \beta_H \cdot P_{H,t} \cdot (K_{H,t})^{\alpha_H} \,. \tag{8}$$

where m_t denotes the rental rate of land. Thus, summing up, for a given level of capital stocks in both sectors, Equations (2) to (8) jointly determine the production and price of each intermediate good, the return to the three production factors, and the production of the final good.

Finally, there is also a land market, in which old housing entrepreneurs can sell their land holdings to young housing entrepreneurs. We assume that trade takes place after land has been used in production, and use V_t to denote the total market value of pre-existing (or "old") land traded in period t. As land is traded after being used in production, and because of our simplifying assumption that land is productive for only one period, old land is unproductive. This raises the question of how V_t is determined in equilibrium, which we postpone until Section 3.3. Here, it suffices to say that in principle, different "vintages" of land could have

[8] As we show in Appendix A.1, allowing for labor reallocation across sectors does not affect our main predictions.

different market values. We denote by $V_{\tau,t}$ the market value at time t of land which has been created in period τ. Naturally,

$$\forall t \geq 1, \quad V_t = \sum_{\tau=0}^{t-1} V_{\tau,t},$$

where $V_{\tau,t} \geq 0$ for all τ and t due to free disposal. For simplicity, we refer to V_t as the value of land from now on.

To complete the characterization of equilibrium, we need to determine the laws of motion of the capital stocks in both sectors. These depend on the interest rate, and to derive it, we now turn to the credit market.

3.2 The credit market

Our small open economy is embedded in an International Financial Market (IFM), which is risk-neutral and willing to borrow or lend at the expected (gross) international interest rate R^*. However, we assume that only bankers have the know-how to collect payments from domestic entrepreneurs, making them necessary intermediaries between domestic credit demand and the IFM. Thus, the domestic credit market equilibrium is determined by the behavior of entrepreneurs, who demand credit, and of bankers, who supply it.

As we explain below, we impose only one constraint on credit contracts: they need to be collateralized. Throughout, we focus on equilibria in which this constraint is binding, i.e., in which the return to capital exceeds the domestic interest rate, which in turn exceeds the international interest rate. Therefore, all domestic agents want to expand their borrowing, but their binding collateral constraints prevent them from doing so. Keeping this in mind, we now characterize the equilibrium of the domestic credit market by solving the optimization problem of entrepreneurs and bankers.

3.2.1 Credit demand

We assume that young entrepreneurs can trade state-contingent credit contracts with bankers. Repayments may be stochastic because, as we will see shortly, housing entrepreneurs' collateral includes land, whose value may be prone to stochastic fluctuations in equilibrium.

Consider a credit contract that gives $Q_{j,t}$ units of credit in period t to the representative young entrepreneur of type j against the promise of a stochastic repayment $F_{j,t+1}$ in period $t+1$. We define the domestic interest rate R_{t+1} as the expected return to this credit contract, which must be equalized across both types of entrepreneurs in equilibrium:

$$R_{t+1} = \frac{E_t(F_{j,t+1})}{Q_{j,t}} \quad \text{for } j \in \{N, H\}\,. \tag{9}$$

Domestic entrepreneurs take the interest rate as given. Therefore, the budget constraints of an entrepreneur of type j during youth and old age are given by

$$K_{j,t+1} = w_{j,t} + \frac{E_t(F_{j,t+1})}{R_{t+1}} - \mathbb{1}_j^H \cdot V_t, \tag{10}$$

$$C_{j,t+1} = r_{j,t+1} \cdot K_{j,t+1} - F_{j,t+1} + \mathbb{1}_j^H \cdot (m_{t+1} + V_{t+1}), \tag{11}$$

where $\mathbb{1}_j^H$ is an indicator function equal to one if $j = H$ and zero otherwise.

Equation (10) shows that young entrepreneurs use their wage and the credit obtained from banks to invest in capital and, in the case of housing entrepreneurs, to purchase the economy's stock of pre-existing land. Note that entrepreneurs never save by lending to the IFM, because we focus throughout on equilibria in which entrepreneurs are constrained. Equation (11), in turn, shows that the old-age consumption of entrepreneurs equals their capital and land income, net of loan repayments.

Entrepreneurial borrowing is subject to a collateral constraint. In particular, we assume that the repayment promised by the young entrepreneur of sector j must satisfy

$$F_{j,t+1} \leq \lambda_j \cdot (r_{j,t+1} \cdot K_{j,t+1}) + \mathbb{1}_j^H \cdot (m_{t+1} + V_{t+1}), \text{ with } \lambda_j \in (0,1). \tag{12}$$

Thus, the entrepreneur cannot promise payments exceeding a fraction λ_j of her capital income and – in the case of housing entrepreneurs – whatever income is derived from land.[9] The collateral constraint can be interpreted as the result of imperfect contract enforcement. For instance, if creditors can seize only a fraction λ_j of entrepreneurs' capital income in the event of default, the latter cannot pledge repayments exceeding this.

Since we focus on equilibria in which the credit constraints of entrepreneurs bind, the return to capital must exceed the domestic interest rate, i.e., $r_{j,t+1} > R_{t+1}$ for $j \in \{N, H\}$. Hence, it is optimal for young entrepreneurs to borrow as much as possible, and Equation (12) holds with equality in all states of nature. Taking this into account, we can combine it with Equation (9) and aggregate across both sectors to obtain the total credit demand by entrepreneurs,

$$Q_t^D = \frac{\sum_{j \in \{N,H\}} \lambda_j \cdot r_{j,t+1} \cdot K_{j,t+1} + m_{t+1} + E_t(V_{t+1})}{R_{t+1}}. \tag{13}$$

[9] The assumption that land income is fully pledgeable is not essential for any of our results, but it greatly simplifies the algebra. See Martín and Ventura (2018) for a detailed discussion of this point.

Equation (13) shows that credit demand, denoted by Q_t^D, is increasing in the expected value of entrepreneurial collateral and decreasing in the domestic interest rate R_{t+1}. By combining this expression with Equation (10), we obtain the law of motion for the capital stock in sector j:

$$K_{j,t+1} = \frac{R_{t+1}}{R_{t+1} - \lambda_j \cdot r_{j,t+1}} \cdot \left(w_{j,t} + \mathbb{1}_j^H \cdot \left[\frac{m_{t+1} + E_t(V_{t+1})}{R_{t+1}} - V_t \right] \right) \tag{14}$$

Equation (14) shows that the future capital stock in each sector depends on the net worth of young entrepreneurs and on a financial multiplier that reflects the extent to which the net worth can be leveraged in the credit market.[10] The net worth includes wages and, in the case of housing entrepreneurs, whatever additional income is obtained from trading and using land. The financial multiplier, in turn, is decreasing in the interest rate R_{t+1} and increasing in the ability of the entrepreneur to pledge her future income λ_j.

3.2.2 Credit supply

Bankers intermediate funds between domestic entrepreneurs and the IFM. Thus, they supply credit domestically (by buying credit contracts from domestic entrepreneurs) and demand credit internationally (by selling credit contracts to the IFM). The IFM is risk-neutral and provides an infinitely elastic credit supply at the exogenous international interest rate R^*. Thus, young bankers can obtain $\frac{E_t(F_{B,t+1})}{R^*}$ units of credit in period t when promising the IFM a stochastic repayment $F_{B,t+1}$ in period $t+1$.

We assume that young bankers, just like young entrepreneurs, receive some labor income, which equals a fraction ϕ (with $\phi \in (0,1)$) of old bankers' profits. There are various ways to microfound this relationship. For instance, we could assume that old bankers need to hire young bankers to perform some services (e.g., loan collection) without which a fraction ϕ of their profits would be lost, and that young bankers have all the bargaining power in the resulting relationship. We could also assume that old bankers leave bequests for the young. In any case, what is important for our purposes is that bank profits have some persistence: they are not entirely paid out as dividends to old bankers, but young bankers receive some retained earnings.[11]

Taking this into account, the budget constraints of bankers during youth and old age are given by

$$Q_t^S = \phi \cdot (F_{N,t} + F_{H,t} - F_{B,t}) + \frac{E_t\left(F_{B,t+1}\right)}{R^*}, \tag{15}$$

$$C_{B,t+1} = (1-\phi) \cdot (F_{N,t+1} + F_{H,t+1} - F_{B,t+1}). \tag{16}$$

[10] Note that in a constrained equilibrium, we necessarily have $\lambda_j \cdot r_{j,t+1} < R_{t+1}$ for $j \in \{N, H\}$. Indeed, if this were not the case, entrepreneurs would be unconstrained (which would imply $r_{j,t+1} = R_{t+1}$).

[11] Thus, our results would be unchanged if young bankers' incomes were a fraction of revenues rather than profits.

As shown in Equation (15), the representative banker uses her income, plus whatever credit she obtains from the IFM, to purchase domestic credit contracts from entrepreneurs. We denote this purchase of credit contracts by Q_t^S, because it represents the domestic supply of credit to entrepreneurs. Old bankers consume their loan income, net of payments to young bankers and to the IFM.

Just like entrepreneurs, young bankers face a collateral constraint, given by

$$F_{B,t+1} \leq \lambda_B \cdot (F_{N,t+1} + F_{H,t+1}), \text{ with } \lambda_B \in (0,1). \tag{17}$$

That is, bankers cannot promise payments that exceed a fraction λ_B of their revenues. This can be interpreted as the result of imperfect contractual enforcement between bankers and the IFM, which enables the latter to seize only part of the former's profits. As we had already anticipated, we focus throughout on equilibria in which bankers are constrained, i.e., in which Equation (17) holds with equality in all states of nature. By combining it with Equation (15), we can derive the domestic supply of credit,

$$Q_t^S = \frac{R^*}{R^* - \lambda_B \cdot R_{t+1}} \cdot \phi \cdot (1 - \lambda_B) \cdot (F_{N,t} + F_{H,t}). \tag{18}$$

Domestic credit supply is increasing in both the domestic interest rate and in the net worth of young bankers.

3.2.3 Credit market clearing

In equilibrium, domestic credit demand, given by Equation (13), must equal domestic credit supply, given by Equation (18). This implies

$$\frac{R_{t+1} \cdot R^*}{R^* - \lambda_B \cdot R_{t+1}} = \frac{\sum\limits_{j \in \{N,H\}} \lambda_j \cdot r_{j,t+1} \cdot K_{j,t+1} + m_{t+1} + E_t(V_{t+1})}{\phi \cdot (1 - \lambda_B) \cdot (F_{N,t} + F_{H,t})}. \tag{19}$$

The left-hand side of Equation (19) is an increasing function of the domestic interest rate, whereas the right-hand side is the ratio of the collateral of young entrepreneurs to the net worth of young bankers. Thus, the expression shows that the equilibrium interest rate is increasing in entrepreneurial collateral, i.e., in domestic credit demand, and decreasing in bank net worth, i.e., in domestic credit supply.

Equation (19) also illustrates the role of collateral constraints in equilibrium. A tightening of entrepreneurs' collateral constraints (captured by a decline in λ_N and/or λ_H) reduces credit demand and thus the domestic interest rate, increasing the wedge between the interest rate and the marginal product of capital. Without these constraints, the marginal product of capital would equal the domestic interest rate in both sectors.

A tightening of bankers' collateral constraints (captured by a decline in λ_B) instead restricts the supply of credit and raises the domestic interest rate, by driving a wedge between the domestic and the international interest rate. Without this collateral constraint, the domestic supply of credit would be perfectly elastic and the domestic interest rate would equal R^*, independently of bankers' net worth.

Entrepreneurial collateral and bankers' net worth both depend on the expected and current values of land, $E_t(V_{t+1})$ and V_t. What determines these values in equilibrium? We turn to this important question next.

3.3 Bubbles and the value of land

At any point in time, the supply of land is perfectly inelastic, as old entrepreneurs want to sell all their land in order to consume. Even though it is unproductive, young housing entrepreneurs may be willing to purchase this land to resell it during old age, if the return of doing so is sufficiently high. As land income can be fully pledged to bankers, young entrepreneurs buy old land if and only if it yields a return which is at least equal to the domestic interest rate R_{t+1}. Indeed, if the return to land were lower, land purchases would tighten their collateral constraint and force them to reduce investment. Furthermore, if the return to land were higher than R_{t+1}, the demand for land would be infinite: by purchasing land and pledging its income to bankers, young entrepreneurs could generate an infinite amount of resources for investment. Thus, in any equilibrium in which land is traded at a positive price, its return must be exactly equal to R_{t+1}. Therefore, for any vintage τ, we have

$$V_{\tau,t} = \frac{E_t\left(V_{\tau,t+1}\right)}{R_{t+1}}, \tag{20}$$

Iterating this equation forward, we can write

$$V_{\tau,t} = E_t\left(\lim_{s\to\infty}\frac{V_{\tau,t+s}}{\prod\limits_{k=1}^{s} R_{t+k}}\right). \tag{21}$$

Equation (21) shows that the current market value of each vintage of land depends only on its expected value at infinity, i.e., on market psychology. This follows naturally because land is productive for only one period and therefore has no fundamental value. Thus, one possible equilibrium is the fundamental one, in which $V_{\tau,t} = 0$ for all t and $\tau < t$. But this need not be the only one. There are potentially also bubbly equilibria, in which the market value of land exceeds its fundamental value. In such equilibria, $V_{\tau,t} > 0$ for some t and $\tau < t$, and the value of each vintage of land can follow any stochastic process as long as it satisfies

Equation (20), i.e., as long as the expected return to owning land equals the equilibrium interest rate.[12] This discussion shows that there are multiple sequences of land values that are consistent with equilibrium. In the next section, we impose a particular stochastic process for the underlying market psychology, and use it to illustrate the effects of housing bubbles and their transmission through the credit market.

4 The transmission of bubbles through the credit market

4.1 Summary of equilibrium conditions and a process for the bubble

Equilibrium conditions As noted before, we restrict our attention to parameter values ensuring that $r_{j,t} > R_t > R^*$ for every sector j and in every period t, so that both entrepreneurs and bankers are financially constrained. Then, given initial conditions for the value of pre-existing land V_0 and for capital stocks $\{K_{j,0}\}_{j\in\{N,H\}}$, a competitive equilibrium is a sequence of values of land $(V_{\tau,t})_{t\geq 1}$, capital stocks $(K_{N,t})_{t\geq 1}$ and $(K_{H,t})_{t\geq 1}$, and interest rates $(R_{t+1})_{t\geq 0}$ such that Equations (14), (19) and (20) hold. All other endogenous variables appearing in these equations only depend on the capital stocks in both sectors, as described in Section 3.1.

A bubble process To characterize an equilibrium, we need to specify an explicit process for $(V_{\tau,t})_{t\geq 1}$ for all τ, i.e., for the market psychology that drives the value of land. There are multiple such processes that are admissible, as long as they satisfy Equation (20) in all periods and histories. However, we impose two key restrictions. First, in order to capture boom-bust episodes like the one experienced by Spain, we impose that market psychology is stochastic and oscillates between a bubbly state, in which land has a positive value, and a fundamental state, in which land has zero value. When the economy transitions from the fundamental to the bubbly state, land is suddenly worth more than its expected value in the fundamental state. This creates some windfall income for agents who own land or derive income from it. The second restriction that we impose is that this windfall accrues exclusively to young housing entrepreneurs (and not to non-housing entrepreneurs or bankers). That is, the bubble is a housing-specific shock, which has no direct effect on the rest of the economy.

To satisfy these two restrictions, we propose a Markov process z_t that oscillates between a bubbly (B) and a fundamental (F) state of nature, transitioning from F to B with probability φ, and from B to F with probability ψ. In the fundamental state, the value of land is zero. In the bubbly state, however, some land

[12] Because of this, it is well-known that bubbly equilibria can only arise if – on average – the interest rate is lower than the growth rate of the economy. Otherwise, the size of the aggregate bubble would eventually exceed the resources of bankers, which would not be consistent with equilibrium. Given our small open economy setting, here we simply assume that the international interest rate is low enough for bubbles to arise (see Martín and Ventura (2012) for a detailed discussion of this topic).

vintages trade at positive values even after having been used in production. Formally, we assume

$$V_{\tau,t+1} = \begin{cases} N & \text{if } z_t = z_{t+1} = B \\ 0 & \text{otherwise} \end{cases}, \text{ for } \tau = t \tag{22}$$

and

$$V_{\tau,t+1} = \begin{cases} V_{\tau,t} \cdot \dfrac{R_{t+1}}{1-\psi} & \text{if } z_t = z_{t+1} = B \\ 0 & \text{otherwise} \end{cases}, \text{ for } \tau < t \tag{23}$$

This process is stochastic and guarantees that the windfall income from bubbles only arises to young housing entrepreneurs. Equation (22) shows that in the bubbly state, young housing entrepreneurs expect - provided the bubble persists during their old age - to sell their land endowment at price N after production. This windfall makes them richer than in the fundamental state, allowing them to relax their collateral constraint and to increase their credit and investment. Equation (23), in turn, guarantees that during a bubbly episode (that is, a succession of periods in the bubbly state), the expected return of purchasing any land vintage equals the domestic interest rate. Indeed, when the bubbly episode ends, the value of each existing vintage becomes zero forever. As the probability of this event is ψ, the realized return to each vintage during a bubbly episode must therefore equal $R_{t+1}/(1-\psi)$. To sum up, during a bubbly episode, each new generation of housing entrepreneurs "creates" a new vintage of the bubble. All of these vintages then yield an expected return R_{t+1} and a realized return $R_{t+1}/(1-\psi)$, until the bubble ends.[13] All vintages created before the start of the bubbly episode remain worthless.

This completes our description of the bubble process. We now proceed to analyze our main research question, namely how a bubble in the housing sector spills over to the rest of the economy through the credit market.

4.2 The aggregate and sectoral effects of a housing bubble

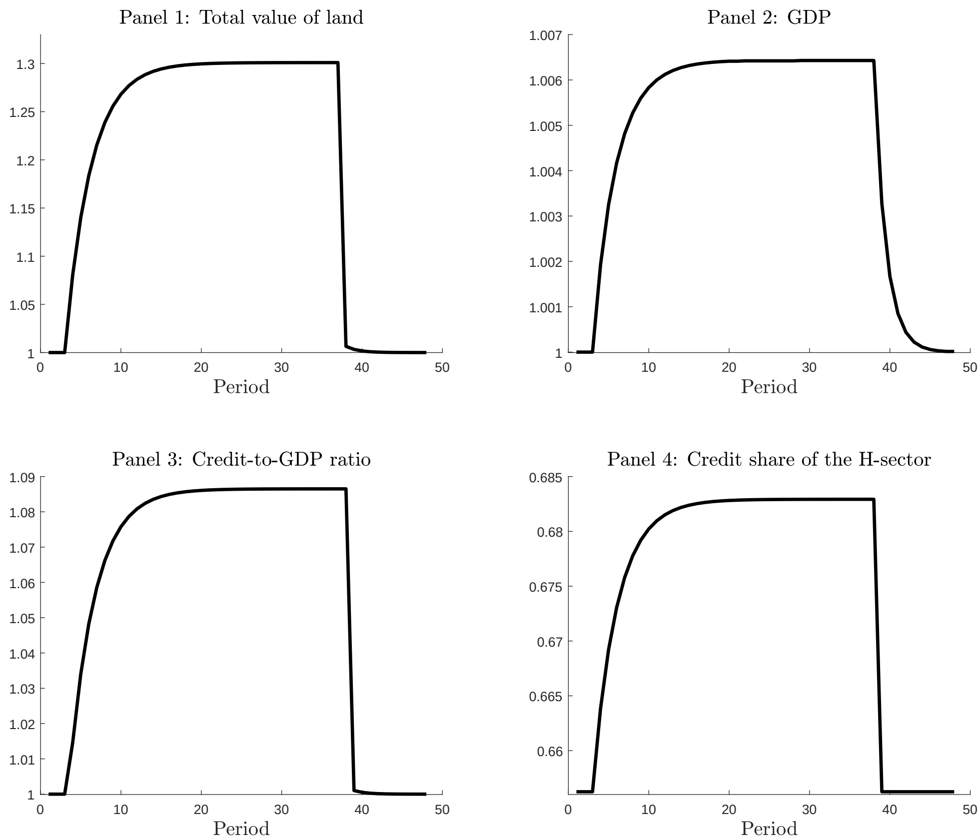
4.2.1 Aggregate effects

Given the bubble process described in the previous section, we can now simulate a housing bubble, that is, a boom-bust episode in land prices. Figure 5 depicts such a simulation. In the figure, the economy initially finds itself in the fundamental steady state.[14] In period 4, it transitions into a bubbly state and remains there until period 38.

[13]While bubble creation directly relaxes the credit constraint of young housing entrepreneurs, trading old vintages of land does not. Indeed, to purchase a unit of land of vintage τ, a young entrepreneur pays a price $V_{\tau,t}$ and can obtain $E_t(V_{\tau,t+1})/R_{t+1}$ in credit by pledging the future land income to bankers. However, Equation (20) implies that these two quantities are equal, showing that young housing entrepreneurs cannot increase the resources available for investment by trading old vintages of land.

[14]The fundamental steady state is the model's unique steady state in the fundamental equilibrium, when $z_t = F$ throughout.

Figure 5: The aggregate effects of a housing bubble



Notes: With the exception of the credit share of the housing sector, all variables are normalized to 1 in the fundamental steady state. The parameter values for the simulation shown in this figure are given in Appendix A.4.

Throughout the bubbly episode, the total value of land rises for two reasons outlined in the market psychology of Equations (22) and (23): the value of new vintages is positive, due to the bubble component N, and the value of old vintages rises at a gross rate of $^{R_{t+1}}/_{(1-\psi)}$ in each period (see Panel 1). Bubble creation enables young housing entrepreneurs to expand their borrowing and investment: even though nothing fundamental has changed in the economy, there is a credit boom and the credit-to-output ratio rises (see Panel 2). Fueled by this expansion in credit and investment, output itself also rises and the economy experiences a boom (see Panel 3). Finally, as the credit boom is ultimately driven by an expansion of collateral in the housing sector, the share of credit allocated to housing increases (see Panel 4). When the bubble bursts and the value of land collapses, the economy crashes as both credit and output collapse.

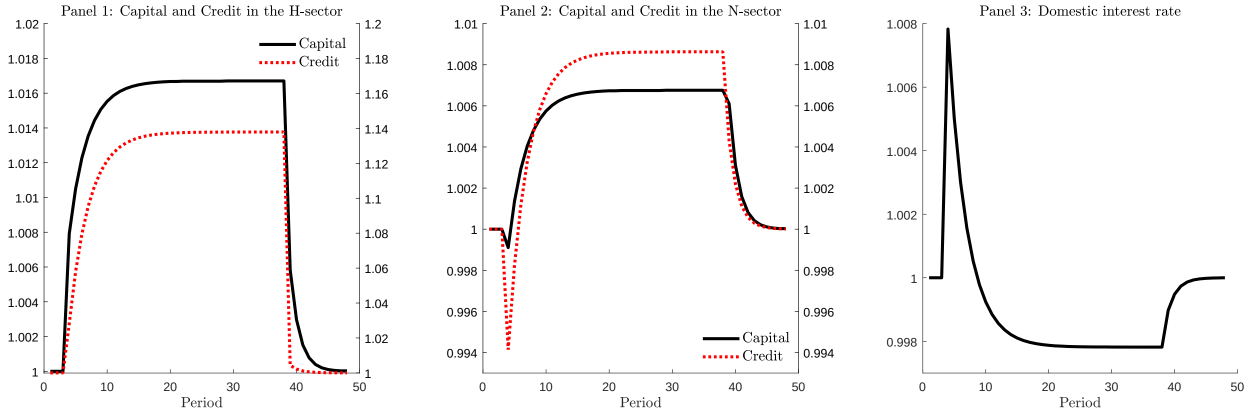
Figure 5 shows that, in a very stylized manner, our model can generate boom-bust episodes like the one experienced by Spain and discussed in Section 2. Just like in Spain, the boom is not driven by TFP: in the model, productivity is constant and the boom is only due to an expectations-driven surge in land values.

However, the main focus of our analysis is not on aggregate developments, but on spillovers from the housing sector to the rest of the economy. We turn to this point in the next section.

4.2.2 Crowding-out and crowding-in in the non-housing sector

Figure 6 plots the evolution of credit and capital in both sectors, as well as the domestic interest rate. Housing sector credit and capital rise throughout the bubbly episode, as shown in Panel 1. This is due to the bubble providing collateral for young housing entrepreneurs, allowing them to expand their credit and investment.[15]

Figure 6: The sectoral effects of a housing bubble



Notes: All variables are normalized to 1 in the fundamental steady state. The parameter values for the simulation shown in this figure are given in Appendix A.4.

On the other hand, non-housing sector credit and capital evolve non-monotonically, as shown in Panel 2. This is the most important prediction of our model, and it is driven by the developments in the credit market, summarized by the evolution of the domestic interest rate in Panel 3. To understand these effects, it is helpful to consider the credit market clearing condition of Equation (19), which we can rewrite as

$$\frac{R_{t+1} \cdot R^*}{R^* - \lambda_B \cdot R_{t+1}} = \frac{\sum_{j \in \{N,H\}} (\lambda_j \cdot r_{j,t+1} \cdot K_{j,t+1}) + m_{t+1} + E_t (V_{t+1})}{\phi \cdot (1 - \lambda_B) \cdot \left(\sum_{j \in \{N,H\}} (\lambda_j \cdot r_{j,t} \cdot K_{j,t}) + m_t + V_t \right)}, \tag{24}$$

where we have taken into account that the net worth of banks in period t is a fraction of the loan repayments by old entrepreneurs in the same period. As long as the economy is in the fundamental steady state in period t, we have $V_t = E_t (V_{t+1}) = 0$.[16] Then, the right-hand-side of Equation (24), which is just the ratio

[15] Note that because of full depreciation, capital and investment are identical.

[16] Recall that V_{t+1} stands for the period $t+1$ value of land created in period t or earlier. Even if a bubbly episode would start in period $t+1$, it would only apply to newly created vintages of land, so V_{t+1} would still be equal to 0.

of entrepreneurial collateral to bank net worth, equals $1/\phi\cdot(1-\lambda_B)$, and there is an analytical solution for the interest rate.

When the economy enters a bubbly episode in period t, there is an immediate increase in entrepreneurial collateral (the numerator of the right-hand side of Equation (24)). Indeed, the vintage of land created in period t is now expected to be sold at a positive price in the future, so that $E_t(V_{t+1})$ becomes positive. This directly increases the value of collateral, but it also allows housing entrepreneurs to increase investment, raising their future capital income and thus increasing the value of their collateral even further. Bank net worth (the denominator of the right-hand side of Equation (24)) is instead not directly affected, as loan repayments to old bankers are predetermined. In particular, they depend only on the value of land vintages created in period $t-1$ or earlier, which are not affected by the start of the bubble. In sum, entrepreneurial collateral (and therefore credit demand) increases on impact but bank net worth (and therefore credit supply) does not. Thus, the equilibrium interest rate must rise,[17] and this crowds out credit and investment in the non-housing sector, as shown in Figure 6.

As the bubbly episode continues beyond its initial period, entrepreneurial collateral and credit demand continue to increase. However, the bubble now also raises bank net worth and thus credit supply, as housing entrepreneurs start to make higher loan repayments to bankers. The simultaneous increase of credit demand and supply may suggest that the ultimate response of the interest rate is ambiguous and depends on parameter values. This is not the case, however, and it can be shown that the interest rate displays a nonmonotonic behavior during bubbly episodes: that is, the initial increase is followed by a decrease, for all admissible parameter values (such that collateral constraints bind). For the market psychology defined in Equations (22) and (23), moreover, the interest rate in the bubbly episode must eventually fall below its value in the fundamental steady state. This is illustrated in Figure 6, where the initial crowding-out of credit and investment in the non-housing sector, driven by higher housing sector credit demand, eventually gives way to crowding-in, driven by higher credit supply.

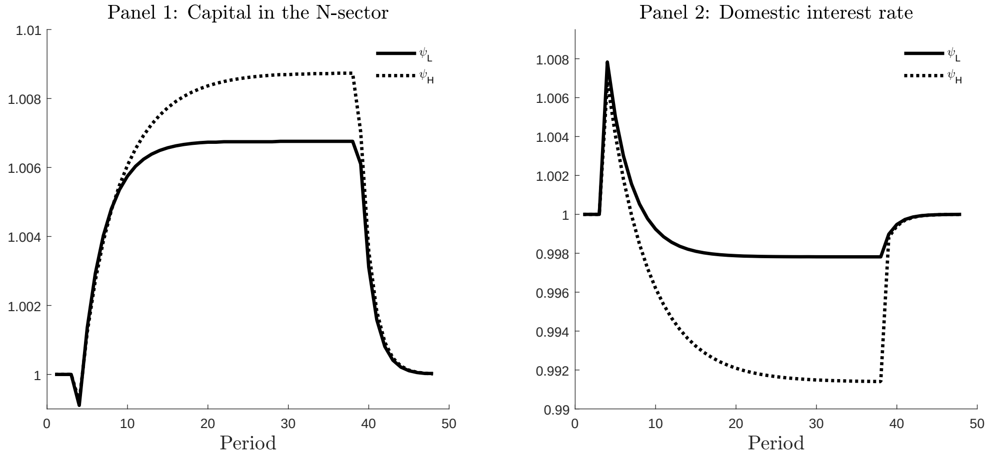
The intuitive reason for the non-monotonic response in the interest rate is both simple and general. To see it, abstract for a moment from the stochasticity of the bubble process. Then, bank net worth in period t is just a fraction $\phi\cdot(1-\lambda_B)$ of entrepreneurial collateral in period $t-1$. That is, bank net worth and entrepreneurial collateral are strongly cointegrated, but the former reacts with a delay to changes in the latter. This implies that even though a bubble initially increases the ratio of entrepreneurial collateral to bank net worth, bank net worth must eventually catch up. Formally, if the bubble lasts long enough, the economy converges to a

[17] Formally, the right-hand side of Equation (24) increases, and as the left-hand side is an increasing function of the interest rate R_{t+1}, the latter must necessarily increase as well.

bubbly steady state, where all endogenous variables are constant,[18] and the ratio of entrepreneur collateral to bank net worth again equals $^1/_{\phi\cdot(1-\lambda_B)}$, just as in the fundamental steady state. Therefore, the interest rate must fall after its initial rise, to revert towards its fundamental steady state value.

However, Figure 6 shows that, given our bubble process, the crowding-in effect is even stronger, and eventually dominates: by period 11, the interest rate has fallen below its fundamental steady state value. This result is driven by the bubble's stochasticity, from which our discussion has abstracted so far, and by our assumptions on the pledgeability of land income. Indeed, as bankers can only pledge a fraction λ_B of their land-backed repayments to the IFM, the evolution of their net worth - and thus the evolution of credit supply - remains proportional to the realized or ex-post value of land V_t. In contrast, the collateral of housing entrepreneurs – and thus the evolution of credit demand – is proportional to the expected value of land $E_t(V_{t+1})$. In a bubbly steady state, in which V_t is constant conditional on the bubbly episode lasting, it must hold that $E_t\left(V_{t+1}\right) = (1-\psi)\cdot V_t < V_t$. That is, the realized value of land must exceed its expected value to compensate land holders for the risk that the bubble bursts. This implies that realized loan repayments in the bubbly steady state exceed their expected value, which raises the net worth of bankers relative to entrepreneurial collateral and reduces the equilibrium interest rate. Formally, as $E_t(V_{t+1}) < V_t$, the right-hand side of Equation (24) and thus the equilibrium interest rate R_{t+1} are smaller in a bubbly steady state than in the fundamental steady state. Moreover, this effect is increasing in the risk of the bubbly episode as captured by the parameter ψ.

Figure 7: The effect of bubble riskiness



Notes: All variables are normalized to 1 in the fundamental steady state. The parameter values for the simulation shown in this figure are given in Appendix A.4.

[18]This is true in particular for the value of land, which must converge to a finite value V. If this were not the case, land would outgrow the economy and thus the net worth of banks, eventually violating feasibility. It is easy to show that $V = \frac{1-\psi}{1-\psi-R}\cdot N$.

Figure 7 illustrates this claim, by plotting the evolution of the interest rate and of capital in the non-housing sector for the same bubbly episode of Figure 6 and two alternative values of ψ, ψ_H and ψ_L, with $\psi_H > \psi_L$. Conditional on lasting for the same number of periods, the riskier episode leads to a larger decline in the interest rate, and to a larger credit and investment boom in the non-housing sector. Naturally, it also leads to a larger bust when the bubbly episode ends.

To sum up, our model predicts that a housing bubble triggers a non-monotonic reaction in the non-housing sector, driven by developments in the credit market. Initially, the interest rate rises and non-housing credit falls, but eventually, the interest rate falls and credit rises again. Finally, if the bubble lasts long enough, non-housing credit rises above its fundamental level, and must fall again once the bubble bursts.

How general are these results? The above discussion suggests that if bankers could fully pledge land-backed loan repayments to the IFM, the non-monotonic response of the interest rate and non-housing credit would remain, but the interest rate would be the same in the bubbly and fundamental steady states. However, as long as young bankers remain exposed to bubble risk (which strikes us as a reasonable assumption in the Spanish case), the strong crowding-in effect, that is, the eventual fall of the interest rate below its fundamental steady state value, is present. Appendix A.2 shows this result more formally.[19]

4.3 Testable predictions: the role of bank and firm heterogeneity

4.3.1 Taking the model to the data

To test our model's predictions, we analyze data from the Spanish boom-bust cycle in housing prices between 1995 and 2015. Obviously, testing our predictions with aggregate data is impossible, as it would require constructing a counterfactual time series for non-housing credit growth in the absence of the bubble. We therefore rely on cross-sectional evidence from micro data, exploiting the fact that not all Spanish banks were equally exposed to the housing bubble. Intuitively, we then expect the crowding-out and crowding-in effects to operate at the bank-level.

To analyze these issues in greater detail and derive rigorous testable predictions, we now discuss a simple extension of our model that explicitly introduces heterogeneous banks. We provide only an intuitive discussion in the main text and refer the interested reader to Appendix A.3 for more detailed derivations. Throughout, we focus on testable predictions for credit, as our micro data does not contain information on interest rates.

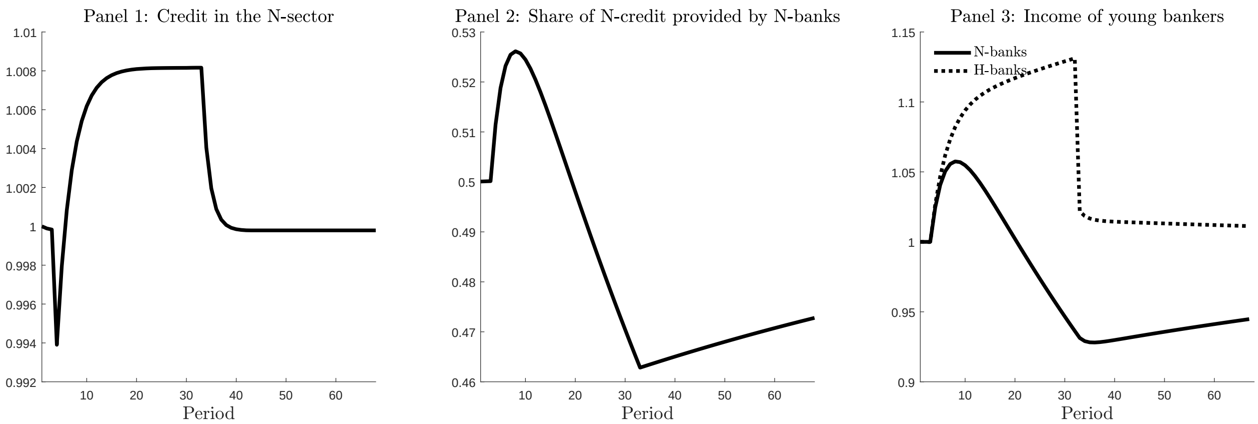
[19] Another alternative assumption, not discussed in the Appendix, would be to consider infinitely-lived banks. Then, the start of a housing bubble may have an immediate positive effect on credit supply, as banks borrow against their expected future net worth. However, as long as banks are sufficiently constrained, this would not overturn our model's initial crowding-out effect.

4.3.2 A model with bank and firm heterogeneity

Consider a slight variation of our model in which there are two types of bankers, which we call H- and N-bankers. While H-bankers can lend to all entrepreneurs, N-bankers can only lend to entrepreneurs in the non-housing sector. Thus, H-banks have a comparative advantage in housing, and are therefore better equipped to lend to this sector when a bubble appears.

All aggregate effects discussed in the previous sections are unchanged in this extended model. In particular, as shown in Panel 1 of Figure 8, total credit for non-housing entrepreneurs follows the same pattern of crowding-out, crowding-in and eventual bust described in the previous sections. However, there are now additional implications at the bank level. On impact, a housing bubble raises the demand for credit from H-banks and thus the interest rate at which these banks lend. In response to this increase, non-housing entrepreneurs – who can borrow from both types of banks – shift their credit demand towards N-banks, as illustrated in Panel 2. The shift equalizes interest rates between both types of banks but, as Panel 1 shows, it cannot prevent a fall in total borrowing by non-housing entrepreneurs.

Figure 8: A housing bubble with heterogeneous banks



Notes: With the exception of the credit share provided by N-banks, all variables are normalized to 1 in the fundamental steady state. The parameter values used for the simulation are given in Appendix A.4.

Over time, the bubble raises the supply of credit and the initial crowding-out effect gives way to crowding-in. Panel 3 shows that the increase in profits generated by the bubble is stronger for H-banks, because they are the only ones able to lend to housing entrepreneurs. Therefore, the relative credit supply of H-banks expands, and eventually raises these banks' share of lending to non-housing entrepreneurs (see Panel 2).[20]

[20]The profits of N-banks evolve non-monotonically. Initially, they increase because non-housing entrepreneurs shift their demand of credit to N-banks, increasing the latters' interest rates and loan volumes. Eventually, as lending by H-banks expands alongside their net worth, the profits of N-banks fall, as they lose part of their clients. In general, note that the evolution of profits is driven by loan volumes. Profit margins evolve non-monotonically, tracking the evolution of the interest rate.

This analysis yields a first series of testable hypotheses, summarized in Prediction 1.

Prediction 1: Credit growth at the bank-firm level.

1. (Non-monotonicity) During the first years of a bubble, the credit of non-housing firms at more exposed banks decreases with respect to the credit of non-housing firms at less exposed banks.[21] This reverts in the later years of the bubble, during which the credit of non-housing firms at more exposed banks increases relative to their credit at less exposed banks.

2. (Crisis response) When the bubble bursts, the credit of non-housing firms at more exposed banks decreases with respect to the credit of non-housing firms at less exposed banks.

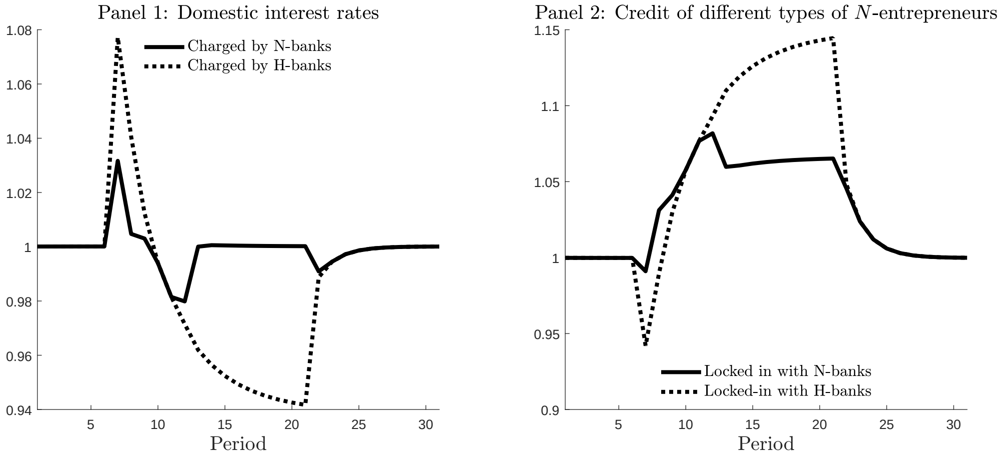
Note that the predictions for the crowding-in effect and the crisis response hold conditionally on the bubble lasting long enough for these effects to materialize (trivially, for instance, a bubble that only lasts one period will not crowd in non-housing credit). Furthermore, if our mechanism is correct, these effects should be driven by the evolution of bank net worth: the net worth of banks that are highly exposed to the housing bubble should grow more during the bubbly episode, and contract more once the bubble bursts.

While the extended model generates variation across banks, it does not generate variation among non-housing entrepreneurs, as they all face the exact same credit supply. This changes if we assume that some entrepreneurs are locked into borrowing from their current bank, perhaps because changes in banking relationships are costly. An extreme version of this is illustrated in Figure 9, where we assume that only a fraction of non-housing entrepreneurs can borrow from both types of banks. The remainder is locked-in either with H- or with N-type banks and can only borrow from that particular type.

As before, non-housing entrepreneurs that can borrow from both types of banks shift part of their borrowing from H- to N-banks during the beginning of the bubbly episode, and from N- to H-banks in later periods. However, these shifts may not be sufficient to equalize interest rates across banks. When this is the case, as in the simulation depicted in Figure 9, the start of a housing bubble raises the relative interest rate charged by H-banks (see Panel 1). This implies that non-housing entrepreneurs locked-in with these banks have lower credit (and investment) growth than non-housing entrepreneurs that are locked-in with N-banks (see Panel 2). This pattern is reversed in later periods: as the credit supply of H-banks increases, their relative interest rate falls and the non-housing entrepreneurs locked in with them exhibit higher credit (and investment) growth than non-housing entrepreneurs locked in with N-banks. Finally, when the bubble bursts, non-housing entrepreneurs locked in with H-banks suffer a larger contraction in credit. This yields a second line of testable predictions, summarized in Prediction 2.

[21] The amount of credit that a single non-housing entrepreneur obtains from N-banks or H-banks is indeterminate, as all banks charge the same interest rate. For the average non-housing entrepreneur, though, the statement is true.

Figure 9: Bank heterogeneity and locked-in entrepreneurs



Notes: All variables are normalized to 1 in the fundamental steady state. The parameter values used for the simulation are given in Appendix A.4.

Prediction 2: Credit growth at the firm level.

1. (Non-monotonicity) In the presence of bank switching costs, non-housing firms that initially borrow more from exposed banks exhibit lower credit growth than other non-housing firms in the first years of the bubble, and higher credit growth in later years.

2. (Crisis response) When the bubble bursts, non-housing firms that initially borrow more from exposed banks exhibit lower credit growth than other non-housing firms.

This simple extension shows that in the presence of bank and firm heterogeneity, our model has strong implications for the patterns of credit growth at the firm and at the bank-firm level. In the next section, we test whether these predictions are borne out by the data.[22] We also provide suggestive evidence for the observed patterns being caused by the mechanisms described by our model.

5 Empirical evidence

In order to test our model's predictions, we rely on micro-data from Spain, described in Section 5.1. Section 5.2 discusses our identification strategy for testing Prediction 1 (credit growth at the bank-firm level). Our baseline results are presented in Section 5.3, together with some robustness checks as well as direct evidence on the net worth channel. Finally, Section 5.4 tests Prediction 2 (credit growth at the firm level).

[22] Of course, our results rely on strong assumptions: some entrepreneurs cannot borrow from certain types of banks, and there is no market for interbank lending. However, these assumptions can be relaxed. As long as some banks are better suited to lend to housing entrepreneurs than others and there are frictions that make bank lending relationships persistent, the effects of bubbles are bound to be different across banks and entrepreneurs. Furthermore, if these frictions were irrelevant in the data, we should just obtain insignificant results in all our regressions.

5.1 Data

We use information from the following data sources:

Credit Registry data (CIR): CIR — *Central de Información de Riesgos* in Spanish — is maintained by the Bank of Spain in its role as primary banking supervisory agency, and contains detailed monthly information on all outstanding loans over 6,000 euros to non-financial firms granted by all banks operating in Spain since 1984.[23] Given the low reporting threshold, virtually all firms with outstanding bank debt appear in the CIR. For each loan, the CIR provides the identity of the parties involved, allowing us to match the loan-level data from CIR with administrative data on firm-level characteristics. For each month, we define each bank-firm relationship as a loan by aggregating all outstanding loans for the bank-firm pair.

From 1991 onward, the CIR also contains information on banks' balance sheets. This data allows us to compute bank-specific measures of bubble exposure. Moreover, using this information we can also account for bank-specific characteristics such as size, capital and liquidity ratios, or default rates.

Firm-level data: For firm-level outcomes besides credit, we use administrative data taken from the Spanish Commercial Registry. This dataset a priori covers the universe of Spanish firms, as they have a legal obligation to deposit their balance sheets at the Registry. For each firm, among other variables, it includes information on the firm's name, fiscal identifier, sector of activity (4-digit NACE Rev. 2 code), location (5-digit zip code), net operating revenue, material expenditures (cost of all raw materials and services purchased by the firm in the production process), number of employees, labor expenditures (total wage bill, including social security contributions) and total fixed assets. Almunia et al. (2018) describe this database in greater detail.

Our final sample contains 1,801,955 firms with an average of 993,876 firms per year. This corresponds to around 85-90% of the firms in the non-financial market economy for all size categories in terms of both turnover and number of employees. Moreover, the correlation between micro-aggregated employment (and output) growth and the National Accounts counterparts is around 0.95 over the period 2003-2013 (see Figure A.3 in the Appendix). Since the coverage is high and stable from 2003 onward, we start our main analysis in that year, but we will also consider some credit results for earlier years.

Table A.9 in the Appendix provides summary statistics for all variables considered throughout the paper.

5.2 Identification strategy at the bank-firm level

In the presence of bank heterogeneity, our model has two distinct predictions regarding the transmission of housing bubbles through the credit market. We first focus on Prediction 1, which refers to credit growth at

[23] In our analysis, we use total credit (the sum of promised and drawn credit lines). Results are unchanged for drawn credit.

the bank-firm level (we will consider Prediction 2 in Section 5.4). Prediction 1 indicates that the crowding-out effect should dominate during the first years of the bubble, so that non-housing firms exhibit lower credit growth from banks with high exposure to the housing bubble. In later years, the crowding-in effect should dominate, so that the opposite pattern should be observed. Finally, when the bubble bursts, firms' credit from more exposed banks should decrease more than credit from less exposed banks.

The Spanish experience provides a great opportunity to test these predictions, as we have detailed data on the characteristics of banks and their credit to different firms. However, there are still two key difficulties. Indeed, even if non-housing credit at exposed banks evolves differently from non-housing credit at less exposed banks, this may be due to differences in the types of firms borrowing from both banks, and not necessarily to banks' bubble exposure. Thus, we first need to isolate the variation in bank-firm credit which is due to changes in the credit supply of banks rather than to firm characteristics. We do this by comparing the evolution of credit for the same firm at different banks, following Khwaja and Mian (2008). Second, we need to isolate the changes in the credit supply of banks that are caused by exposure to the housing bubble. This requires finding an exogenous measure of exposure. We do this by considering banks' specialization in housing-related credit before the start of the bubble.

More formally, we estimate the following empirical specification for all non-housing firms of our sample:

$$\text{Credit\_growth}_{fbt} = \beta_t \mathrm{E}_{b0} + \theta_t X_{bt-1} + \delta_t W_{fbt-1} + \eta_{ft} + u_{fbt}. \tag{25}$$

$\text{Credit\_growth}_{fbt}$ refers to credit growth of firm f with bank b in year t, defined as $100 \cdot \frac{c_{fbt}-c_{fbt-1}}{c_{fbt-1}}$, where c_{fbt} is the yearly average of outstanding credit of firm f with bank b in year t.[24] E_{b0} measures bank b's bubble exposure (which we discuss in detail below). X_{bt-1} stands for a set of bank controls, namely the natural logarithm of total assets, capital ratio, liquidity ratio, and default rate. Finally, W_{fbt-1} refers to firm-bank controls, namely, the length of the firm-bank relationship in months and a dummy for past defaults.

Crucially, as many firms borrow from several banks at the same time, we can also include time-variant firm fixed effects η_{ft} into Equation (25). These account for firms' credit demand, as in Khwaja and Mian (2008). That is, our identification compares the same firm borrowing from two different banks in a given period. Thus, as credit demand is kept constant, differences in credit growth can be attributed to the supply side, for instance, to differences in bubble exposure across the two banks.

This identification relies on the crucial assumption that firms' credit demand is the same for all banks and/or that banks' credit supply is not firm-specific. Recently, Paravisini et al. (2017) have suggested that this

[24]Throughout, we winsorize growth rates to be bounded by +200% and -100%, in order to reduce the impact of outliers.

assumption may be violated in the presence of bank specialization. However, three points alleviate this concern in our case. First, we include bank-firm covariates in our regressions (W_{fbt-1}) and thus control for relationship lending to some extent. Second, if bank exposure (E_{b0}) is truly exogenous with respect to the omitted factors subsumed in the error term, the β estimates would be unbiased even in the presence of bank specialization (see Amiti and Weinstein, 2018). Third, a switch in the sign of the estimates for β during a bubbly episode (as predicted by our model) would be difficult to explain with bank specialization alone.

Turning to the second challenge described above, we measure the exposure of a given bank b to the housing bubble by the ratio of mortgage-backed credit over total credit before the beginning of the bubble:[25]

$$\mathrm{E}_{b0} = \frac{\text{mortgage-backed credit}_{b,1992-1995}}{\text{total credit}_{b,1992-1995}} \tag{26}$$

This measure provides us with a source of variation in banks' bubble exposure that predates the beginning of the housing bubble, and can thus be considered as exogenous to the extent that the bubble was an unanticipated event. Of course, bubble exposure may still be correlated with some bank characteristics. To alleviate this concern, we introduce a large number of bank controls in Equation (25), and we also show that our results do not change if we use two alternative exposure measures.

5.3 Bank-firm level results

5.3.1 Annual estimates

Figure 10 plots the estimated β_t coefficients estimated from Equation (25). As emphasized above, the inclusion of firm-year fixed effects ensures that we are comparing the difference in credit growth of the same firm with two different banks (with different bubble exposures) in each year.

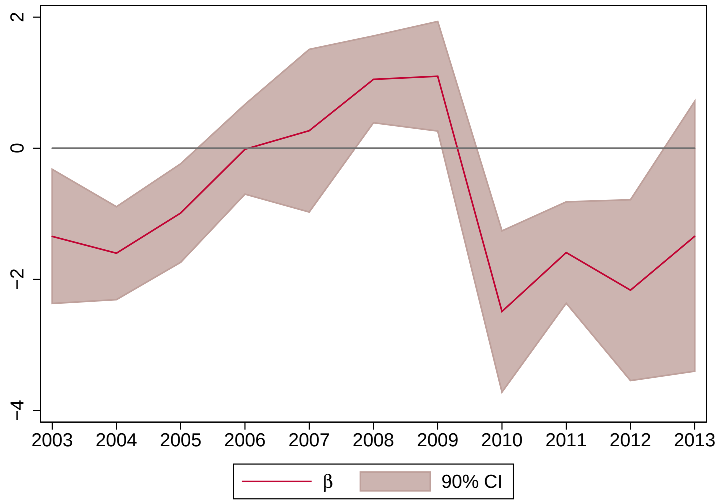
Overall, Figure 10 confirms that our Prediction 1 is consistent with the data. The effect of bank bubble exposure on credit growth of non-housing firms is first negative, then becomes positive, and finally again turns negative after the burst of the bubble.[26] This pattern supports the crowding-in and crowding-out effects described by our model, and allows us to identify their timing. According to our estimates, the crowding-out effect dominates between 2003 and 2006.[27] Crowding-in takes over at the very end of the

[25] Note that mortgage-backed credit includes loans to firms and households.

[26] This pattern is confirmed estimating Equation (25) at the monthly frequency (see Figure A.2 in the Appendix).

[27] As noted earlier, we start our main analysis in 2003, when our firm-level data starts being fully representative. Nevertheless, Table A.2 in the Appendix reports our results for estimating Equation (25) for the period 1996-2002. These results indicate that bank exposure had essentially no effect on credit growth in 1996 and 1998. Results are mixed (but insignificant) for 2000 and 2002, so that overall, it seems that crowding-out starts in earnest around 2003. This is roughly consistent with the development of aggregate variables. Even though it is of course impossible to empirically determine the starting date of the bubble, the time series for house prices, firm leverage and the housing share of firm credit all exhibit a break around 2001-2002, when they start growing much faster than before (see Figures 2-4).

Figure 10: Bubble exposure and credit growth for non-housing firms.



Notes: This plot shows the OLS estimates of the β_t coefficient from Equation (25).

housing boom, from 2007 to 2009. This result may be surprising at first, given that Spain's economic crisis already started in 2008. However, note that our data (see Figure 2) indicate that house prices peaked in 2008. Furthermore, as discussed in much greater detail in Santos (2017b), the Spanish banking system still appeared relatively stable in 2008 and 2009. The share of non-performing loans for construction and real estate firms did not exceed 5% at the end of 2008 and 10% at the end of 2009 (it was to reach more than 35% at the peak of the crisis). Most bank balance sheets were still growing through 2009.[28] In this context, it is not surprising that we observe the crowding-in effect predicted by our model for the last stages of the bubble. Finally, a negative effect emerges from 2010 onward, when the banking crisis started in earnest.

In light of the annual pattern in Figure 10, Table 1 presents the estimates for three selected years. Columns (1) to (3) report our estimates for Equation (25) in 2004, 2008 and 2012. In 2004, crowding-out dominated. The same non-housing firm had lower credit growth with more exposed banks than with less exposed banks: a one standard deviation increase in banks' exposure reduced annual credit growth by 1.59 percentage points. In 2008, instead, crowding-in dominated and credit at more exposed banks exhibited higher growth. Finally, during the bust in 2012, non-housing firms exhibited lower credit growth at more exposed banks. These three effects are significant not only statistically but also economically: the estimated impact of banks' bubble exposure on bank-firm credit growth represents 18% of the average growth rate in 2004 (8.62), 31% in 2008 (3.51), and 75% in 2012 (-2.88).

In columns (4)-(6), we substitute firm fixed effects by a rich set of firm controls together with a set of

[28]See Santos (2017b), Figure 1 (P.2) and Figure 2 (P.3). Only one small bank needed to be rescued before 2010.

industry-municipality fixed effects, as in Bentolila et al. (forthcoming). The firm controls included are total assets, number of employees, own funds over total assets, return on assets, a dummy for young firms (less than three years old), and an exporter dummy. This allows us to consider the universe of borrowing firms instead of only firms borrowing from more than one bank (multibank firms), with the firm-level variables controlling for credit demand. Finally, columns (7)-(9) report estimates from the same specification with firm controls but using the same sample of multibank firms used in columns (1)-(3). In both cases, the results remain virtually unchanged.[29]

Table 1: Bubble exposure and credit growth at the bank-firm level: baseline results

	Firm fixed effects			Firm controls			Firm controls (multibank)		
	2004	2008	2012	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bank bubble exposure	-1.59***	1.09***	-2.15**	-1.57***	1.18**	-2.32**	-1.74***	1.22**	-2.46**
(s.e.)	(0.48)	(0.43)	(0.96)	(0.60)	(0.55)	(1.03)	(0.64)	(0.57)	(1.15)
Average dep. variable	8.62	3.51	-2.88	11.30	5.58	-2.13	11.53	5.87	-1.58
Firm fixed effects	YES	YES	YES	NO	NO	NO	NO	NO	NO
Firm controls	NO	NO	NO	YES	YES	YES	YES	YES	YES
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry × municipality FE	NO	NO	NO	YES	YES	YES	YES	YES	YES
Multiple banks per firm	YES	YES	YES	NO	NO	NO	YES	YES	YES
Balance-sheet data	NO	NO	NO	YES	YES	YES	YES	YES	YES
R-sq	0.37	0.35	0.34	0.18	0.15	0.19	0.19	0.17	0.20
# observations	549,964	666,849	504,233	410,624	499,585	389,384	352,070	426,772	331,267
# firms	179,423	207,796	160,736	179,509	214,419	177,449	120,955	141,606	119,332
# banks	118	111	62	115	110	61	114	108	61

Notes: All regressions are based on Equation (25) and have annual credit growth at the bank-firm level as the dependent variable. Bank bubble exposure is proxied by the share of mortgage-backed credit (E_{b0}). Bank controls are the natural logarithm of total assets, capital ratio, liquidity ratio, and default rate. Firm-bank controls are the length of firm-bank relationship in months and a dummy for past defaults. Firm controls are total assets, number of employees, own funds over total assets, return on assets, a dummy for young firms (less than three years old), and an exporter dummy. To ease the interpretation, the bank bubble exposure regressor has zero mean and unit variance. Standard errors multi-clustered at the bank and firm level in parentheses.

These results are consistent with the existing empirical literature, and enable us to reinterpret some of its findings. Jimenez et al. (2014) have used a similar measure of exposure of Spanish banks to real estate (although they interpret it as a proxy for access to securitization), and used it to analyze the (positive) effect of this exposure on credit supply. Despite there being some differences between their empirical specification and ours, their results are broadly in line with the estimates reported in Table 1: there is an initial negative effect of bank exposure on the credit growth of non-housing firms, and an eventual positive effect.[30] Our

[29]Table A.4 in the Appendix also shows that our baseline estimates in Table 1 are robust to the exclusion of saving banks (*cajas de ahorros*) from the sample.

[30]Note that their initial negative effect is not statistically significant. However, it is worth emphasizing that in their 2001-2004 regression (column 8 of Table V in their paper), there is an additional difference with respect to our baseline specification, as they do not include either bank controls or bank-firm controls.

model, however, provides a distinct interpretation of the data. We consider the ratio of mortgage-backed credit over total credit as a proxy for banks' exposure to the housing bubble, and the estimated crowding-out and crowding-in effects as two manifestations of the financial transmission mechanism. Indeed, our results so far allow us to reconcile the apparently conflicting findings in Jimenez et al. (2014) and Chakraborty et al. (2018). While Jimenez et al. (2014) highlight the positive effect of banks' exposure to housing on credit of non-housing firms in Spain, Chakraborty et al. (2018) find that banks that were more exposed to housing price growth in the United States reduced corporate credit. Our analysis suggests that crowding-out and crowding-in effects are not incompatible, but just operate at different points in time.

Finally, Table A.3 in the Appendix presents the OLS and IV counterparts to our reduced-form regressions in this section. More specifically, we regress annual credit growth on contemporaneous exposure (banks' share of mortgage-backed credit, E_{bt}) instrumented with initial exposure (E_{b0}). Looking at IV estimates in columns (4)-(6), the estimated effects are even larger. Moreover, the first-stage estimates reported in Panel B of Table A.3 confirm that our instrument is relevant, with F-statistics well above 10 in most specifications (Stock and Yogo, 2005).[31]

5.3.2 Alternative proxies for bubble exposure

Our baseline estimates use banks' shares of mortgage-backed credit as a proxy for their exposure to the housing bubble. In this section, we consider two alternative proxies.

The first alternative proxy for bubble exposure is based on the geographical distribution of banks' activities, and is similar to the measure used by Chakraborty et al. (2018). For this measure, banks are considered to be more exposed if they operate in municipalities that are prone to stronger housing bubbles. To generate an exogenous source of variation in housing prices at the municipality-level, we follow an empirical strategy that relies on housing supply elasticities, which was first used in Saiz (2010) and has been adapted to Spain by Basco and Lopez-Rodriguez (2017). Basco and Lopez-Rodriguez measure this elasticity as the ratio of potential plot surface over the built urban surface, and compute it using census data from the Spanish Cadastre (Catastro) in 1995, before the start of the housing bubble and the soil liberalization laws.[32]

We then define a bank-specific exposure measure as

[31] We have also considered a different IV specification, using banks' share of mortgage lending in each year between 1992 and 1995 (and therefore four instruments) instead of the average, as in our baseline analysis. These regressions confirm our results. Furthermore, the p-values of the Hansen overidentification restriction tests (Hansen, 1982) are always above 0.2, showing that the null hypothesis cannot be rejected. These results are available upon request.

[32] Potential plot surface includes all undevelopable land, except protected non-urban areas (e.g. rivers or natural parks), plots classified as of rural use, and public goods land (e.g. local surface occupied/covered by transport infrastructure and utilities).

$$E_b^{HSE} = \sum_m \omega_{bm} HSE_m, \tag{27}$$

where ω_{bm} refers to the share of total credit of bank b in municipality m in 1995[33] and HSE_m is the housing supply elasticity for municipality m in 1995. Note that the latter measure should be negatively associated with the housing bubble, as municipalities with more available land should have lower housing price increases. In order to ease interpretation, we change the sign of the elasticity measure, such that higher values (less land available for construction) correspond to higher bubble exposure (higher housing price increases), and refer to this variable as land unavailability.

Table 2: Bubble exposure and credit growth at the bank-firm level: HSE exposure

	Firm fixed effects			Firm controls			Firm controls (multibank)		
	2004	2008	2012	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bank bubble exposure (E_b^{HSE})	-1.09**	0.73**	-1.24**	-1.08**	0.64*	-1.18*	-1.25**	0.68	-1.44**
(s.e.)	(0.48)	(0.34)	(0.53)	(0.52)	(0.39)	(0.64)	(0.58)	(0.46)	(0.70)
Average dep. variable	8.59	3.52	-3.21	11.28	5.59	-2.53	11.49	5.88	-2.07
Firm fixed effects	YES	YES	YES	NO	NO	NO	NO	NO	NO
Firm controls	NO	NO	NO	YES	YES	YES	YES	YES	YES
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry × municipality FE	NO	NO	NO	YES	YES	YES	YES	YES	YES
Multiple banks per firm	YES	YES	YES	NO	NO	NO	YES	YES	YES
Balance-sheet data	NO	NO	NO	YES	YES	YES	YES	YES	YES
R-sq	0.36	0.35	0.33	0.18	0.15	0.18	0.19	0.17	0.19
# observations	566,026	673,608	581,531	420,173	503,907	433,641	361,134	430,580	373,324
# firms	182,724	209,515	180,053	181,181	215,580	189,909	122,142	142,190	129,592
# banks	155	148	117	137	147	116	137	147	116

Notes: See notes to Table 1.

Table 2 reports the estimates using this alternative exposure measure in our baseline specification given by Equation (25). The structure of Table 2 is analogous to that of Table 1 and the estimated effects are also very similar, albeit slightly smaller in magnitude: -1.09 percentage points versus -1.59 in 2004, 0.73 versus 1.09 in 2008 and -1.24 versus -2.15 in 2012.

The second alternative proxy for bubble exposure is given by banks' lending to housing firms before the start of the bubble. That is, we define bank exposure as the ratio of credit to housing firms (those operating in the construction and real estate sectors) over total credit to non-financial corporations in the year 1995. Table A.5 in the Appendix show that our main results remain robust also under this alternative measure.

[33] This share can be constructed by matching the CIR to our firm-level data, which includes zipcodes of firms' headquarters.

5.3.3 The extensive margin

The crowding-out and crowding-in pattern induced by the housing bubble may not only matter for the intensive margin of credit growth, but also for the formation or the termination of lending relationships. To analyze these effects, we substitute the dependent variable in Equation (25) by two measures for the extensive margin of credit.

First, we follow Chodorow-Reich (2014) and consider a measure of credit growth of firm f with bank b in year t that incorporates the creation of new lending relationships and the termination of existent loans:

$$\text{Extensive\_Credit\_growth}_{fbt} = \frac{c_{fbt} - c_{fbt-1}}{0.5 \cdot (c_{fbt} + c_{fbt-1})} \tag{28}$$

This definition yields a growth measure that is symmetric around zero and bounded between -2 and 2, providing an integrated treatment of new loans, ended loans, and continuing loans.

Table 3: Bubble exposure and credit growth at the bank-firm level: the extensive margin

	Extensive_Credit_growth			Dropped_loan		
	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)
Bank bubble exposure	-1.50**	2.32***	-3.81***	0.002	-0.01***	0.01***
(s.e.)	(0.73)	(0.63)	(1.47)	(0.002)	(0.00)	(0.00)
Average dep. variable	8.51	-0.08	-4.11	0.13	0.13	0.15
Firm fixed effects	YES	YES	YES	YES	YES	YES
Bank controls	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES
Multiple banks per firm	YES	YES	YES	YES	YES	YES
R-sq	0.48	0.35	0.34	0.47	0.35	0.34
# observations	641,480	781,875	596,034	638,658	784,769	608,198
# firms	204,764	240,195	187,181	203,998	240,671	189,574
# banks	117	110	62	117	110	62

Notes: Bank bubble exposure is proxied by the share of mortgage-backed credit (E_{b0}). All regressions are based on Equation (25), but consider two alternative dependent variables, Extensive_Credit_growth and Dropped_loan. Bank controls are the natural logarithm of total assets, capital ratio, liquidity ratio, and default rate. Firm-bank controls are the length of firm-bank relationship in months and a dummy for past defaults. To ease the interpretation, the bank bubble exposure regressor has zero mean and unit variance. Standard errors multi-clustered at the bank and firm level in parentheses.

Second, we analyze how banks' bubble exposure affects the probability of ending a credit relationship by considering as dependent variable a dummy that takes the value one if a given bank-firm (loan) pair was active in year $t-1$ but it is not active in year t ($\text{Dropped\_loan}_{fbt}$).

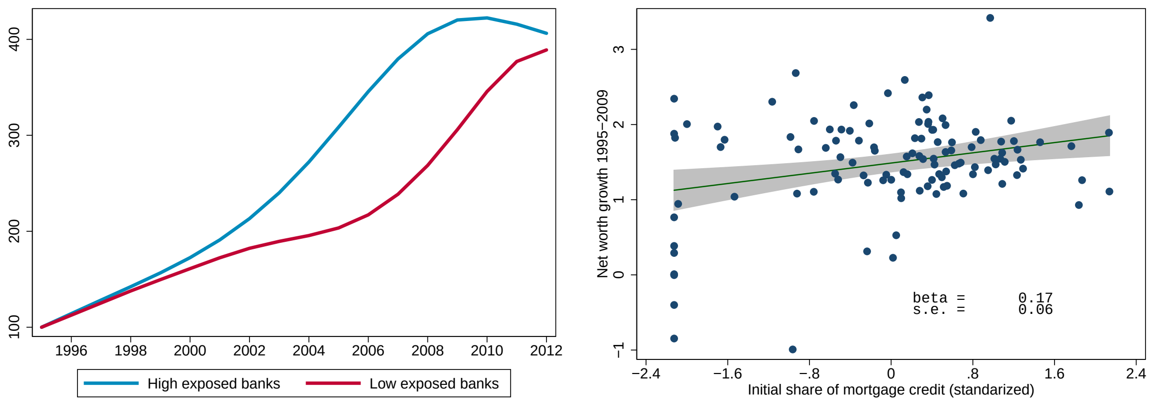
Table 3 presents the results, using again our baseline exposure measure. Columns (1)-(3) consider the extensive-margin growth rate defined in Equation (28) as dependent variable. The crowding-out estimate in column (1) is very similar to that of Table 1. However, the magnitude of the crowding-in effect is significantly larger now, which can be seen by comparing the coefficient estimate for 2008 with the average growth rate that is close to zero in that year. Finally, the negative effect of bank bubble exposure during the bust is also larger. Thus, it appears that taking into account the extensive margin of credit strengthens our results.

Columns (4)-(6) in Table 3 consider Dropped_loan as the dependent variable. Banks more exposed to the bubble are more likely to terminate a lending relationship with non-housing firms in 2004, even though the point estimate is not significant. In contrast, those banks are less likely to do so in 2008 and more likely again during the bust in 2012.

5.3.4 The role of bank net worth

In our model, the eventual crowding-in effect of the bubble for non-housing credit is driven by the evolution of bank net worth. In particular, the profits and net worth of banks more exposed to the housing bubble grow faster throughout the entire bubbly episode, and this allows them to increase their credit supply. Furthermore, the net worth of these banks shrinks more during the crisis.

Figure 11: Banks' net worth and bubble exposure



Notes: In the left panel, bank net worth in 1995 is normalized to 100. High (low) exposed banks are those above (below) the 90th (10th) percentile of the share of mortgage credit before 1995. In the right panel, each dot represents a bank.

This pattern is confirmed in the data, as shown in the left panel of Figure 11, which displays the evolution of net worth for banks with high and low exposure to the bubble. Moreover, the right panel of Figure 11 confirms that there is a positive and significant correlation between banks' bubble exposure (initial share of mortgage credit) and the growth of net worth over the period 1995-2009. Table A.6 in the Appendix shows that this association is still positive and significant when controlling for other bank characteristics. Of course, this evidence does not decisively prove that our crowding-in effect is driven by bank net worth. But it is consistent with this explanation, particularly when considered jointly with our previous results.

Moreover, there is also evidence against alternative explanations for the crowding-in effect. For instance, crowding-in during the last years of the bubble may have been due to a diversification attempt by banks that were highly exposed to housing, which consequently cut loans to the housing sector and redirected credit to non-housing firms. This hypothesis seems to be at odds with the data, however. Estimating Equation (25) for a sample of housing firms shows that the effect of bank-bubble exposure on credit growth for housing firms was positive (but not statistically significant) in 2008, and not significantly different from the effect of exposure in 2003 (see Figure A.4 in the Appendix). This suggests that exposed banks were not cutting their loans to the housing sector in 2008 and, if anything, continued to lend more to housing firms.

Another alternative explanation for the eventual crowding-in effect is that there was reduction in the demand for housing credit during the last years of the bubble, again freeing up resources for highly-exposed banks to lend to non-housing firms. Unfortunately, isolating the effect of credit demand to test this hypothesis is challenging because we do not have an exogenous source of variation in firms' bubble exposure. Still, it is worth noting that average annual credit growth for housing firms was 6.2% in 2008. This growth rate admittedly confounds supply and demand forces but, in light of the high number, it seems hard to argue that credit demand from housing firms was contracting in 2008.

5.4 Firm-level analysis

5.4.1 Baseline estimation

We now turn to the firm-level analysis in order to test Prediction 2 of our model. As we argued before, firms' costs of switching banks play a key role in translating banks' bubble exposure to firm outcomes. In the absence of switching costs, all non-housing firms should obtain the same credit irrespective of the bank from which they originally borrowed. But this is no longer true in the presence of switching costs, in which case the crowding-out and crowding-in effects of financial transmission should also be observable at the firm-level. To assess these firm-level effects we run the following regression:

$$\text{Credit\_growth}_{ft} = \beta_t \mathrm{E}_{ft} + \theta_t X_{ft-1} + v_{ft} \tag{29}$$

where $\text{Credit\_growth}_{ft}$ refers to overall credit growth of firm f in year t. X_{ft-1} refers to a set of firm controls, namely, total assets, number of employees, own funds over total assets, return on assets, a dummy for young firms (less than three years old), and an exporter dummy. A set of industry-municipality fixed effects is also included. Finally, E_{ft} measures the exposure of firm f to bubble-exposed banks. This is computed as a weighted average of bank-level exposures, such that[34]

$$\mathrm{E}_{ft} = \sum_b \frac{c_{fbt}}{c_{ft}} \mathrm{E}_{b0}. \tag{30}$$

Table 4: Bubble exposure and credit growth at the firm level

	All firms			Multibank firms		
	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)
Firm bubble exposure	-1.03**	1.16***	-2.39***	-1.87**	1.07***	-3.06***
(s.e.)	(0.51)	(0.29)	(0.73)	(0.68)	(0.32)	(1.01)
Average dep. variable	19.11	10.65	4.21	26.93	16.39	11.64
Firm controls	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES
Industry × municipality FE	YES	YES	YES	YES	YES	YES
Only multibank firms	NO	NO	NO	YES	YES	YES
Balance-sheet data	YES	YES	YES	YES	YES	YES
R-sq	0.30	0.26	0.33	0.31	0.29	0.35
# observations	153,030	187,920	158,287	87,468	107,646	93,290

Notes: The dependent variable is annual credit growth at the firm level in all columns. Bank bubble exposure is proxied by the pre-bubble share of mortgage-backed credit at the firm-level (E_{ft}). All regressions are based on Equation (29). Firm-bank controls are the length of firm-bank relationship in months and a dummy for past defaults. Firm controls are total assets, number of employees, own funds over total assets, return on assets, a dummy for young firms (less than three years old) and an exporter dummy. To ease the interpretation, the bank bubble exposure regressor has zero mean and unit variance. Standard errors multi-clustered at the main bank and industry-municipality level in parentheses.

Table 4 presents the estimated coefficients for Equation (29) for the three selected years. Columns (1)-(3) refer to the sample of all firms while columns (4)-(6) are based on a sample of multibank firms, as in our baseline specification in Section 5.3. In both cases, we find strong evidence in favor of the successive crowding-out and crowding-in effects predicted by the model. This suggests that non-housing firms are not able to fully undo the effects of bubble-induced credit supply shocks, consistent with the notion that switching banks is costly. However, estimates are lower than those at the bank-firm level shown in Table 1, which does suggest that firms are partially able to undo the effect of exposure by switching to other banks. Nevertheless, the magnitude of the effects remains economically significant, especially in the sample of all firms. In 2004, for instance, the

[34] Ideally, weights should be measured before the bubble started in order to enhance exogeneity. However, the number of observations would be drastically reduced given that many bank-firm relationships active in 2004, 2008, and 2012 were not active in 1995. In any case, our estimates remain similar if we use lagged shares based on credit_{fbt-1} and credit_{ft-1}.

crowding-out effect of a one standard deviation increase in bubble exposure represents approximately -5% of the average sample credit growth. Crowding-in is even larger in magnitude, representing 11% of the average sample credit growth.

In the Appendix, we report two more robustness checks which confirm these findings. Table A.7 shows the OLS and IV estimates of Equation (29), instrumenting current bank exposure by pre-bubble exposure. Table A.8 reports results when using the bubble exposure of the firm's main bank (i.e., the bank from which the firm borrows most) as a proxy for firm exposure.

5.4.2 Cumulative effects

All our results so far have been based on year-to-year growth rates. In this section, we instead explore the overall effect of the housing bubble on non-housing firms. For that purpose, we consider a permanent sample including 28,709 non-housing firms that are observed in our data in every year between 2002 and 2012.

We first confirm that our baseline firm-level estimates, reported in Table 4, also hold in this permanent sample of firms. Then, we substitute the dependent variable in Equation (29) in order to consider the cumulative growth rate since 2002 instead of the annual growth rate.

Table 5: Bubble exposure and cumulative credit growth at the firm level.

	2004 (1)	2005 (2)	2006 (3)	2007 (4)	2008 (5)	2009 (6)	2010 (7)	2011 (8)	2012 (9)
Firm bubble exposure	-4.10**	-4.18*	-2.42	-0.04	-0.28	0.83	-0.44	-5.24**	-9.43***
(s.e.)	(2.01)	(2.40)	(2.69)	(3.41)	(3.21)	(2.69)	(2.89)	(2.70)	(3.80)
Average dep. variable	46.94	75.37	107.79	143.22	166.98	166.47	166.55	166.42	168.36
Firm controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry × municipality FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Only multibank firms	NO	NO	NO	YES	YES	YES	YES	YES	YES
Balance-sheet data	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-sq	0.39	0.35	0.37	0.36	0.35	0.38	0.39	0.39	0.39
# observations	28,709	28,709	28,709	28,709	28,709	28,709	28,709	28,709	28,709

Notes. The dependent variable is cumulative credit growth at the firm level between the year 2002 and each of the years in columns (1)-(9). All other aspects are defined as in the notes to Table 4.

Table 5 presents the results. The negative effect induced by the initial crowding-out is statistically significant until 2005. Afterwards, crowding-in starts and the negative impact of bubble exposure vanishes gradually, becoming positive (but not significant) in 2009. When the bubble bursts, the effect turns negative and significant in cumulative terms: a one standard deviation increase in initial firm bubble exposure reduces cumulative credit growth by 9.43 percentage points. Thus, in this sample, crowding-in is just large enough to compensate the initial crowding-out by 2009. However, the bursting of the bubble then hits exposed firms very strongly (even though we lack the data to test whether this effect is temporary or permanent).

5.4.3 Real effects

Finally, we analyze whether the results on firm credit reported thus far have any implications for real outcomes. To this end, we estimate Equation (29) one more time, but we now use a firm's value added growth instead of credit growth as a dependent variable.[35] Following Chaney et al. (2012) we also saturate the specification with a set of firm fixed effects to account for unobserved heterogeneity that might blur the interaction between financial shocks and real outcomes at the firm level.[36]

Table 6 reports the estimated effects. In columns (1)-(3) we focus on the baseline measure of firm's bubble exposure. The estimated effects show that the differences in credit growth had real consequences: the value added of non-housing firms that borrowed more from more exposed banks grew less than that of their peers in 2004, while it grew more in 2008. Finally, value added growth was significantly lower in these firms when the bubble burst in 2012. This pattern remains unchanged when considering only the exposure of the firm's main bank (see columns (4) to (6)).

Table 6: Bubble exposure and value added growth at the firm level

	Baseline exposure			Main bank exposure		
	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)
Firm bubble exposure (E_{f0})	-0.28**	0.42**	-0.52***	-0.21**	0.36**	-0.47***
(s.e.)	(0.12)	(0.20)	(0.11)	(0.10)	(0.16)	(0.12)
Average dep. variable	1.57	-13.43	-6.86	1.56	-13.38	-6.80
Firm controls	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Balance-sheet data	YES	YES	YES	YES	YES	YES
R-sq	0.44	0.45	0.45	0.45	0.45	0.36
# observations	147,082	178,942	170,973	144,063	174,858	162,926

Notes: The dependent variable is annual value added growth at the firm level in all columns. Bank bubble exposure is proxied by the pre-bubble share of mortgage-backed credit at the firm-level (E_{ft}). Firm-bank controls are the length of firm-bank relationship in months and a dummy for past defaults. Firm controls are total assets, number of employees, own funds over total assets, return on assets, a dummy for young firms (less than three years old) and an exporter dummy. To ease the interpretation, the bank bubble exposure regressor has zero mean and unit variance. Standard errors multi-clustered at the main bank and industry-municipality level in parentheses.

[35] A firm's value added is defined as the difference between sales (net operating revenue) and material expenditures. Results are unchanged if we consider sales instead.

[36] Including firm fixed effects in equation (29) is equivalent to running a set of year-by-year regressions with the variables expressed in deviations from the firm-specific averages. Credit estimates in Table 4 are also robust to this specification.

The magnitude of the real effects estimated in Table 6 is lower than that of the credit effects in Table 4, but still economically significant. For instance, a one standard deviation increase in firm's bubble exposure results in a 0.42 percentage point increase in value added growth, which represents 3% of the absolute value of average value added growth in 2008. This figure is even larger for 2004 (18%) and 2012 (7.5%).

6 Conclusion

In this paper, we developed a multi-sector model with bubbles and financial intermediaries, and used it to guide an empirical analysis of the recent Spanish housing boom and bust. Our model suggests that the financial system plays an important role in transmitting housing bubbles to the rest of the economy, and that the direction of this transmission varies over time. Initially, a housing bubble increases credit demand for housing, and therefore crowds out credit and investment from non-housing firms. Eventually, however, the expansion in bubble-collateralized lending raises banks' net worth and thus their credit supply to all sectors. Thus, our results reconcile the seemingly contradictory crowding-out and crowding-in results in the literature on the macroeconomic effects of housing booms, by identifying them as different phases of the same phenomenon. Furthermore, our empirical analysis shows that the recent experience of Spain is consistent with these theoretical predictions.

On the policy front, our findings shed light on the costs and benefits of housing booms and busts. It may well be that housing expansions crowd out credit that is necessary for productive investment in other sectors, as many have argued. However, our findings suggest that this concern is likely to be temporary, because housing bubbles eventually raise credit to all sectors if they last long enough. Of course, housing booms driven by rational bubbles (as in our model) are also intrinsically fragile. Although this is well understood, our model shows that this cost is likely to be large – and to spread well beyond the housing sector – once the bubble makes up a substantial share of banks' net worth. This has natural macroprudential implications that are beyond the scope of this paper.

Finally, our results are not limited to housing bubbles, but generalize to other sectoral shocks. Indeed, our model highlights the general role of the financial system as a transmission mechanism: when banks or other lenders face collateral constraints, a positive shock to one particular sector first reduces credit availability for other sectors, but eventually stimulates it. Thus, the mechanisms outlined in this paper can potentially help to explain more general comovement dynamics of economic sectors over the business cycle.

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A Theoretical Appendix (for online publication)

A.1 Labor reallocation and land depreciation

In this section, we relax two simplifying assumptions made in Section 3.1. First, we assume that labor is not sector-specific, but that young entrepreneurs can work in both sectors. Then, we analyze a model in which land does not fully depreciate during production.

A.1.1 A model with mobile labor

We now assume that young entrepreneurs can work both in the H and in the N-sector. To keep the aggregate stock of labor equal to 1, we assume that each young entrepreneur is endowed with 0.5 units of generic labor. The goods market equilibrium conditions in this model are still described by Equations (3) and (4), as in the baseline model. The situation in the labor market changes, however. Labor mobility implies that the wage must be equalized in both sectors, that is,

$$w_t = (1-\alpha_N) \cdot P_{N,t} \cdot \left(\frac{K_{N,t}}{L_{N,t}}\right)^{\alpha_N} = (1-\alpha_H-\beta_H) \cdot P_{H,t} \cdot \left(\frac{K_{H,t}}{L_{H,t}}\right)^{\alpha_H} \cdot (L_{H,t})^{-\beta_H} . \tag{31}$$

Together with the labor market clearing condition, which implies $L_{N,t} + L_{H,t} = 1$, Equation (31) pins down the equilibrium allocation of labor as a function of capital stocks in both sectors. The returns to capital and land are given by

$$r_{j,t} = \alpha_j \cdot P_{j,t} \cdot \left(\frac{K_{j,t}}{L_{j,t}}\right)^{\alpha_j - 1} (L_{j,t})^{-\beta_j} , \tag{32}$$

for each sector j, and

$$m_t = \beta_H \cdot P_{H,t} \cdot (K_{H,t})^{\alpha_H} (L_{H,t})^{1-\alpha_H-\beta_H} . \tag{33}$$

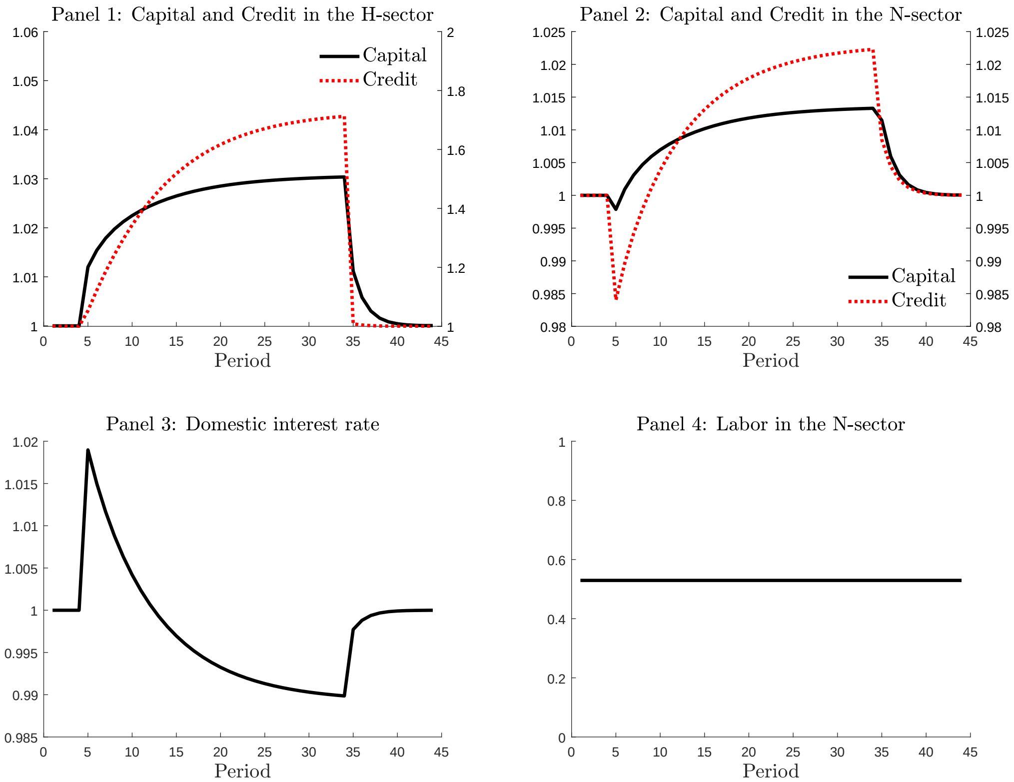
The credit market also works in the same way as in the baseline model. Thus, domestic credit demand is still defined by Equation (13), and the law of motion for the capital stock in sector j is

$$K_{j,t+1} = \frac{R_{t+1}}{R_{t+1} - \lambda_j \cdot r_{j,t+1}} \cdot \left(\frac{w_t}{2} + \mathbb{1}_j^H \cdot \left[\frac{m_{t+1} + E_t(V_{t+1})}{R_{t+1}} - V_t\right]\right) \tag{34}$$

Likewise, bankers' credit supply is still given by Equation (18). All other equations are unchanged, and the model can then be solved just as our baseline model.

Figure A.1 plots a bubbly episode in this more general model. Panels 1 to 3 show that all of the predictions described in the main text still hold: a bubble first crowds out credit and investment from the non-housing sector, and then crowds it in. Panel 4 shows that the labor market does not operate as a transmission mechanism in our model. Indeed, the increase in housing capital increases the marginal product of labor in the housing sector, but the fall in the relative price of housing sector output lowers it. With Cobb-Douglas aggregation, these two effects exactly cancel out.[37]

Figure A.1: A bubbly episode with mobile labor



Notes: All variables (except the share of labor employed in the N-sector) are normalized to 1 in the fundamental steady state.

A.1.2 A model without full land depreciation

We now assume that land does not fully depreciate during the production process. Precisely, we assume that in every period, young housing entrepreneurs are endowed with η units of new land (where $\eta \in (0,1)$), which can first be used in production in the next period. After production, a fraction $1-\eta$ of this land remains productive, while the remaining fraction η becomes unproductive. This implies that the total stock of productive land in the economy is constant and equal to one. Formally, $T = \eta \cdot \sum_{k=0}^{+\infty} (1-\eta)^k = 1$. This does not change most of the model's equilibrium conditions, except for the equations pinning down the

[37] If the final good were instead a CES aggregate of the two intermediates, the housing bubble would attract labor to the housing sector if the elasticity of substitution between intermediates were larger than 1, and lower labor in the housing sector if it were lower than 1. Nevertheless, none of our results on transmission through the credit market would change.

value of land. Now, as land does not fully depreciate, "old" vintages have some fundamental value, so V_t is different from zero even in the absence of a bubble. Precisely, we now have, for every vintage τ,

$$V_{\tau,t} = \frac{m_{t+1} \cdot \eta \cdot (1-\eta)^{t-\tau} + E_t\left(V_{\tau,t+1}\right)}{R_{t+1}}. \tag{35}$$

Iterating this equation forward, we get

$$V_{\tau,t} = \eta \cdot (1-\eta)^{t-\tau} \cdot E_t\left(\sum_{s=1}^{\infty} m_{t+s} \cdot \frac{(1-\eta)^{s-1}}{\prod\limits_{k=1}^{s} R_{t+k}}\right) + E_t\left(\lim_{s\to\infty} \frac{V_{\tau,t+s}}{\prod\limits_{k=1}^{s} R_{t+k}}\right). \tag{36}$$

Thus, the aggregate value of land can now be written as

$$V_t = \underbrace{E_t\left(\sum_{s=1}^{\infty} m_{t+s} \cdot \frac{(1-\eta)^{s}}{\prod\limits_{k=1}^{s} R_{t+k}}\right)}_{V_t^F} + \underbrace{E_t\left(\lim_{s\to\infty} \frac{V_{t+s}}{\prod\limits_{k=1}^{s} R_{t+k}}\right)}_{V_t^B}, \tag{37}$$

where V_t^F stands for the fundamental component of land prices and V_t^B for its bubble component. The equilibrium and the bubble process in this model are defined analogously to the baseline. Then, it is clear that our main results will be unaffected: the start of a bubbly episode still raises credit demand more than credit supply (increasing the interest rate and crowding out non-housing credit), but this eventually increases loan repayments to bankers, expands their net worth and triggers a crowding-in effect.

A.2 The role of land pledgeability

In our baseline model, banks can pledge a fraction λ_B of their loan income to the IFM. As discussed in Section 4.2, we now generalize the model to allow for differences in the pledgeability of loan income collateralized by capital and loan income collateralized by land. Precisely, we assume that banks can pledge a fraction $\lambda_B \in (0,1)$ of their income backed by capital, and a fraction $\lambda_B^T \in (0,1)$ of their income backed by land. We continue to assume, for simplicity, that entrepreneurs can pledge their entire land income to bankers.[38]

These assumption imply that there are now two domestic interest rates, one for loans backed by capital, which we continue to denote by R_{t+1}, and one for loans backed by land, which we denote by R_{t+1}^T. We continue to focus on constrained equilibria, in which the return to housing capital $r_{H,t+1}$ exceeds both domestic interest

[38] Thus, in our setting, lending against land and buying land is the exact same thing for bankers.

rates, and the latter both exceed the international interest rate R^*. Note that as in the baseline model, bubbles on old land can arise as long as the value of land is expected to grow at the interest rate R^T_{t+1}.

In equilibrium, banks must be indifferent to grant loans backed by capital or land. As they can leverage both types of loans on the IFM, the total return to a given type of loan is given by the product of the part of the return they keep and the relevant leverage ratio. Therefore, equal returns to both types of loans implies

$$(1-\lambda_B)\,R_{t+1}\frac{R^*}{R^*-\lambda_B R_{t+1}} = \left(1-\lambda_B^T\right)R^T_{t+1}\frac{R^*}{R^*-\lambda_B^T R^T_{t+1}}. \tag{38}$$

In equilibrium, total credit demand by entrepreneurs is

$$Q_t^D = \frac{\sum\limits_{j\in\{N,H\}} \lambda_j \cdot r_{j,t+1}\cdot K_{j,t+1}}{R_{t+1}} + \frac{m_{t+1}+E_t\left(V_{t+1}\right)}{R^T_{t+1}}, \tag{39}$$

The budget constraint of young bankers is still given by Equation (15). Their collateral constraint becomes

$$F_{B,t+1} \leq \lambda_B \cdot \left(\sum_{j\in\{N,H\}} \lambda_j \cdot r_{j,t+1}\cdot K_{j,t+1}\right) + \lambda_B^T \cdot \left(m_{t+1}+V_{t+1}\right). \tag{40}$$

Combining the binding collateral constraint with young bankers' budget constraint, it comes that credit supply is given by

$$\begin{aligned} Q_t^S \;=\; & \phi \cdot \left((1-\lambda_B)\cdot\left(\sum_{j\in\{N,H\}} \lambda_j \cdot r_{j,t}\cdot K_{j,t}\right) + \left(1-\lambda_B^T\right)\cdot\left(m_t+V_t\right)\right) \\ & + \tfrac{\lambda_B}{R^*}\cdot\left(\sum_{j\in\{N,H\}} \lambda_j \cdot r_{j,t+1}\cdot K_{j,t+1}\right) + \tfrac{\lambda_B^T}{R^*}\cdot\left(m_{t+1}+E_t\left(V_{t+1}\right)\right). \end{aligned} \tag{41}$$

Equalizing credit supply and credit demand, and using Equation (38) to simplify the resulting expression, we get

$$\frac{R_{t+1}\cdot R^*}{R^*-\lambda_B\cdot R_{t+1}} = \frac{(1-\lambda_B)\sum\limits_{j\in\{N,H\}} \lambda_j \cdot r_{j,t+1}\cdot K_{j,t+1} + \left(1-\lambda_B^T\right)\cdot\left(m_t+E_t\left(V_{t+1}\right)\right)}{\phi\,(1-\lambda_B)\left((1-\lambda_B)\sum\limits_{j\in\{N,H\}} \lambda_j \cdot r_{j,t}\cdot K_{j,t} + \left(1-\lambda_B^T\right)\cdot\left(m_t+V_t\right)\right)}, \tag{42}$$

which is the equivalent of Equation (24) in the main text (and coincides exactly with the latter if $\lambda_B = \lambda_B^T$). This model always features the usual non-monotonic response of interest rates: a housing bubble initially provides collateral to housing entrepreneurs, increases the value of their future loan repayments, and raises both domestic interest rates.[39] Eventually, bank net worth catches up, and the interest rates fall again. Furthermore, as long as $\lambda_B^T < 1$, the right-hand side of Equation (42), and thus both interest rates, are smaller in the bubbly steady state than in the fundamental steady state.

Equation (42) also shows very clearly how this "strong" crowding-in result depends on the degree to which bankers can pledge land income to the IFM. In particular, it shows that if λ_B^T gets closer to 1, the strong crowding-in effect becomes weaker. In the limit case in which $\lambda_B^T = 1$, so that banks can fully transfer the risk associated with the housing bubble to the IFM, it disappears: the interest rates in the bubbly steady state are then identical to those in the fundamental steady state. To sum up, this discussion shows that a strong crowding-in effect, raising non-housing credit above its fundamental steady-state, requires bankers to be exposed to the housing bubble's risk.[40] We believe this is a reasonable assumption for the Spanish case. For instance, Santos (2017a) shows that Spanish banks needed to keep a large fraction of housing-related loans on their books (including, in particular, essentially all loans to real estate developers).

A.3 Bank and firm heterogeneity

A.3.1 Assumptions

In this section, we derive the equilibrium conditions for the extended model with bank and firm heterogeneity described in Section 4.3. In this extension, we assume that there are two different types of bankers, N-bankers and H-bankers, and three different kinds of entrepreneurs in the non-housing sector: a mass θ_N of entrepreneurs which can only borrow from N-banks, a mass θ_H of entrepreneurs which can only borrow from H-banks, and a mass $\theta_{NH} = 1 - \theta_N - \theta_H$ of entrepreneurs which can borrow from both banks. Note that in Figure 8, we assume that $\theta_H = \theta_N = 0$, that is, all non-housing entrepreneurs are able to borrow from both banks. In Figure 9, instead, we consider the more general case in which we assume that $\theta_H > 0$ and $\theta_N > 0$, that is, some non-housing entrepreneurs are locked in with one type of bank.

We also assume in this extension that bankers of type j receive an exogenous endowment of x^j units of the final good when they are young. Indeed, without this technical assumption, the share of non-housing credit intermediated by one type of bankers (that is, the relative size of banks) would be indeterminate even in the absence of housing bubbles. This is due to the fact that banker income depends on loan volumes,

[39] Equation (42) pins down only R_{t+1}. However, Equation (38) shows that R^T_{t+1} moves one-to-one with R_{t+1}.

[40] This model can be easily extended further by assuming that bankers are also endowed with some new land. In this extension, the appearance of a housing bubble would have an immediate positive effect on credit supply. However, as long as the share of land created by bankers is small enough, this does not overturn our results. In the extreme case in which all land is created by bankers, the start of a bubble would directly increase credit supply and lower the interest rate. However, in that case, the bubble would no longer be a housing-specific shock, but rather a direct shock to the banking system.

which creates strong feedback effects: if N-bankers give a lot of credit to non-housing entrepreneurs in period t, young N-bankers in period $t+1$ have high income, which they can use again to lend to non-housing entrepreneurs. Introducing an exogenous endowment, even if it is arbitrarily small, slightly weakens this feedback and allows us to pin down the relative size of banks in the fundamental steady state.

A.3.2 Equilibrium conditions

Individual optimization Intermediate goods and factor market clearing conditions are unchanged with respect to the baseline model, and therefore still given by Equations (3) to (8). Note that we have

$$K_{N,t} = K_{N,t}^{N} + K_{N,t}^{H} + K_{N,t}^{NH}, \tag{43}$$

where K_N^i stands for the capital stock of non-housing entrepreneurs of type i. As all entrepreneurs supply the same capital, they all receive the same rate of return $r_{N,t}$.

We continue to impose parameter conditions ensuring that the return to capital for all entrepreneurs is higher than the interest rate on their loans, which is in turn higher than the international interest rate. The budget constraint for young entrepreneurs is now

$$\begin{cases} K_{N,t+1}^{i} = \theta_i \cdot w_{N,t} + \frac{E_t\left(F_{N,t+1}^{i}\right)}{R_{N,t+1}^{i}}, \quad \text{with } i \in \{N, H, NH\} \\ K_{H,t+1} = w_{H,t} + \frac{E_t(F_{H,t+1})}{R_{H,t+1}} - V_t, \end{cases}, \tag{44}$$

where $R_{N,t+1}^{i}$ is the interest rate faced by non-housing entrepreneurs of type i. For non-housing entrepreneurs locked in with H-banks, this is $R_{H,t+1}$, the interest rate of H-banks (which is also the interest rate paid by housing entrepreneurs). For non-housing entrepreneurs locked in with N-banks, it is $R_{N,t+1}$, the interest rate of N-banks. Finally, for non-housing entrepreneurs which can borrow from both banks, it is $\min\left(R_{N,t+1}, R_{H,t+1}\right)$, as these entrepreneurs always borrow from the cheapest source. Note that it is now possible that the equilibrium interest rate at H-banks differs from the one at N-banks because some entrepreneurs are locked in (they would like to switch to a bank with a lower interest rate, but they cannot), and because banks are financially constrained.[41]

The collateral constraint then implies that credit demand for entrepreneurs of type (j, i) is given by

[41] This is also the reason for why the domestic interest rate is higher than R^* in the model without heterogeneity: any bank would like to undercut the domestic interest rate and attract all borrowers, but it cannot do so, as it is constrained and therefore unable to serve more borrowers than it currently does.

$$Q^i_{j,t} = \frac{\lambda_j \cdot r_{j,t+1} \cdot K^i_{j,t+1} + \mathbb{1}^H_j \left(m_{t+1} + E_t(V_{t+1})\right)}{R^i_{j,t+1}}, \tag{45}$$

Finally, the behavior of both types of bankers is exactly analogous to the one of the single banker in the model without heterogeneity.[42] Thus, the credit supply of a type-j banker is given by

$$Q^j_{B,t} = \frac{R^*}{R^* - \lambda_B \cdot R_{j,t+1}} \left(\phi \cdot (1-\lambda_B) \cdot F^j_{Bt} + x^j\right),$$

where $F^j_{B,t}$ denotes the repayments received by type-j bankers.

Credit market clearing Depending on parameter values, the equilibrium can be of three different types. If parameter values are such that $R_{H,t+1} > R_{N,t+1}$, then credit market clearing conditions are given by

$$Q^N_{N,t} + Q^{NH}_{N,t} = Q^N_{B,t} \quad \text{and} \quad Q_{H,t} + Q^H_{N,t} = Q^H_{B,t}. \tag{46}$$

If parameter values are such that $R_{H,t+1} < R_{N,t+1}$, then the credit market clearing conditions are given by

$$Q^N_{N,t} = Q^N_{B,t} \quad \text{and} \quad Q_{H,t} + Q^H_{N,t} + Q^{NH}_{N,t} = Q^H_{B,t}. \tag{47}$$

Finally, if parameter values are such that $R_{H,t+1} = R_{N,t+1} = R_{t+1}$, then there exists $s^N_{NH} \in [0,1]$ such that the credit market clearing conditions are given by

$$Q^N_{N,t} + s^N_{NH} Q^{NH}_{N,t} = Q^N_{B,t} \quad \text{and} \quad Q_{H,t} + Q^H_{N,t} + \left(1 - s^N_{NH}\right) Q^{NH}_{N,t} = Q^H_{B,t}. \tag{48}$$

In each period t, we solve the model by first conjecturing that interest rates are equalized. Then, we can solve the model exactly as described in Section 4.1, and use Equation (48) to deduce s^N_{NH}. If this number is between 0 and 1, our initial conjecture was correct, and we have found the equilibrium. Otherwise, if this number is negative, it must be that the equilibrium interest rate at N-banks is higher than the one at H-banks. We can then solve for the equilibrium by combining Equation (47) with the other equilibrium conditions of Section 4.1 (and verify that the solution indeed holds $R^H_{t+1} < R^N_{t+1}$). Finally, if the computed s^N_{NH} is larger than 1, then the equilibrium interest rate at H-banks is higher than the one at N-banks, and we can solve for the equilibrium by combining Equation (46) with the other equilibrium conditions.

[42] Bank competition prevents banks of the same type from price discrimination (e.g., charging higher interest rates to locked-in clients). This could not be an equilibrium because another bank could offer a slightly lower interest rate for the locked-in clients, attract them (and give up some low-return non-locked-in clients to respect the collateral constraint).

A.4 Parameter values

Table A.1 gives the parameter values used for drawing Figures 5, 6 and A.1.

Table A.1: Parameter values for the simulations

Parameter	Value	Parameter	Value
τ	0.50	λ_H	0.10
α_N	0.55	λ_B	0.20
α_H	0.55	R^*	0.20
β_H	0.05	ψ	0.08
ϕ	0.60	N	0.0004
λ_N	0.10		

All other figures use largely the same parameter values. In Figure 7, we set $\psi_L = 0.08$ and $\psi_H = 0.2$. In Figure 8, $\theta_H = \theta_N = 0$. In Figure 9 instead, we set $\theta_H = 0.44$ and $\theta_N = 0.48$, and change N to 0.005, and ψ to 0.25. In both of the latter figures, $x^N = 0.0000105$ and $x^H = 0.00005$.

B Data Appendix (for online publication)

B.1 Data sources for Section 2

House prices and the number of new houses built are taken from the Spanish Ministry of Construction.[43] We use the series "valor tasado de vivienda libre" (Table 1). Prices are defined as the average price per square meter of "free" (that is, non-subsidized) housing, and estimated every trimester by the ministry on the basis of data provided by valuation experts. We take a simple average to aggregate this data to a yearly series. The number of new houses instead refers to the number of new housing construction projects started in a given year ("Numero de viviendas libres iniciadas", Table 3.1).

Series for real GDP and business economy GDP are taken from the Spanish Statistical Institute (INE, `www.ine.es`). In line with the Eurostat definition, the business economy contains NACE sectors A to N, excluding only public administration and defense, social security, health and education, arts and entertainment.

Finally, credit series are taken from Table 8.9 of the Bank of Spain's economic bulletin.[44] These contain the

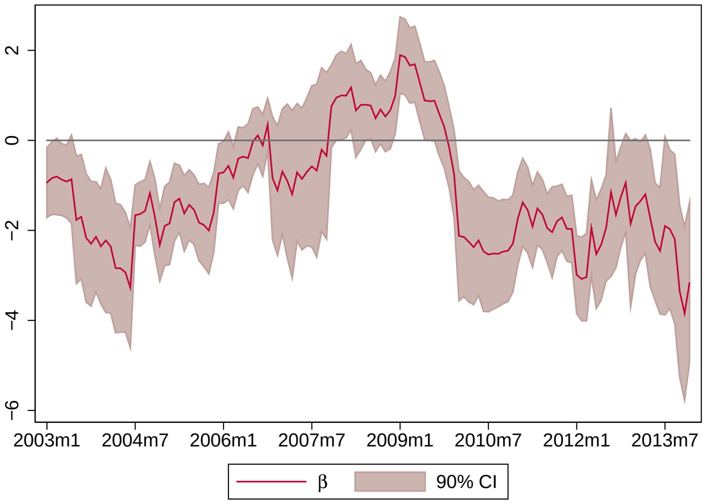
[43] See `http://www.fomento.gob.es/MFOM/LANG_CASTELLANO/ATENCION_CIUDADANO/INFORMACION_ESTADISTICA/Vivienda/Estadisticas/`.

[44] See `https://www.bde.es/webbde/es/estadis/infoest/bolest.html`.

overall credit given to firms (credit to productive activities), as well as the credit given to housing-related activities (construction and real estate).

B.2 Additional results

Figure A.2: Bubble exposure and credit growth for non-housing firms at the monthly level.



Notes: This plot shows the β_t coefficient for an estimation of Equation (25) at the monthly frequency. The dependent variable in these regressions is credit growth at the bank-firm level between month m in year $t-1$ and month m in year t.

Figure A.3: Micro-aggregated output and employment growth

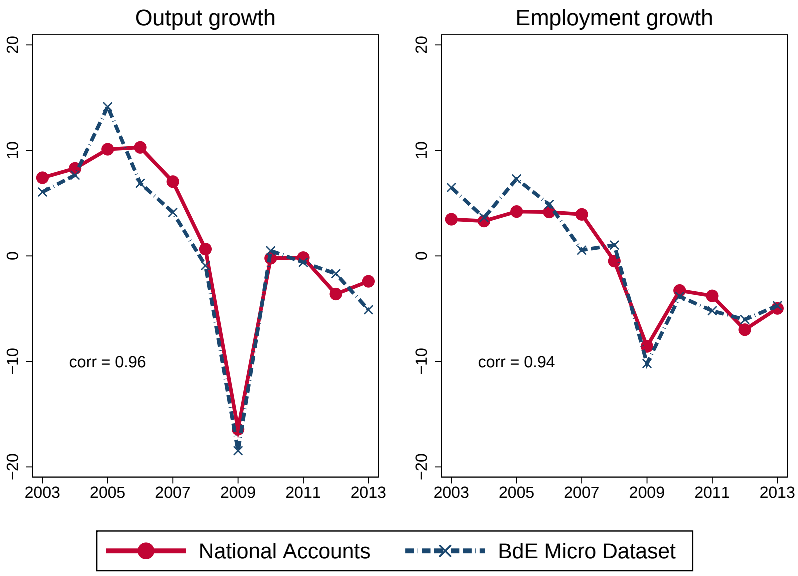


Figure A.4: Bubble exposure and credit growth for housing firms.

Notes: This plot shows the OLS estimates of the β_t coefficient from Equation (25) in a sample of housing firms.

Table A.2: Bubble exposure and credit growth at the bank-firm level: results for 1996-2002.

	1996	1998	2000	2002
	(1)	(2)	(3)	(4)
Bank bubble exposure (E_{b0})	-0.26	-0.31	-2.24	0.71
(s.e.)	(0.65)	(0.43)	(1.42)	(0.61)
Average dep. variable	4.20	10.33	11.78	6.89
Firm fixed effects	YES	YES	YES	YES
Firm controls	NO	NO	NO	NO
Bank controls	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES
Industry × municipality FE	NO	NO	NO	NO
Multiple banks per firm	YES	YES	YES	YES
Balance-sheet data	NO	NO	NO	NO
R-sq	0.35	0.37	0.36	0.36
# observations	349,653	433,383	425,533	516,780
# firms	108,730	137,307	140,040	169,235
# banks	165	156	144	126

Notes: The dependent variable is annual credit growth at the bank-firm level in all columns. Bank bubble exposure is proxied by the share of mortgage-backed credit (E_{b0}). All regressions are based on Equation (25). Bank controls: log total assets, capital ratio, liquidity ratio, and default rate. Firm-bank controls: length of firm-bank relationship in months and past defaults. To ease the interpretation, the bank bubble exposure regressor has zero mean and unit variance. Standard errors multi-clustered at the bank and firm level in parentheses.

Table A.3: Bubble exposure and credit growth at the bank-firm level.

PANEL A: Dep. variable is bank-firm credit growth (Credit_growth$_{fbt}$)						
	OLS			IV		
	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)
Bank bubble exposure	-0.56	1.41***	-0.02***	-2.07***	1.52***	-4.44**
(s.e.)	(0.79)	(0.36)	(0.00)	(0.70)	(0.52)	(2.27)
Average dep. variable	8.71	3.50	-2.93	8.61	3.51	-2.88
Firm fixed effects	YES	YES	YES	YES	YES	YES
Firm controls	NO	NO	NO	NO	NO	NO
Bank controls	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES
Industry $\times$ municipality FE	NO	NO	NO	NO	NO	NO
Multiple banks per firm	YES	YES	YES	YES	YES	YES
Balance-sheet data	NO	NO	NO	NO	NO	NO
R-sq	0.37	0.35	0.34			
# observations	558,978	678,439	526,092	549,959	666,846	504,233
# firms	181,749	210,806	166,783	179,421	207,796	160,736
# banks	171	165	120	117	110	62

PANEL B: First-stage. Dep. variable is mortgage-backed credit at the bank level (E$_{bt}$)						
Bank bubble exposure (E$_{b0}$)	0.15***	0.16***	0.12***	0.15***	0.15***	0.10***
(s.e.)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
Bank controls	NO	NO	NO	YES	YES	YES
F-stat	79.97	85.50	20.66	26.62	23.33	9.15
F-stat (p-value)	0.00	0.00	0.00	0.00	0.00	0.15
R-sq	0.40	0.43	0.24	0.54	0.51	0.43
# observations	121	116	66	121	116	66

Notes. See notes to Table 1 for Panel A. Year-by-year regressions at the bank level are reported in Panel B.

Table A.4: Bubble exposure and credit growth at the bank-firm level. Without cajas.

	Firm fixed effects			Firm controls			Firm controls (multibank)		
	2004	2008	2012	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Bank bubble exposure	-2.27***	1.16**	-1.57**	-2.23***	1.20*	-1.48*	-2.42***	1.27	-1.59*
(s.e.)	(0.52)	(0.59)	(0.78)	(0.66)	(0.73)	(0.81)	(0.72)	(0.80)	(0.90)
Average dep. variable	8.92	3.74	-2.10	11.62	5.71	-1.09	11.84	6.00	-0.41
Firm fixed effects	YES	YES	YES	NO	NO	NO	NO	NO	NO
Firm controls	NO	NO	NO	YES	YES	YES	YES	YES	YES
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry × municipality FE	NO	NO	NO	YES	YES	YES	YES	YES	YES
Multiple banks per firm	YES	YES	YES	NO	NO	NO	YES	YES	YES
Balance-sheet data	NO	NO	NO	YES	YES	YES	YES	YES	YES
R-sq	0.39	0.38	0.36	0.20	0.17	0.20	0.22	0.19	0.21
# observations	356,728	435,533	418,573	289,667	359,984	339,018	247,493	304,667	286,096
# firms	127,396	150,398	141,146	145,081	179,080	164,515	102,907	123,763	111,593
# banks	78	73	54	76	72	53	75	70	53

Notes: The dependent variable is annual credit growth at the bank-firm level in all columns. Bank bubble exposure is proxied by the share of mortgage-backed credit (E_{b0}). All regressions are based on Equation (25) but excluding saving banks (cajas) from the sample. Bank controls: log total assets, capital ratio, liquidity ratio, and default rate. Firm-bank controls: length of firm-bank relationship in months and past defaults. Firm controls: total assets, number of employees, own funds over total assets, return on assets, a dummy for young firms (less than three years old), and an exporter dummy. To ease the interpretation, the bank bubble exposure regressor has zero mean and unit variance. Standard errors multi-clustered at the bank and firm level in parentheses.

Table A.5: Bubble exposure and credit growth at the bank-firm level: credit to housing firms exposure

	Firm fixed effects			Firm controls			Firm controls (multibank)		
	2004	2008	2012	2004	2008	2012	2004	2008	2012
Bank bubble exposure (E_b^H)	-1.33***	0.90**	-2.18***	-1.25**	0.99**	-2.49***	-1.42**	1.00*	-2.74***
(s.e.)	(0.48)	(0.42)	(0.70)	(0.56)	(0.50)	(0.89)	(0.60)	(0.55)	(0.95)
Average dep. variable	8.43	3.39	-3.34	11.16	5.48	-2.67	11.36	5.77	-2.22
Firm fixed effects	YES	YES	YES	NO	NO	NO	NO	NO	NO
Firm controls	NO	NO	NO	YES	YES	YES	YES	YES	YES
Bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry × municipality FE	NO	NO	NO	YES	YES	YES	YES	YES	YES
Multiple banks per firm	YES	YES	YES	NO	NO	NO	YES	YES	YES
Balance-sheet data	NO	NO	NO	YES	YES	YES	YES	YES	YES
R-sq	0.37	0.35	0.33	0.18	0.15	0.18	0.19	0.17	0.19
# observations	559,976	665,343	576,152	416,027	498,120	429,635	356,979	424,690	369,050
# firms	181,935	208,625	179,895	180,785	215,117	189,974	121,737	141,687	129,389
# banks	164	156	124	162	154	123	161	152	123

Notes: The dependent variable is annual credit growth at the bank-firm level in all columns. Bank bubble exposure is proxied by the share of credit to housing firms over total credit to non-financial corporations (E_b^H). All regressions are based on Equation (25). Bank controls: log total assets, capital ratio, liquidity ratio, and default rate. Firm-bank controls: length of firm-bank relationship in months and past defaults. Firm controls: total assets, number of employees, own funds over total assets, return on assets, a dummy for young firms (less than three years old), and an exporter dummy. To ease the interpretation, the bank bubble exposure regressor has zero mean and unit variance. Standard errors multi-clustered at the bank and firm level in parentheses.

Table A.6: Banks net worth and bubble exposure — Regression analysis

	(1)	(2)
Bank bubble exposure	0.17***	0.12**
(s.e.)	(0.06)	(0.05)
Average Dep. Variable	1.48	1.48
Bank controls	NO	YES
R-sq	0.08	0.27
# observations	113	113

Notes. Dependent variable is the growth rate of banks net worth over the 1995-2009 period. Bank controls: log total assets, capital ratio, liquidity ratio, and default rate. In order to ease interpretation, bank bubble exposure refers to initial bank bubble exposure normalized to have zero mean and unit variance.

Table A.7: Bubble exposure and credit growth at the firm level.

PANEL A: Dep. variable is firm credit growth (Credit_growth$_{ft}$)						
		OLS			IV	
	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)
Firm bubble exposure	-1.13**	1.07***	-5.46***	-1.33**	1.57***	-4.69***
(s.e.)	(0.57)	(0.24)	(1.35)	(0.64)	(0.37)	(1.52)
Average dep. variable	19.11	10.65	4.21	19.11	10.65	4.21
Firm controls	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES
Industry × municipality FE	YES	YES	YES	YES	YES	YES
Only multibank firms	NO	NO	NO	NO	NO	NO
Balance-sheet data	YES	YES	YES	YES	YES	YES
R-sq	0.30	0.26	0.34			
# observations	153,973	189,235	164,544	153,030	187,920	158,287

PANEL B: First-stage. Dep. variable is mortgage-backed credit at the firm level (E$_{ft}$)						
Firm bubble exposure (E$_{f0}$)	0.77***	0.74***	0.51***	0.77***	0.74***	0.52***
(s.e.)	(0.06)	(0.07)	(0.08)	(0.06)	(0.07)	(0.08)
Firm controls	YES	YES	YES	NO	NO	NO
Firm-bank controls	YES	YES	YES	NO	NO	NO
Industry × municipality FE	YES	YES	YES	YES	YES	YES
F-stat	29.37	16.75	10.37	178.98	115.18	42.99
F-stat (pvalue)	0.00	0.00	0.00	0.00	0.00	0.00
R-sq	0.73	0.68	0.55	0.72	0.67	0.53
# observations	153,030	187,920	158,287	205,354	261,945	

Notes. See notes to Table 4 for Panel A. Year-by-year regressions at the firm level are reported in Panel B.

Table A.8: Bubble exposure and credit growth at the firm level. Main bank exposure.

	All firms			Multibank firms		
	2004	2008	2012	2004	2008	2012
	(1)	(2)	(3)	(4)	(5)	(6)
Firm bubble exposure	-1.07**	1.07***	-1.68**	-1.89***	0.88***	-1.98**
(s.e.)	(0.44)	(0.30)	(0.79)	(0.56)	(0.33)	(1.00)
Average dep. variable	18.88	10.52	2.94	24.98	16.36	10.27
Firm controls	YES	YES	YES	YES	YES	YES
Firm-bank controls	YES	YES	YES	YES	YES	YES
Industry × municipality FE	YES	YES	YES	YES	YES	YES
Only multibank firms	NO	NO	NO	YES	YES	YES
Balance-sheet data	YES	YES	YES	YES	YES	YES
R-sq	0.2991	0.2616	0.3216	0.307	0.298	0.3428
# observations	149,900	183,575	147,597	84,526	103,505	83,198

Notes. See notes to Table 4.

Table A.9: Summary statistics.

Panel A: Year 2004	Mean	Std. Dev.	25th pctile	Median	75th pctile	# obs.
Bank-firm variables						
$\text{Credit\_growth}_{fbt}$	8.77	54.32	-17.41	-0.05	14.81	1,141,125
Length of firm-bank relationship in months	54.91	47.39	17	41	82	1,523,576
Past defaults	0.16	0.36	0	0	0	1,523,576
Bank variables						
Share of mortgage-backed credit in 1995 (E_{b0})	0.34	0.20	0.18	0.35	0.49	123
Share of mortgage-backed credit (E_{bt})	0.52	0.22	0.45	0.57	0.65	179
log total assets	13.61	2.32	11.84	13.46	15.51	185
Capital ratio	0.12	0.17	0.06	0.07	0.10	185
Liquidity ratio	0.10	0.09	0.03	0.08	0.14	185
Default rate	0.022	0.105	0.005	0.009	0.014	179
Firm variables						
$\text{Credit\_growth}_{ft}$	16.18	62.04	-15.60	0.00	26.67	611,373
Demand shock	12.27	67.94	-18.45	-2.74	19.25	606,286
Total assets (thousands euros)	1676.90	4699.00	149.47	385.10	1112.70	369,581
Number employees	17.20	232.68	3	5	12	369,581
Own funds over total assets	0.39	0.29	0.13	0.33	0.62	369,581
Return on assets	0.02	0.16	-0.01	0.02	0.07	369,569
Young dummy (age$<$ 3 years)	0.06	0.24	0	0	0	369,581
Exporter dummy	0.05	0.22	0	0	0	369,581
Municipality variables						
Land unavailability	-0.59	1.28	-0.16	-0.35	-0.66	5,615

Panel B: Year 2008	Mean	Std. Dev.	25th pctile	Median	75th pctile	# obs.
Bank-firm variables						
$\text{Credit\_growth}_{fbt}$	2.59	47.27	-18.83	-1.87	6.66	1,536,592
Length of firm-bank relationship in months	49.61	44.65	13	36	72	1,998,797
Past defaults	0.20	0.40	0	0	0	1,998,797
Bank variables						
Share of mortgage-backed credit in 1995 (E_{b0})	0.34	0.19	0.18	0.35	0.49	121
Share of mortgage-backed credit (E_{bt})	0.58	0.23	0.51	0.65	0.73	175
log total assets	14.13	2.42	12.23	14.02	16.07	181
Capital ratio	0.12	0.19	0.05	0.08	0.10	181
Liquidity ratio	0.07	0.07	0.02	0.06	0.11	181
Default rate	0.022	0.054	0.010	0.016	0.025	175
Firm variables						
$\text{Credit\_growth}_{ft}$	6.61	52.05	-16.83	-1.46	11.48	792,979
Demand shock	-2.26	56.88	-25.22	-9.90	3.14	782,523
Total assets (thousands euros)	2018.92	5265.05	180.16	476.83	1389.62	459,105
Number employees	16.81	244.11	3	5	11	459,105
Own funds over total assets	0.41	0.30	0.14	0.36	0.67	459,105
Return on assets	0.002	0.17	-0.02	0.01	0.05	459,068
Young dummy (age$<$ 3 years)	0.03	0.17	0	0	0	459,105
Exporter dummy	0.05	0.22	0	0	0	459,105
Municipality variables						
Land unavailability	-0.59	1.28	-0.16	-0.35	-0.66	5,615

Table A.10: Summary statistics — continued

Panel C: Year 2012	Mean	Std. Dev.	25th pctile	Median	75th pctile	# obs.
Bank-firm variables						
Credit_growth$_{fbt}$	-4.83	36.76	-19.23	-3.78	0.00	1,389,262
Length of firm-bank relationship in months	47.39	44.35	13	35	68	1,792,747
Past defaults	0.32	0.46	0	0	1	1,792,747
Bank variables						
Share of mortgage-backed credit in 1995 (E$_{b0}$)	0.30	0.20	0.15	0.26	0.44	71
Share of mortgage-backed credit (E$_{bt}$)	0.53	0.28	0.44	0.64	0.72	146
log total assets	13.80	2.46	12.07	13.46	15.44	168
Capital ratio	0.25	0.33	0.07	0.09	0.19	168
Liquidity ratio	0.14	0.13	0.01	0.12	0.20	168
Default rate	0.079	0.099	0.024	0.060	0.097	146
Firm variables						
Credit_growth$_{ft}$	3.31	46.83	-19.44	-3.06	7.90	731,651
Demand shock	-14.87	42.65	-33.05	-16.96	-3.47	723,938
Total assets (thousands euros)	2107.55	5426.17	193.25	503.09	1455.15	362,987
Number employees	16.44	262.79	2	4	9	362,987
Own funds over total assets	0.44	0.31	0.16	0.41	0.72	362,987
Return on assets	-0.02	0.16	-0.05	0.004	0.03	362,974
Young dummy (age< 3 years)	0.02	0.14	0	0	0	362,987
Exporter dummy	0.06	0.24	0	0	0	362,987
Municipality variables						
Land unavailability	-0.59	1.28	-0.16	-0.35	-0.66	5,615

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