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Abstract

This paper empirically investigates the impact of local house price booms on capital misallocation within manufacturing industries. Using the geographic variation provided by the salient Spanish housing boom (2003-2007), we show that manufacturing firms exposed to positive local house price shocks received more credit from banks and their investment grew more intensively when they had a larger proportion of collateralizable real estate assets. We exploit the geographical variation in both house prices and pre-boom urban land supply at municipality level to document that this collateral channel was exacerbated for firms located in urban land-constrained geographical areas where real estate appreciation was larger. The interaction of geographical conditions, that led to heterogeneous housing booms, with the collateral channel on investment resulted in an increasing dispersion of the capital-labor ratio within industries. A simple counterfactual calculation suggests that the misallocation generated by the collateral channel on investment could account for between one-quarter and half of the fall in TFP experienced in the Spanish manufacturing sector over the housing boom.

Keywords: housing boom, misallocation, collateral channel, productivity.

JEL classification: E22, E44, O16, 047.

Resumen

En este documento se investiga empíricamente el impacto de la heterogeneidad en el incremento de los precios de la vivienda a nivel municipal en la ineficiente asignación del capital dentro de las industrias manufactureras. Utilizando el extraordinario *boom* inmobiliario que tuvo lugar en España entre 2003 y 2007, mostramos cómo las empresas manufactureras expuestas a mayores *shocks* locales en los precios inmobiliarios y con una mayor proporción de activos inmobiliarios potencialmente colateralizables recibieron más crédito por parte del sector bancario, y que su tasa de inversión creció más intensamente. Usando la variación geográfica a nivel municipal tanto en los precios de la vivienda como en la oferta de suelo urbano previa al *boom* inmobiliario, documentamos que el canal creado por el aumento del valor del colateral fue más potente para las empresas localizadas en áreas geográficas con restricciones de suelo disponible donde los incrementos del precio de la vivienda fueron mayores. La interacción de las condiciones geográficas que conducen a *booms* inmobiliarios heterogéneos con el impacto de la revalorización del valor del colateral en la inversión da como resultado un incremento de la dispersión de la ratio capital-trabajo dentro de las industrias manufactureras. Un simple cálculo del escenario contrafactual sugiere que la mala asignación de los recursos causada por la revaloración del colateral de las empresas podría explicar entre un cuarto y la mitad de la caída de la productividad total de los factores experimentada por el sector manufacturero español durante el *boom* inmobiliario.

Palabras clave: *boom* inmobiliario, colateral, ineficiencia asignativa, productividad.

Códigos JEL: E22, E44, O16, 047.

1 Introduction

Productivity growth started to decline before the onset of the global financial crisis of the late 2000s in several advanced economies (Fabina and Wright, 2013, Fernald, 2015). This slowdown in productivity occurred during an economic expansion period sustained by strong internal demand that in some advanced economies, such as the United States or many European countries, coincided in time with large increases in house prices and corporate debt. The coincidence of these remarkable macroeconomic facts underlines the need for a better understanding of the relationship between house price booms and the dynamics of corporate investment and productivity. In this paper, we exploit the salient case of the Spanish housing boom (2003-2007) to empirically investigate the potential causal effect of house price fluctuations on corporate investment and credit through the impact of local house price shocks on the collateral value of firms. Through the identification of this channel, we examine the capacity of heterogeneous local housing booms to generate capital misallocation within manufacturing industries, and thereby create aggregate productivity losses in the economy.

Spain is a proper case to examine the link between house prices, credit-funded investment and productivity dynamics. Indeed, over the first decade of 2000s, Spain experienced a noteworthy increase of both non-residential investment and corporate credit that coincided in time with a significant reduction of productivity and an outstanding housing boom.[1] In particular, corporate investment increased by 70% from 2000 to 2007, departing from more moderate investment expansions in the range of 25%-35% such as the ones registered in the United States or in the main euro-area economies (OECD, 2018). The notable accumulation of capital by the private sector in Spain was mainly funded through credit from the banking sector resulting in the surge of the debt of non-financial institutions from 64% to 124% of GDP between 2000 and 2007. This corporate credit expansion was possible due to the increasing prominence of loans collateralized with real estate assets, in a context where house prices raised at a cumulative rate of 120% over this period (Santos, 2014, Jiménez et al., 2020). This corporate credit boom was not just used to fund construction and real estate activities but it was spread throughout major sectors of activity (IMF, 2011). This credit expansion contributed to boost real GDP, which grew at an average yearly growth of 3.5% over the 2000-2007 period. However, this growth was driven by the accumulation of factors as indicated by a standard growth accounting decomposition that shows a decline in total factor productivity (TFP) (Garcia-Santana et al., 2020). According to the estimates in Feenstra, Inklaar and Timmer (2015), Spanish real productivity declined at an average annual rate of 0.5% between 2000 and 2007, and this fall was also documented within the manufacturing industry using the EUKLEMS database (Stehrer et al., 2019).[2]

[1]See Section 2 for a more detailed discussion on the dynamics of house prices, investment and corporate debt occurred in Spain during this period.

[2]The examination of the Spanish productivity dynamics across sectors reveals that its fall over the boom cannot be exclusively explained by an increase of the relative weight of the construction and real estate sectors in the economy (IMF, 2011). In particular, according to the IMF estimates less than half of Spain's productivity gap with the rest of the Eurozone can be attributed to differences in its sectoral activity composition.

In order to rationalize the connection between these aggregate developments, we consider a stylized static partial equilibrium model in which firms with borrowing constraints have a heterogeneous ability to collateralize their assets. The model serves the purpose to understand the potential interactions between house prices and firms' composition of assets that may result in heterogeneous borrowing capacity and investment rates across firms within an industry. The predictions of the model guide our empirical analsysis and rely on two fundamental assumptions. First, in line with the collateral channel literature (e.g., Chaney, Sraer and Thesmar, 2012), we postulate that the borrowing capacity of firms depends on the valuation of their real estate (or housing) assets. Second, consistent with the urban economics literature (Glaeser, Gyourko and Saiz, 2008, Saiz, 2010), we assume that initial local geographical conditions determine the housing supply and, thus, the response of local house prices during a housing boom. Given these assumptions, the model predicts that, within a manufacturing industry, firms located in geographically constrained municipalities have the capacity during a housing boom to borrow and invest more than firms with the same composition of assets but whose collateralizable housing assets are located in areas with lower geographical constraints. In addition, for firms located in the same geographical area, the model predicts that the effect of a local housing boom on firms' borrowing and investment is exacerbated among firms whose collateral is relatively abundant on housing assets. These predictions relate the heterogeneity of firms' investment rates with local housing booms, pointing to the capacity of these booms to create misallocation of resources within an industry. In line with models *à la* Hsieh and Klenow (2009), this misallocation is defined in our framework as an increase of the industry variance in the capital-labor ratio with respect to the efficient case in which the relative value of firm's assets does not change. The size of this capital misallocation measure depends on the heterogeneity of local house price booms whose relative size amplifies the distortion on investment and credit allocation across firms within an industry. Lastly, in the model, these measures of misallocation have a direct relation with the productivity in a given industry, so that this collateral channel lead to aggregate productivity losses during a housing boom.

We test the predictions of our stylized model using a panel of manufacturing firms that were active during the Spanish housing boom (2003-2007). This panel contains detailed firm-level information on their financial statements, as well as measures of local house prices during the housing boom and proxies of housing supply elasticities for Spanish municipalities. Taking into account our data availability and theoretical predictions, we specify an empirical model that considers the potential impact on capital accumulation of the interaction between the relative composition of collateralizable assets of firms and the geographic location of these assets. In a reduced-form investment equation, we proxy the relative weight of real estate assets on firms' total assets by firms' tangibility rate, meanwhile the impact of geographic conditions on real estate value is captured by local house price shocks. The coefficient associated to the interaction of these two variables measures the differential effect of house prices growth on the investment rate of firms depending on the tangibility of their collateral. In the presence of financial frictions, the model predicts a positive sign implying that an increase in local house prices in a municipality raises the investment rate for the average firm in the sample, and this increase is higher the larger the tangibility of firm's assets. This specification also allows us to estimate the house price elasticity of investment measured as the coefficient associated to the local house price shocks plus the coefficient associated to the interaction term, the latter being multiplied by the average share of firm's tangible assets.

The OLS estimates of our investment equation could be biased because local house prices shocks can be positively correlated with firms' investment opportunities, and these house prices might capture local demand shocks. In order to address the potential endogeneity of local house prices, we run a two-stage least square (2SLS) estimate of the investment equation where local house price shocks are instrumented using the pre-boom buildable urban land ratio in a municipality, that is a proxy of housing supply elasticity, interacted with the aggregate long-term real interest rate of mortgage loans granted to households by the banking sector. This empirical strategy has been broadly used in the literature that estimates the real effects of house price shocks, and it relies on the assumption that, when a housing boom occurs, local geographic conditions determines the size of the change in house prices at local level, but it is exogenous to firms' investment decisions during the boom. For a first assessment of the empirical robustness of our identification strategy, we provide evidence on several first-stage regressions indicating the relevance of our instrument and its predictive power on house prices at municipality level. This identification strategy is also enhanced with the inclusion of a set of industry-location-time fixed-effects that abstract from location-specific shocks that could affect all firms within an industry during a given year.

The OLS and 2SLS estimates of the investment equation are consistent with the main prediction of the model. Our estimates indicate not only that the investment rate of the average firm increases when local house prices raises, but also that the larger the tangibility of firm's assets the higher the increase in investment. The OLS estimates of both the interaction coefficient and the house price elasticities of investment are lower than the 2SLS ones, consistent with the expected downward bias in the OLS coefficients. The 2SLS estimates from our preferred specification point to a house price elasticity of investment for the average firms of 0.13, in a context of a housing boom where average local house price rises yearly at 14%.[3] These results can be interpreted as a first evidence of capital misallocation through the lens of our model. In particular, our estimates point to a causal heterogeneous impact of local house price shocks on the accumulation of capital that depends on firms' relative composition of assets. For instance, given the same local house price shock, manufacturing firms in the 75th percentile of the distribution of the share of tangible fixed assets invest 98 pp more than manufacturing firms in the bottom 25th percentile. At the same time, the elasticity of house prices growth to the investment rate is close to 0 for manufacturing firms with the median tangibility rate

[3]In order to put this result in the context of the literature, we consider the main estimate reported in Chaney, Sraer and Thesmar (2012) that situates the house price - investment elasticity at 6% for the average firm in the U.S.

(0.234). This result points out that firms with relatively low tangibility rates could be forced to cut investment during housing booms in the presence of the collateral channel.

Following the predictions of the model that relate the borrowing capacity of firms with their collateral value, we also specify a reduced-form credit equation equivalent to the investment equation but now considering as dependent variable the growth rate of outstanding credit provided by the banking sector. The OLS and 2SLS estimates of this equation are consistent with the prediction of the model, that is, firms within an industry located in municipalities that experience higher house price appreciations receive more banking credit, and the allocation of credit is positively related with the tangibility of their collateral. The 2SLS estimates indicate a remarkable magnitude of this impact with a sizeable house price elasticity of credit for the average manufacturing firm of 0.29. In addition, the 2SLS estimates also point to a heterogeneous impact of local house prices on corporate credit. The larger the share of tangible fixed assets of firms, the larger the additional credit growth for the same local house price shock. This result points to misallocation of banking credit in the intensive margin within manufacturing industries. As a complementary result, we illustrate the potential relevance of the collateral channel on the extensive margin of credit. Indeed, estimates show that local house price shocks increased the number and the proportion of new loans for firms that had a larger proportion of real estate assets that are collateralizable.

Finally, we undertake several sensitivity analyses to evaluate the robustness of our findings. We first explore the potential heterogeneous relevance of the collateral channel depending on either firm size or the legal nature of banks (commercial versus savings banks) that provided credit to manufacturing firms. The robustness of the several estimates presented show that neither firms of a specific size nor the nature of the main provider of credit drives our baseline results, discarding the possibility that the average impact of the collateral channel during the housing boom was due to a particular segment of the demand or the supply of capital. Second, we control for time-varying firm variables (that are not constant at the industry-region-year level) that can be confounding factors of both investment and credit, and could also be related to both the valuation of firms' collateral and our instrument for local house prices shocks. In particular, our results are robust to the inclusion of two covariates that control for firms' financial conditions (leverage ratio and financial costs), as well as to the inclusion of firms' productivity shocks to control for the supply determinants of capital accumulation. Third, we add as controls in our baseline reduced-form regressions predictors of the tangibility rate of firms (quintiles of the initial log assets value of firms) interacted with the log change of house prices, in order to mitigate the potential source of bias created by the endogeneity of the tangibility decision over time. The inclusion of these controls on the pre-boom relative size of the firm in terms of assets value, which are good predictors of the tangibility rate, produces minor changes on the house prices elasticities of investment and credit. In the last place, we undertake further robustness tests of our main estimates to explore the sensitivity of our results to alternative definitions of the investment rate; the impact of excluding from the estimation sample either firms that are subsidiaries of multinational firms or large firms that are located in small or medium-size municipalities; the effect on the efficiency of our estimates of clustering standard errors at different levels; or the relevance of the collateral channel beyond manufacturing industries. This set of sensitivity analysis supports the empirical relevance of the collateral channel on both investment and the allocation of credit by the banking sector among manufacturing firms.

In the last section, we explore the quantitative contribution of the capital misallocation generated by the collateral channel on investment to explain the fall of aggregate productivity in the Spanish manufacturing sector between 2003 and 2007. To quantify the aggregate relevance of this channel, we first document a positive correlation between local house price growth and the dispersion of the log capital-labor ratio within manufacturing industries at the municipality level. This suggestive evidence is consistent with the theoretical prediction that the average dispersion of capital in a given manufacturing industry increases more when the collateralizable real estate owned by firms are located in municipalities that experience a larger increase in house prices, revealing misallocation of resources within an industry. At the same time, the collateral channel affects the allocation of capital in the geographical space. Municipalities that experience a higher house price appreciation accumulate more capital due to this collateral channel, thereby generating capital misallocation across the space in line with the geographic dimension of labor misallocation documented in Hsieh and Moretti (2019).

Considering our reduced-form estimates and the guidance of our theoretical model, we provide a simple back-of-the-envelope calculation of the impact of the housing boom on aggregate productivity through their effect on capital dispersion within manufacturing industries. At the empirical level, an important challenge to compute the aggregate effect of local housing booms is the difficulty to measure the actual size of the house price shock in the economy. To mitigate this limitation, we follow Glaeser, Gyourko and Saiz (2008) and Mian and Sufi (2011) and make the conservative assumption that the average size of the house price shock in the economy can be proxied by the differential growth rate in the average price of residential houses located in the first and the fourth quartile of the pre-boom buildable urban land ratio distribution of municipalities in Spain. Using our estimates on the price elasticity of the variance of the capital-labor ration and the actual log-difference in real house price growth, we compute that the housing boom could account for between 35% and 50% of the actual aggregate increase in the dispersion of capital among manufacturing industries between 2003 and 2007. Given the theoretical mapping between changes in the variance of the log capital-labor ratio and TFP growth, this back-of-the-envelope computation indicates that the differential local house price growth (created by the housing boom) can account for between one-third and half of the total decline in aggregate TFP in the Spanish manufacturing sector during the housing boom. This exercise illustrates the potential quantitative relevance of local house price booms in reducing aggregate productivity through the collateral channel on investment.

Related literature. This paper relates to different strands of the literature. First, the paper is related with the literature on firms' misallocation of resources that originates from the seminal paper of Hsieh and Klenow (2009). Since then, there has been a large number of empirical investigations on the reasons why the actual allocation of inputs may depart from the optimal one (see Jones, 2016). Among them, this paper is related with research that investigates the role of financial frictions and housing booms to create misallocation of resources. In the former branch of studies, Midrigan and Xu (2014) and Banerjee and Duflo (2014) show the capacity of financial frictions in reducing aggregate productivity and thus the possible improvement in inputs allocation among firms when loosening financial restrictions. We differ from these contributions showing, in the opposite direction, that misallocation within industries can increase when the easing of financial conditions is biased toward the holding of a specific type of asset such as real estate. On the role of housing booms to create misallocation, the literature used to focus on the sectoral distortions created when booms transfer resources towards construction and real-estate activities draining inputs from other productive activities such as manufacturing (Basco, 2016; Garcia-Santana et al., 2020)[4]. Instead, this paper examines the spreading capacity of local housing booms to create misallocation within industries whose main activity is non-related with the construction sector.

The paper is also related with the literature that connects housing booms with corporate investment and credit allocation across firms. Chakraborty, Goldstein and MacKinlay (2018) show that in the United States the housing boom created a crowding-out effect that decreased firms' investment because of banks active in strong housing markets increased residential mortgage lending to the detriment of commercial lending on firms. Martín, Moral-Benito and Schmitz (forthcoming) also find that during the Spanish housing boom banks first crowd-out non-housing credit but later on they were able to expand their credit supply on firms as the housing boom improved bank's net worth. In this paper we show that firms in industries non-related to housing activities but more exposed to local house price booms received more credit. We identify the collateral channel within firms created by local housing booms as the mechanism that lead banks to expand corporate credit. In this sense, the paper is related with several papers that have studied the connection between house price fluctuations and corporate investment. In particular, our mechanism is close to Chaney, Sraer and Thesmar (2012) that showed the existence of a sizeable collateral channel on the U.S. corporate investment[5]. We complement these results showing the relevance of the collateral channel on investment as a potential source of misallocation of resources within industries. This channel also differentiates our contribution from a closed paper to us by Gopinath et al. (2017). In the latter, the authors argue that a declining trend in real interest rates pushed capital inflows in southern euro-area economies causing a misallocation of capital towards firms with more net worth and thereby reducing the TFP in countries like Spain. Instead, we identify a micro-mechanism associated to local house prices that can explain how capital inflows, when associated to housing booms, can create mis-

[4]For the case of Spain, Garcia-Santana et al. (2020) suggest that the misallocation across sectors during the Spanish housing boom was related with the degree of connections in each industry with the public sector.

[5]An alternative branch of this literature connects the impact of house price booms with the sectoral composition of the activity. As an example, Arce, Campa and Gavilán (2013) provide a model to explain how differences in the collateral composition across sectors may explain the relative increase in investment and debt of the construction sector with respect to the manufacturing sector during the credit boom fueled by a fall in interest rate.

allocation of capital within manufacturing industries. The consideration of heterogeneous local house prices booms introduces a geographical dimension in the misallocation of inputs that allows us to explore the quantitative contribution of housing booms to the decline of aggregate productivity.

This paper is also related to the urban economics literature that shows the impact of initial geographical conditions on the evolution of local house prices (Glaeser, Gyourko and Saiz, 2008, Saiz, 2010), as well as with the investigations that relate this connection with the evolution of credit and the real economy (Mian and Sufi, 2009, Mian and Sufi, 2011, and Mian, Rao and Sufi, 2013). We contribute to this literature by considering the relationship between local house prices, through geographic conditions, and capital misallocation within industries. The geographic dimension of misallocation is also explored in Hsieh and Moretti (2019) that showed the significant impact of local restrictions to housing supply to create spatial misallocation of labor across metropolitan areas in the United States. We also explore this spatial channel but instead we identify the impact of housing supply restrictions on capital misallocation within industries as a source of aggregate productivity losses.

The paper proceeds as follows. In section 2, we present suggestive aggregate evidence on the remarkable dynamics of credit-funded corporate investment, house prices and productivity occurred in Spain during the late 2000s. In section 3, we lay out a stylized model that connects the collateral channel of investment and credit created by local house price booms with capital misallocation within manufacturing industries. Section 4 introduces the administrative firm-level and municipality-level data used in our empirical analysis. In section 5, we first present the identification strategy to estimate the causal impact of local house price booms in investment and credit across manufacturing firms. Then, we discuss the estimates obtained from an instrumental variable procedure and the implications of these results in terms of capital misallocation. In section 6, we provide a back-of-the envelope computation on the aggregate effects of local house price booms on productivity through the misallocation of capital among manufacturing industries. Section 7 concludes.

2 Macroeconomic Background and Suggestive Evidence

In this section, we provide suggestive evidence on the relevance of the salient macroeconomic event occurred in Spain during the late 2000s. We argue that this episode was exceptional in terms of house prices, investment and corporate debt dynamics, and we relate these trends with productivity dynamics as well as to the pre-boom local real estate market conditions in Spain.

The boom in house prices in Spain in the late 2000s was a large macroeconomic event by international standards. Indeed, Figure 1a reports the evolution of the Case-Shiller residential house prices index in Spain and in the United States. Notice that the extraordinary US housing boom resulted in an average house price growth of 70% from 2000 to 2007, meanwhile in Spain house prices rose well-above 120% over the same period. This impressive increase in house prices in Spain was heterogeneous across municipalities and correlated with local geographical conditions. To give empirical content to those geographical conditions, we use the ratio of buildable urban land in a municipality in 1997 (before the housing boom). This measure was built in Basco, Lopez-Rodriguez and Elias (2021) in the spirit of the housing supply elasticity measure developed by Saiz (2010) for the U.S.[6] Simple descriptive evidence indicates that the average (real) house price growth per square meter during the peak of the housing boom (2003-2007) was 9.5 percentage points higher for municipalities in the bottom quartile of the land availability distribution than in the top quartile. For ease of exposition, we label municipalities in these percentiles as housing supply inelastic and elastic, respectively.

The large increase in house prices coincided with a boom in non-residential corporate investment in Spain. The magnitude of this rise in investment was not comparable with investment dynamics in other developed countries. As illustrated in Figure 1b, the non-residential corporate investment in Spain raised by 70% between 2000 and 2007, meanwhile other big economies in the euro area, such as Italy or Germany, with a common monetary policy experienced cumulative increases of just 26% and 35% respectively. The United States also experienced a slower growth path than Spain with a 33% cumulative increase of non-residential corporate investment during the expansion started in 2002 (OECD, 2018). Besides of the aggregate numbers, the non-residential investment boom in Spain was also heterogeneous across municipalities and the size of this boom also correlated with their pre-boom local housing market conditions. This geographical heterogeneity can be noticed from descriptive statistics on the percentage change in the average real stock of capital per labor expenditures of firms located in both elastic and inelastic municipalities over the business cycle.[7] In particular, the average real stock of capital per labor expenditures increased in municipalities with constraints in their supply of buildable urban land by 180% from 2000 to 2007, whereas it only increased by 35% in housing supply elastic municipalities. In contrast, the drop in the real stock of capital per labor expenditure in 2013, from the peak of the boom in 2007, was larger in inelastic towns (-35% versus -8%) that also experienced a fall in house prices higher than in elastic towns. This evidence hints to a connection between local house price dynamics and investment related with pre-boom local housing market conditions.

Spanish non-financial corporations funded their investment projects with an intensive use of banking credit. This trend resulted in an increase of the aggregate corporate leverage ratio in terms of GDP well-above the rise that this ratio experienced in other euro zone countries that also received capital inflows during the 2000s (see Figure 1c). One outstanding feature of the banking credit in Spain during this period was the increasing relevance of collateralized loans with real estate assets as a guarantee (see Figure 1d). Indeed, the share of credit to non-financial corporations that had real estate guarantees as a collateral peaked 45% of total

[6]See subsection 4.2 for further details on both the measure of buildable urban land and the residential house prices used in this paper.

[7]The average real stock of capital per labor expenditure in each town-quartile is obtained weighting the capital-labor ratio of each firm by the firm production's share in the aggregate production of firms located in that quartile of the distribution of the buildable urban land for Spanish municipalities.

granted credit in 2007, representing 35% of GDP. Note that the peak in collateralized credit also coincides with the peak in house prices (see Figure 1a).

The use of collateralized loans was particularly relevant in the manufacturing sector. According to the Central Credit Register owned by the Bank of Spain, the share of credit granted in commercial and industrial loans backed by real guarantees was on average 82.1% during the period 2000-2007. The remarkable increase of house prices in Spain emerges as a potential explanation of the boom in collateralized loans that fuelled private investment through the banking credit. Arguably, this mechanism could have been more powerful in areas where geographical conditions limited the supply of housing and thus house prices increased more. The Spanish boom in non-residential investment financed by debt coincided with an increase in standard empirical measures of capital misallocation within industries (Gopinath et al., 2017) and, consistently, a documented fall in aggregate total factor productivity (TFP). Figure 2 provides suggestive evidence on the potential contribution of local housing markets conditions to exacerbate this misallocation of capital. The figure reports the evolution of an average measure of capital misallocation for firms located respectively in elastic and inelastic municipalities, and also for the average municipality, from 2000 to 2012. We measure misallocation using the variance of the log real capital-labor ratio, which is considered a key determinant of productivity dynamics (Hsieh and Klenow, 2009). The variance of the real capital-labor ratio (of non-financial firms) in the average municipality increased by 27.3% between 2000 and 2007, which points to rising aggregate misallocation of capital in Spain. This aggregate fact was also documented in Gopinath et al. (2017). However, the aggregate figure hides the geographical heterogeneity reflected in the differential increase across municipalities depending on their (pre-boom) urban land availability. Indeed, note that the lines for housing supply elastic and inelastic municipalities grow apart during the housing boom and start to converge after the burst. Quantitatively, during the 2000-2007 period the increase in the variance of the log real capital-labor ratio in inelastic municipalities (40.1%) almost doubled the increase in the elastic ones (23.5%).

The suggestive evidence presented in this section paints a picture consistent with the view that the housing boom could have exacerbated the misallocation of capital in Spain. In addition, it hints to the interaction between geographical constraints and the collateral channel as the potential mechanism through which the rise in local house prices could have contributed to an increase in both non-residential investment and debt. This collateral channel is more likely to be quantitatively relevant in Spain because firms highly rely on collateralized loans to obtain funds from the banking system. To empirically investigate these hypotheses, in the next section we first present a simple model that examines the impact of the collateral mechanism at the firm level on aggregate capital misallocation when local geographical conditions result in heterogeneous house prices dynamics. Then, section 5 reports the results on the causal relation between local housing booms and capital misallocation, suggested by the aggregate evidence discussed in this section and predicted by the model. To perform this analysis, we use an administrative database that matches firm and bank-level data on investment and credit with local data on house prices and buildable urban land supply at municipality level (see section 4 for details).

3 House Prices, Investment and Misallocation

In this section, we present a simple theoretical model to derive the most salient empirical predictions on the effects of local house price booms on corporate investment and banking credit, when firms exhibit a heterogeneous composition of collateralizable assets. The model also serves the purpose to define the concepts of capital misallocation and local housing booms used in this paper. These definitions are needed to derive the conditions under which the misallocation of capital within industries, originated by a collateral channel, can create productivity losses in the economy.

To analyze the impact of a collateral channel on corporate investment, we consider a stylized static partial equilibrium model in which firms with heterogeneous composition of assets face borrowing constraints. We assume an economy composed of J manufacturing industries but, for analytical simplicity, we consider one representative industry within the manufacturing sector. In this industry there is a continuum of firms with mass I, indexed by i. Firms are endowed with physical capital k used for production and two non-productive capital inputs that can be collateralized: real estate or housing assets h_i and non-real estate assets η_i.

We assume that financial markets are not perfect. Borrowers could avoid total repayment of debt by paying a fraction θ of the value of their collateralized assets. Thus, firms face the following borrowing constraint, $Rd_i \leq \theta \left[ps_i^h H + \eta_i\right]$, where R is the real interest rate, d_i, is the amount borrowed by firm i, p is the price of real estate assets and $s_i^h = h_i/H$ is the share of real-estate assets owned by firm i.[8] Firms in this industry have access to a production technology, $f(k) = k^{\alpha}$. We assume that $f'(k) > R$, which guarantees that the borrowing constraint is binding. Therefore, since $k = d$, the investment of firm i is $k_i = \theta \left[ps_i^h H + \eta_i\right]/R$.

In this economy, goods and capital markets are integrated but real estate markets are local. In particular, there is a continuum of municipalities with mass M, indexed by m. The real estate assets of each firm are located in a municipality m where the firm is placed. We assume that in each municipality the supply of housing is given by $H_m^S = h_m(p_m, \varepsilon_m) = p_m^{\varepsilon_m}$, where p_m is the house price and ε_m is the elasticity of housing supply in municipality m. We denote by $\sigma_m = \sigma$ the fundamental demand for houses in the municipality.

In order to isolate the effect of heterogeneous composition of collateralized assets on firms' investment and inputs allocation, we assume that the only difference between firms within an industry is their composition of assets. For simplicity, we assume that *low-i* firms only own real estate assets and *high-i* firms uniquely own non-real estate assets.[9] In particular,

[8] The micro-foundation of this borrowing constraint is the presence of moral hazard in the lender-borrower relationship. As in the seminal paper by Kiyotaki and Moore (1997), the borrower needs to provide assets as a collateral to obtain credit. The parameter θ could be interpreted as a measure of financial development such that the lower is θ, the less the borrower needs to avoid repayment and, thus, the less credit will be granted. A similar collateral constraint is used in Monacelli (2009) and Basco (2014).

[9] This assumption simplifies the notation and algebra but qualitative results are the same when assuming that firms have both types of collateralizable assets but in different proportions. The theoretical derivations in this section, thus, provide predictions in terms of averages.

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

In line with the suggestive macroeconomic evidence for Spain described in section 2, we assume that in this economy emerges a housing boom that is heterogeneous across municipalities as a result of their initial geographical conditions. In particular, we assume that the demand for houses (real estate) in a municipality m is given by $\sigma + B$, with the decoupling of demand with respect the fundamental level given by $B > 0$. This demand decoupling is assumed, for analytical simplicity, to be homogeneous across municipalities. These assumptions imply that, given the housing supply in the municipality, the equilibrium house price is $p_m^* = (\sigma + B)^{1/\varepsilon_m}$, which is directly related with the decoupling of housing demand, B, and inversely related with the elasticity of housing supply in the municipality, ε_m. The increase in house prices created by a decoupling in demand is what we label as a housing boom. Note that, given a level of demand decoupling B, the local housing boom is larger in municipalities with a lower housing supply elasticity (see Glaeser, Gyourko and Saiz (2008), Mian and Sufi (2011) or Basco (2014) for a theoretical justification and evidence for the U.S.). Thus, lower housing supply elasticities create larger increases in local house prices when the wedge between local housing demand and its fundamental level widens.[10]

We last assume a symmetry condition such that $\eta = \frac{1}{\kappa}\sigma^{\frac{1+\varepsilon}{\varepsilon}}$. This assumption implies that, in the absence of local housing booms, the relative price of assets is the same and, therefore, the value of the endowment is the same for all firms.

Considering these assumptions, we can derive a set of empirical predictions on the effects of local housing booms on corporate investment, credit and allocation of capital within an industry when firms have a heterogeneous composition of collateralizable assets.

Prediction 1 In an economy (municipality) that experiences a housing boom, investment rates in an industry increase relatively more among firms that own real estate assets. Given the composition of collateralizable assets, the difference in relative investment rates among firms within an industry is larger for firms located in municipalities with lower housing supply elasticities, which experience larger house price increases.

[10]We make these assumptions in order to consider the case in which housing demand is above its fundamental level, in line with the real estate market situation in Spain over the period 2003-2007 that preceded the house price burst across Spanish regions (Santos, 2014). However, in the model we do not take a stand neither on the origin of the demand decoupling nor on the roots of the so-called housing bubble in Spain. The framework is thus consistent with several alternative explanations about the origin of the housing boom such as i) a potential rational housing bubble due to a shortage of assets created by international capital inflows (see Basco, 2014 for a theoretical model on this mechanism); ii) the existence of unrealistic expectations on future house price increases (see Case and Shiller, 2003 for a discussion of this channel in the United States); iii) the presence of behavioural housing bubbles that explain capital inflows (Laibson and Mollerstrom, 2009); or iv) rational housing bubbles that emerge from financial frictions in a closed economy (Arce and López-Salido, 2011).

The equilibrium relative investment rate of firms that own real estate assets ($i < \kappa$) located in municipality m that experiences a housing boom (B), with respect to an equilibrium without a housing boom (NB), is[11]

$$\frac{k_m^{\text{with real estate, B}}}{k_m^{\text{without real estate, B}}} = \frac{\frac{1}{\kappa}\left[\sigma + B\right]^{\frac{1+\varepsilon_m}{\varepsilon_m}}}{\eta} \equiv \Phi(B, \varepsilon_m) > 1 = \frac{k_m^{\text{with real estate, NB}}}{k_m^{\text{without real estate, NB}}}.$$

This expression implies that for the set of firms within an industry located in the same municipality, the relative investment rate of firms that own real estate assets (with respect to firms without those assets) increases when there is a housing boom in the municipality ($B > 0$).

We obtain a similar expression that illustrates the amplifying effect on investment rate differentials among firms within an industry created by the heterogeneity of geographical conditions across municipalities. In particular, given the same composition of collateralizable assets and the same housing demand decoupling B, the difference in relative investment rates among firms within an industry is larger for firms located in housing supply inelastic municipalities:[12]

$$\Phi(B, \varepsilon_m) > \Phi(B, \varepsilon_{m'}) \text{ if } \varepsilon_m < \varepsilon_{m'}$$

The intuition for this result is that a housing booms raises the collateral value of firms that own real estate assets. This effect is exacerbated in municipalities where ε is small because the increase in housing prices is decreasing with the housing supply elasticity. This channel indicates that capital accumulation across space is shaped by geographical conditions. Note that in the absence of a housing boom, i.e., when housing demand is equal to its fundamental level, firms with different composition of assets have the same endowment value and thus invest the same amount regardless of their geographic location across the space.

In the model, we assume that investment is equivalent to credit ($D = K$) and there is no credit rationing. Thus, we can derive a corollary of the previous investment prediction on credit allocation.

Prediction 2 In an economy (municipality) that experiences a housing boom, the volume of credit allocated within an industry is larger among firms that own real estate assets. Given the composition of collateralizable assets, the allocation of credit within an industry is larger for firms located in municipalities which experience larger house price appreciations due to lower housing supply elasticities.

In case we considered the existence of credit rationing in this economy, a corollary of the previous prediction is that the likelihood of receiving credit depends on the value of the firms'

---

[11]Note that we are using the equilibrium house price to obtain this expression. In particular, in each municipality m, the relative rate of investment is given by $k^w/k^{nw} = (1/\kappa)(p^* \cdot \mathrm{h})/\eta$, where $p^* = (\sigma + B)^{1/\varepsilon}$ and $h = p^{\varepsilon}$. The superscripts w and nw denote, respectively, with and without real estate.

[12]It is straightforward, given symmetry condition, that $\Phi(B, \varepsilon) > 1$. In addition, $\frac{\partial \Phi(B,\varepsilon)}{\partial \varepsilon} < 0$ because $\frac{1+\varepsilon}{\varepsilon}$ decreases with ε.

collateral. In the presence of local housing booms, firms in the same industry that are located in a given municipality are more likely to receive credit when they own real estate assets. The larger the size of the local housing boom, i.e., the lower the housing supply elasticity is, the larger is the probability of receiving credit when firms own real estate assets.

Prediction 3 In an economy (municipality) that experiences a housing boom, the dispersion of capital among firms within an industry is larger when firms have heterogeneous valuations of their collateralizable assets. This industry misallocation of capital is larger when municipalities experience heterogeneous house price appreciations due to their initial geographical conditions (i.e., heterogeneous housing supply elasticities).

Given the equilibrium investment condition for firms within an industry, the standard deviation of capital in municipality m that experiences a housing boom (B), with respect to the equilibrium in which the municipality does not experience a housing boom (NB), is given by

$$st.d(k)_m^{\mathrm{B}} = (\Phi_m - 1)\frac{[(M-\kappa)M\kappa]^{\frac{1}{2}}}{\Phi_m\kappa + M - \kappa} > 0 = st.d(k)_m^{\mathrm{NB}}. \quad (1)$$

This expression indicates that in the benchmark case in which no municipality experiences a housing boom, $\Phi_m = 1$ for all m, the standard deviation of capital within an industry is zero. In this case, the heterogeneity in the composition of collateralizable assets does not create capital misallocation. In the case of a local housing boom occurring, $\Phi_m > 1$ for some m, the standard deviation of capital among firms within an industry is positive when firms located in this booming municipality do not have the same composition of assets (i.e., it would be higher than zero unless all firms had real estate assets, ($\kappa = M$), or no firm had real estate assets, ($\kappa = 0$)). In the case that municipalities experience heterogeneous local housing booms, the dispersion of capital within an industry increases even when firms have the same heterogeneous composition of collateralizable assets but they are located in different municipalities, resulting in heterogeneous valuations of firms' collateral. In particular, given the same composition of collateralizable assets, the dispersion of capital between firms within an industry increases because of the heterogeneous valuations of firms' collateral that arise due to the location of real estate assets in municipalities with a lower housing supply elasticity. That is, $st.d(k)_m^{\mathrm{B}} > st.d(k)_{m'}^{\mathrm{B}}$ if $\varepsilon_m < \varepsilon_{m'}$. This is the case because $\frac{\partial st.d(k)^B}{\partial\varepsilon} < 0$, given $\frac{\partial\Phi}{\partial\varepsilon} < 0$.

This prediction implies that the allocation of capital within an industry is less efficient when a housing boom gives rise to heterogeneous local house price booms across municipalities, resulting in firms having heterogeneous valuations of their collateralizable assets. The intuition is that firms, within an industry, located in areas where house prices are booming are able to invest more and obtain more credit because the value of their real estate assets increases more than the collateral value of firms located in municipalities that experience lower house price appreciations. Thus, geography emerges as a channel that shapes the allocation of capital through their impact on real estate prices. The next prediction relates this misallocation of capital to lower TFP.

Prediction 4 The average TFP within an industry is lower when a housing boom creates a change in the relative valuation of firms' collateralizable assets and firms have a heterogeneous proportion of real estate assets. Given a heterogeneous composition of collateralizable assets across firms within an industry, the decline in the (average) industry TFP is larger when a larger proportion of firms are located in municipalities with lower housing supply elasticities, which experience lager house price appreciations.

We compute a measure of the average TFP within an industry departing from the common production function $f(k) = k^{\alpha}$. Given the simplifying assumption on two types of firms in terms of the composition of collateralizable assets, the aggregate output in an industry is thus $Y = [k_1^{\alpha}]^{\frac{\kappa}{M}} [k_2^{\alpha}]^{\frac{M-\kappa}{M}}$, where 1 refers to firms with low i index, and 2 for firms with high i index. Considering that $Y = TFP{\cdot}\mathrm{K}^{\alpha}$, it follows that the average TFP within an industry when the size of a housing boom is the same across municipalities ($\Phi_m = \Phi$) is given by

$$TFP = \left[\frac{\Phi\kappa}{\Phi\kappa + M - \kappa}\right]^{\alpha\frac{\kappa}{M}} \left(\frac{M-\kappa}{\Phi\kappa + M - \kappa}\right)^{\alpha\frac{M-\kappa}{M}}. \tag{2}$$

It is straightforward to see that industry TFP has an inverse-U shape with maximum at $\Phi = 1$, absent any housing boom (NB), when housing demand equals the fundamental level in all municipalities ($TFP^{max} = TFP^{NB}$). When municipalities experience a local housing boom ($B > 0$), the collateral value of firms that own a higher proportion of real estate assets increases relatively more ($\Phi > 1$), and thus the average TFP decreases ($TFP^{B} < TFP^{NB}$). In the case that municipalities experience heterogeneous local housing booms, Φ would differ across municipalities. Then, equation 2 would result in a weighted average of industry TFP contributions at municipality level, weighted each contribution by the mass of firms located in each municipality. In this case, the higher the housing supply elasticity in a municipality where firms locate, the larger the wedge between the equilibrium TFP in this municipality and the optimal equilibrium (TFP_m^B¡TFP_m^{max}). At the same time, it is worth noting that, if all firms were identical in terms of the composition of their collateralizable assets, industry TFP would be independent of Φ and, in this case, local housing booms would not create productivity losses.

In line with misallocation models a la Hsieh and Klenow (2009), the variance of the capital-labor ratio with an industry is a sufficient statistic for the TFP within an industry. In order to obtained closed form solutions, we assume that $M = 1$ and $\kappa = 1/2$. In that case, by plugging equation (1) for the housing boom equilibrium into equation (2), we find that,

$$TFP = \left[\frac{1 - var(k)}{4}\right]^{\frac{\alpha}{2}} \tag{3}$$

This equation indicates that the higher the variance of capital within an industry, the lower the average TFP. In our case, in the absence of a housing boom that creates an increase of house prices, the variance of capital would be zero and the average TFP would reach its maximum (technical) level (i.e. efficient allocation of resources). In case of having a housing boom, the average TFP would be lower, and the higher the size of the local house price appreciation the lower the TFP (the higher the variance of capital). The magnitude of the aggregate TFP loss would depend on the relative size of the local house price boom in each municipality and the location of the mass of firms across these municipalities.

These predictions are derived for a representative manufacturing industry. The aggregate impact of the collateral channel on productivity in a manufacturing sector composed of J industries, would simply be the weighted average of productivity losses within each industry weighted by, for example, the contribution of each industry in the value-added of the manufacturing sector.

Discussion on asset price booms and misallocation. In this paper, we focus on the impact of local housing booms on the misallocation of capital. However, the same implications on capital allocation and productivity would emerge if the boom was attached to other collateralizable assets (e.g. financial assets). The root of the misallocation is the artificial increase in the collateral value of some firms regardless of their productivity. This mechanism emerges when the boom in the price of a specific asset modifies the relative valuation of collateralizable assets, having the capacity to create an asymmetric access to credit and investment rates across firms that is not related to differences in their idiosyncratic productivities.

4 Data

In this section, we introduce the data used in the empirical analysis implemented in section 5. In order to test the empirical predictions of the model, we use a rich firm-level panel dataset with detailed information on administrative banking credit records and financial statements of manufacturing firms over the Spanish housing boom. We match this firm-level panel with municipality-level residential house prices indices that are available for the peak of the Spanish housing boom that took place from 2003 to 2007 (Santos, 2014). We complement this matched database with pre-housing boom data on buildable urban land at municipality level. This database will allow us to use the geographical variation across Spanish municipalities before the housing boom to examine the impact of local house price booms on firms' outcomes in terms of investment and banking credit. In this section, we also discuss the computation of the main variables of the empirical analysis, measurement issues and relevant assumptions. We defer the discussion on our identification strategy to section 5.

4.1 Financial statements and banking credit data at firm-level

The firm-level data comes from two administrative data sources on firms' activity and banking credit that we match using the fiscal identifier of firms. The first dataset comes from the reported unconsolidated financial statements that all firms are required to yearly submit by law to the Commercial Registry (*Registro Mercantil Central*). We use the information on the Commercial Registry from the database built in Almunia, Lopez-Rodriguez and Moral-Benito (2018) for the period 2000-2013 that contains annual information of around 85% of registered firms in the Spanish non-financial market economy.[13] Figure A.1 in appendix A shows that over the 2003-2007 period the dataset for the manufacturing sector tracks accurately the evolution over time of the production and the full-time employment according to official census statistics provided by the Spanish National Statistical Office (*Instituto Nacional de Estadística*). In the same appendix A, table A.1 indicates that the manufacturing firms sample reaches during the housing boom an average coverage with respect to annual aggregates of 85% for both the wage bill and the number of firms, and close to 80% for employment. Lastly, table A.2 shows that the dataset replicates the firm-size distribution of Spanish manufacturing firms in terms of employment over the housing boom.

This panel dataset includes, among other variables, annual information for each firm on its fiscal identifier, 5-digit zip code location on its headquarters, sector of activity or industry (4-digit NACE Rev. 2 code), average number of employees (full-time equivalent) and the most relevant information contained in their financial statements composed by the Balance Sheet and the Profit and Loss Account. The main variables used in our empirical analysis included in the reported financial statements are: (i) net operating revenue; (ii) material expenditures (cost of all raw materials and services purchased by the firm in the production process); (iii) labor expenditures (total wage bill, including social security contributions); (iv) total assets and fixed assets; (v) fixed tangible and intangible assets; (vi) financial expenditures; and (vii) total outstanding debt.

This dataset allow us to compute two firm-level measures of investment: i) the log difference of capital, where capital is measured as the real book value of fixed assets; and ii) the log difference of capital-labor ratios, where capital is defined as above and labor refers to wage bill expenditures in real terms. We also compute measures of (i) leverage, computed as the ratio of total outstanding debt to the book value of total assets; (ii) the share of tangible fixed assets, calculated as the proportion of the book value on physical property (real estate assets, factories and equipment) over the book value of total assets; (iii) financial costs, computed as the ratio of financial expenditures to total outstanding debt; and (iv) firm-level productivity (TFP) estimated using the procedure proposed by Levinsohn and Petrin (2003). Real magnitudes result from deflating nominal values using two-digit industry-specific deflators for capital, output and materials. The different book value measures of assets are deflated with investment goods price indices; labor expenditures are deflated using gross output price indices; and material expenditures and valued-added are deflated using price indices on intermediate consumption at industry level. These industry-specific deflators are computed by the Bank of Spain (*Banco de España*) using data from the Spanish National Statistical Office. The sample of manufacturing firms with investment data used in our empirical analysis contains 255,855 firm-year observations that correspond to 71,213 firms over the 2003-2007 period.

[13] The non-financial market economy includes all sectors of activity excluding the ones related with the activity of the public sector (e.g. health, education, public security or administration), mining industries and the financial activity (e.g. banking or insurance activities). See Almunia, Lopez-Rodriguez and Moral-Benito (2018) for details on the cleaning process and construction of the database as well as a more exhaustive representativeness analysis of this micro dataset with respect to official statistics of the Spanish economy.

We merge the annual database in financial statements with annual aggregated firm-level information on loan applications and credit exposures of firms with the banking system. This firm-level credit data come from the loan level Central Credit Register (*Central de Información de Riesgos*, CIR) collected by the Bank of Spain in its role of supervisor of the Spanish banking system. This credit register contains detailed monthly information on both granted credit and drawn down credit from new and outstanding loans over 6,000 euros to non-financial firms granted by all banks operating in Spain.[14] We aggregate this monthly-bank-level data to obtain information on firm's annual total credit granted by the banking system. Using information on the type of lender that provides credit, we create an identifier on the main provider of firm's annual credit identifying whether firm's banking funds mainly come from commercial banks or savings banks. This distinction on the main credit provider is useful to investigate the hypothesis that savings banks played a significant negative role on credit misallocation over the housing boom because of the bad incentives created by their capital structure and political control (Fernández-Villaverde, Garicano and Santos, 2013).

In addition to information on granted loans, CIR also compiles since 2002 monthly requests lodged by banks to obtain information on outstanding loans of potential borrowers. Lenders receive monthly information on the default status and outstanding debts with all banks of their current borrowers. These requests thus reveal information on borrowers' applications to banks without outstanding debt. This information opens us the possibility to explore the impact of the housing boom on the extensive margin of credit. Indeed, we compile firm-year level data on new loans granted by banks and the set of loan applications in order to infer both loans-denial rates and the new loans granted by banks to nonconcurrent borrowers. With this information we are able to construct three annual magnitudes aimed to measure different dimensions of the extensive margin of credit. In particular, we compute : (i) an identifier that takes value one when at least one firm's loan application is accepted by a bank; (ii) the number of firm's loan applications that are accepted by banks; and (iii) the proportion of new loans of a firm over the total number of firm's loans granted by banks. The sample of manufacturing firms with banking credit data used in our empirical analysis contains 207,506 firm-year observations that correspond to 61,896 firms over the 2003-2007 period.

In Panel A of Table 1 we present summary statistics for the sample of manufacturing firms that are located in municipalities for which data on house prices and the pre-boom ratio of buildable urban land are available.

4.2 House prices and buildable urban land data at municipality-level

The empirical strategy implemented in the paper requires complementing the firm-level dataset with geographic-base data on municipalities where firms are located. In particular, we use

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

residential house prices indices and a pre-boom measure of buildable urban land at municipality level. This municipality-level data is matched with the firm-level dataset using the geographic location reported by firms in their financial statements.

In order to capture the dynamics of local housing booms, we use residential house price indices at municipality level considering that the change in those local indices well-proxy the dynamics of the value of real estate assets owned by firms located in a given municipality.[15] The information on municipal residential house prices comes from the census of real estate transactions owned by the Spanish Ownership Registry (*Registro de la Propiedad*) and shared with the Bank of Spain since 2003. To compute the price indices, we first calculate the market value price per square meter for each residential housing transaction and then we aggregate those prices for all transactions made in a municipality during a natural year to create a yearly average prices per square meter. The price indices for residential housing are calculated from 2003 to 2007 for municipalities with more than 1,000 inhabitants and more than 30 transactions per year. These indices are deflated using the Consumer Price Index provided by the Spanish National Statistical Office.

According to our empirical predictions, the dynamics of real estate prices affects firms' investment and credit decisions but those prices can be endogenous to these decisions. To address the endogeneity problem, in our empirical analysis, we instrument house prices growth using a proxy for the housing supply elasticity in the geographic area of analysis, in line with the empirical strategy followed by Mian and Sufi (2011), Chaney, Sraer and Thesmar (2012) and Basco (2014). In particular, we use the measure built in Basco, Lopez-Rodriguez and Elias (2021) to proxy the physical-geographical relative capacity to build new real estate assets in a municipality. This measure is computed, for Spanish municipalities, as the pre-housing boom ratio of available buildable urban land to urban land with already built structures. The construction of this ratio follows the insights provided by Glaeser, Gyourko and Saiz (2008) on the impact of supply (geographic) factors on house price dynamics and adapts to the Spanish case the housing supply elasticity measure proposed by Saiz (2010) for the metropolitan areas in the United States. The data to construct the proxy for the housing supply elasticity in a given municipality come from the census data on land classifications reported by the Spanish Cadastre (*Dirección General del Catastro*). Within potential urban land, the measure considers undevelopable total land after excluding protected non-urban areas (e.g., rivers or natural parks), plots classified as restricted for rural use, and public goods land (e.g., municipality surface occupied by transport and utilities infrastructure). The ratio is calculated for several years sufficiently removed from the housing boom (from 1995 to 1998) to avoid feedback effects of booming prices on the availability of undevelopable urban land during the Spanish housing boom in the 2000s. We conjecture that municipalities with a lower buildable urban land ratio (i.e., lower housing supply elasticity) should have experienced larger house price increases over the housing boom.

[15] See next subsection 4.3 for a discussion of the empirical evidence on the co-movement of prices in real estate markets in Spain.

Indeed, Table C.1 in appendix C, shows that there is a negative cross-sectional correlation between the ratio of buildable urban land (computed for different years) and housing price growth across Spanish municipalities during the housing boom years (2003-2007). We choose the ratio of buildable urban land in 1997 as a baseline in our empirical analysis because using this year we maximize the number of municipalities with data in both house prices and the buildable urban land measure.[16]

Our empirical strategy uses the geographical variation in the size of local housing booms to identify the impact of local house price shocks on firms' investment decisions. We illustrate this spatial variation in Figure B.1 in Appendix B for the case of the two provinces with the highest level of economic activity and population in Spain (Madrid and Barcelona). The map plots cumulative growth rates of real house prices and buildable urban land ratio at the municipality level within these two provinces. The municipality distribution of these magnitudes at province level is divided in quartiles. Larger house price growth rates are reported with more intense red colours, meanwhile greater urban land supply is reflected with more intense blue colours. This figure shows the existence of significant heterogeneity of these magnitudes within provinces opening the possibility, in addition to the expected correlation among these magnitudes, of using this geographical variation to identify the causal effects of local house booms on investment and credit as will be discussed in the next section.

In Panel B of Table 1 we present summary statistics on house prices and the pre-boom ratio of buildable urban land for those municipalities whose population exceeds 1,000 inhabitants and that have manufacturing firms included in the sample.

4.3 Measurement Issues

We make several assumptions to overcome the limitations of available data to accurately measure the impact of local housing booms on the valuation of real estate assets owned by firms. First, in financial statements, we are not able to disentangle the value of real estate assets from other fixed assets, particularly equipment, for the vast majority of firms. As an alternative, we use the relative value of tangible fixed assets over total assets as a proxy of the relative weight of firms' real estate in their assets. This is a plausible assumption given that our empirical strategy relies on using geographical and time variation in the unit value of these tangible fixed assets that we presume to be mainly driven by local changes in real estate prices over time rather than changes in prices of the rest of fixed assets (equipment) included in this category. In particular, we can presume that the dynamics of equipment prices should not exhibit significant variation across firms within a competitive industry. In addition, in our empirical analysis we include industry-year and location (province)-year fixed effects that should absorb unobserved differences in the valuation change of tangible fixed assets not related with the dynamics of local housing markets.

[16]The results of the paper are robust to using different years (1995, 1996 and 1998) of the urban land measure as a baseline.

Second, there are no price indices available at municipality level for each category of real estate assets that firms use to own. To overcome this limitation, we assume that real estate markets at municipality level are synchronized and, thus, residential house prices are able to capture the dynamics of the local markets on real estate assets owned by firms. This assumption holds at the aggregate level, where evidence shows the co-movement of prices in real estate markets. Indeed, Figure B.2 in Appendix B, shows that aggregate price indices on different real estate assets (commercial real estate, offices and industry plants) are highly correlated with the residential house price index (e.g., serial correlation among real estate price time series is above 0.90 over the period 2000-2012).

Third, financial statements do not provide detailed information on the geographical location of real estate assets owned by firms. We assume that changes in the valuation of firms' real estate collateral are driven by the changes in the value of real estate assets located in the municipality where firms have their headquarters. This assumption seems reasonable given that in Spain small and medium manufacturing firms represent roughly 99% of the census[17], and they are almost exclusively single-plants Almunia et al., 2018. In addition, although the probability of holding real estate assets in different municipalities is higher among large firms, multi-plant firms are a minority proportion even within this set of business.[18] Lastly, evidence for the U.S. shows that for multi-plant firms the location of headquarters tends to reveal a significant proportion of the value of real estate assets owned by large firms Chaney, Sraer and Thesmar, 2012.

5 Empirical Analysis

This section discusses the identification strategy of our empirical analysis and reports the main results of the paper. The specification of the empirical model to test the predictions stated in section 3 is discussed in subsection 5.1, as well as the threads to identification. In subsection 5.2, we provide estimates on the causal impact of local house price shocks on the investment rate of firms through a collateral channel. In subsection 5.3, we explore the causal impact of this collateral channel on both the intensive and the extensive margin of credit allocation among manufacturing firms. In subsection 5.4, we present estimates of regression specifications that address specific sources of endogeneity that could bias our baseline estimates, and several sensitivity analyses to evaluate the robustness of our results. The set of estimates discussed below support the empirical relevance of the collateral channel on both investment and the allocation of credit among manufacturing firms.

[17]Large firms are defined as the ones having more than 50 employees (full-time equivalent) and they represent roughly 1% of manufacturing firms according to the Spanish National Statistical Office (see Almunia, Lopez-Rodriguez and Moral-Benito, 2018.

[18]The prevalence of single-plant firms among Spanish manufacturing firms has also been discussed in Gopinath et al. (2017). In particular, this paper argues that an official survey (*Encuesta Sobre Estrategias Empresariales*) on large manufacturing firms over the housing boom in Spain indicates that just 15% of all large firms in this sector are multi-plant firms. This small proportion of large firms is the same in the sample of manufacturing firms that we use in our empirical analysis in section 5.

5.1 Specification and identification strategy

We test the predictions of the model using the panel of manufacturing firms that were active during the Spanish housing boom (2003-2007) described in section 4. The model predicts that when a housing boom occurs, the heterogeneous composition of collateralizable assets among firms within an industry results in a heterogeneous borrowing capacity and differential investment rates among them. In particular, when housing demand is above its fundamental level, firms with a larger proportion of real estate assets benefit from a housing-driven boom because the value of their collateral increases more than the collateral of firms in the same industry but with a lower share of collateralizable real estate assets. At the same time, the model predicts that firms with the same relative composition of collateralizable assets are able to borrow and invest more when they are located in geographical areas where house prices increase relatively more. Considering this potential interaction between the relative composition of collateralizable assets and the geographic location of firms, we consider the following empirical model as our baseline specification:

$$Inv_{imt} = \beta_0 + \beta_1 \Delta HP_{mt} + \beta_2 Tang_{imt} + \beta_3 \Delta HP_{mt} * Tang_{imt} + \beta_4 X'_{imt} + \gamma_i + \delta_{srt} + \epsilon_{imt}, \quad (4)$$

where Inv_{imt} is the investment rate of firm i located in municipality m in year t, that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms; ΔHP_{mt} is the log-difference of house prices between years $t-1$ and t in the municipality m; $Tang_{imt}$ refers to tangibility rate measured as the share of tangible fixed assets to total assets of firm i located in municipality m in year t; and X'_{imt} is a vector of firms' characteristics. In order to enhance identification, we include firm fixed effects γ_i that control for unobserved time-invariant firm's characteristics; and a set δ_{srt} of industry-region-year fixed effects. In a first specification, we allow for industry-year fixed effects that control for industry-specific shocks that affect firms within an industry, regardless of their composition of collateralizable assets and their geographic location. In an extended specification, we include industry-region-year fixed effects, in order to also abstract from location (region)-specific shocks that would affect all firms within an industry during a year. Standard errors are clustered at the municipality level.

The interpretation of this reduced form equation is based on the predictions of the stylized model of investment, discussed in section 3, in which the composition of firms' collateralizable assets interacts with the geographic location of real estate assets.[19] In particular, the coefficient β_3 measures the differential effect of house prices growth on the investment rate of firms depending on the tangibility of their collateral. In the presence of financial frictions, the model predicts $\beta_3 > 0$, that is, an increase in local house prices in a municipality raises, for the average firm in the sample, the investment rate and this rate is higher the larger the tangibility of firm's

[19] In line with Chaney, Sraer and Thesmar (2012), the model justifies a specification that regress annual investment rate on current values of the tangibility rate and house price growth. Conditional on repaying debt at the end of a period, firms depend on the valuation of their collateral to obtain funds and invest in the subsequent period.

assets. The elasticity of house prices growth to the investment rate of the average firm is thus computed as β_1 plus the interaction of β_3 and the average share of firm's tangible assets.

Equation 4 is informative about the potential effect of local housing booms on investment but it is silent about the financial channel embedded in the model. In our stylized model, firms are financially constrained and their borrowing constraint is related to the value of their collateral. Thus, for a given house price shock, borrowing capacity of the firm increases with its share of real estate assets. To test this financial channel hypothesis (prediction 2), we estimate equation 4 but considering as the dependent variable the net credit growth ΔC_{imt}, measured as the log difference of total banking outstanding credit in real terms between $t-1$ and t of firm i. The model also predicts $\beta_3 > 0$, that is, firms within an industry located in municipalities that experience higher house price appreciations receive more banking credit the larger the tangibility of their collateral.

The OLS estimates of equation 4 can be biased because the potential endogeneity of local house prices. Indeed, house prices in a municipality can be positively correlated with firms' investment opportunities, and these prices can proxy for local demand shocks. In order to address this endogeneity concern, we adapt a broadly used empirical strategy in the macro and finance literature that estimates the real effects of house price shocks.[20] In particular, we run a two-stage least square (2SLS) estimate of equation 4 where house prices at municipality level are instrumented using a proxy of the pre-boom housing supply elasticity in the municipality interacted with the aggregate long-term real interest rate of home mortgages. We use our measure of the pre-boom buildable urban land ratio in a municipality, as described in section 4, as a proxy of housing supply elasticity; and for the long-term real interest rate we use the rate of the flow of yearly mortgage loans granted to households for the purchase of a house with an initial mortgage term of more than 10 years, from the Bank of Spain between 2003 and 2007.

In order to show the relevance of our instrument, we run a first-stage regression at municipality level over the period 2003-2007[21], such that,

$$\Delta HP_{mt} = \alpha_0 + \alpha_1 HSE_m * \Delta R_t + \lambda_t + \tau_m + \xi_{mt}, \tag{5}$$

where ΔHP_{mt} is the log difference of residential house price index in real terms between years $t-1$ and t in the municipality m; HSE_m is the housing supply elasticity in municipality m, measured by the buildable urban land ratio in a pre-boom year; ΔR_t is the difference in the average long-term real interest rate of home mortgages at national level between years $t-1$ and t; λ_t is a year fixed effect that captures aggregate shocks that could create macro-fluctuations

[20] We follow the empirical strategy used, among others, by Himmelberg, Mayer and Sinai (2005), Mian and Sufi (2011), Chaney, Sraer and Thesmar (2012) or Chakraborty, Goldstein and MacKinlay (2018).

[21] This exercise aims just to illustrate the relevance of the instrument to predict the dynamic of house prices across municipalities in Spain. In subsection 5.2, the 2SLS estimates will report each of the F-statistics of the first-stage corresponding to the firm-level regression 4 in which every regressor that contains house price growth at municipality level is instrumented with the interaction of pre-boom buildable urban land ratio in the municipality and the real long-term interest rate.

in house prices; and τ_m is a location (municipality) fixed effect that control for unobserved time-invariant municipality characteristics.

According to economic theory, when there is an aggregate fall in the real long-term interest rate of home mortgages, the demand for houses increases. In municipalities with a larger ratio of pre-boom buildable urban land, the increase in housing demand can be absorbed to a greater extent by housing supply through expanding construction. Instead, in municipalities with lower buildable urban land ratio, the increase in housing demand pushed by a fall in real interest rates cannot be fully absorbed by supply and, thus, translate into higher house prices. At the same time, in the presence of a housing boom across municipalities, an increase of the real interest rate to curb housing demand would be more effective in municipalities with higher housing supply elasticity. We thus expect a negative sign in the coefficient α_1, given that during a housing boom a surge in the real interest rate should have a larger effect in mitigating house price increases in municipalities with larger buildable urban land availability. In particular, a more positive interaction term (larger real rate increase times higher positive pre-boom buildable urban land measure) is associated with a lower positive residential house price increase, and hence the negative coefficient. Table 2 reports the estimates of the equation 5 using proxies for the housing supply elasticity at municipality level for several pre-boom years (1995, 1996, 1997 and 1998). Estimates shows that the coefficient associated to α_1 is negative and significant at the 1% level for the proxy of the housing supply elasticity in different pre-boom years.[22] The resulting F-test for the nullity of the instrument are above 10 (see Stock and Yogo, 2005), indicating the relevance of instrument and its predictive power on house prices at municipality level.

Turning to identification, in the next subsection we provide 2SLS estimates that rely on the assumption that, when a housing boom occurs, pre-boom buildable urban land availability determines the size of the change in house prices at the municipality level, but it is exogenous to firm investment decisions during the boom. This identification strategy is enhanced with the inclusion of the set of fixed effects discussed above, but it is still thread by specific sources of endogeneity and omitted variables that could bias estimates. In subsection 5.4 we will discuss how the inclusion of a vector X'_{imt} of firms' characteristics could mitigate the existence of these potential biases.

5.2 Investment and the housing boom

Table 3 presents OLS and 2SLS estimates of equation 4 for the baseline sample of manufacturing firms. This sample includes firms that i) are active in at least one year in the housing boom period (2003-2007); ii) have positive stock of capital in the years included in the sample; and iii) are located in municipalities where both residential house price indices and measures of housing supply elasticities are available.

[22] In what follows, we use the proxy of the housing supply elasticity in 1997 in order to maximize the coverage of our estimation sample. The estimates provided in the next sections using the 1997 measure are robust when considering alternative pre-boom years to measure the constraints in the buildable urban land of municipalities.

The OLS estimates (reported in columns 1 to 3 of Table 3) are consistent with the main prediction of the model. The coefficient on the interaction between local house price growth and the share of tangible fixed assets is positive and significant at the 1% level in all specifications. These estimates point out that the investment rate of the average firm increases when local house prices raise, and the larger the tangibility of firm's assets the higher the increase in the investment rate. The results are robust to the inclusion of firm fixed effects and different sets of industry-location-time fixed effects. The discussion that follows of the empirical results focuses on our preferred specification that includes industry-region-year fixed effects to abstract from location-specific shocks that could affect all firms within an industry during a given year.

According to the OLS estimates corresponding to our preferred specification, column (3), the elasticity of house prices growth to the investment rate is -0.04 when the firm has no tangible fixed assets and 0.13 when 100% of firm's assets value are real state assets. Note that these elasticities imply that firms with no real estate assets may be forced to cut investment during housing booms. Quantitatively, these price elasticities imply that moving from the 25th percentile of the share of tangible fixed assets distribution to the 75th percentile, increases the investment rate by 4 pp. (0.13x0.31), which represents 45% of the average yearly investment growth rate in the manufacturing sector (see Table 1).

The OLS estimates of the house price-investment elasticity can be downward biased by the potential positive correlation between house prices and investment opportunities. Thus, the endogeneity of house prices and the potential biases created imply that the OLS estimates can be considered as a lower bound on the impact of local housing-driven shocks on firms' collateral on investment. To overcome this limitation, we adopt an identification strategy based on instrumental variables as discussed above in order to investigate the causal relation between local house prices and investment. The two-stage least square (2SLS) estimates of equation (3) are reported in columns 4 to 6 of Table 3. In these specifications, local house price growth is instrumented by the interaction between pre-boom urban land availability in the municipality and the aggregate long-term real interest rate of home mortgages. This instrumental variables strategy assumes that initial geographic conditions predict the size of the house price change, and these initial conditions are exogenous to firm investment decisions during the housing boom. The resulting F-tests reported in Table 3 for the nullity of the instruments are above 10, indicating the relevance of the instrument and its predictive power on house price growth in the sample of manufacturing firms.[23]

The 2SLS estimates indicate that the main prediction of the model on the connection of house prices and investment through the collateral channel holds empirically. Indeed, the coefficient of the interaction term remains positive and statistically significant at the 1% level. Compared to the OLS estimates discussed above, the 2SLS coefficient estimates of the interaction term are larger in magnitude, in line with the expected negative sign of the bias created by the

[23]Tables that report 2SLS estimates include F-statistics of the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple regressors. These statistics refer to the corresponding test for the null hypothesis that the first-stage coefficients equal zero.

endogeneity issues. In particular, the results from our preferred specification, column (6), show a house price-investment elasticity for the average manufacturing firm of 0.13, given that the mean tangibility rate in the manufacturing sector is 0.28. This elasticity means that a 1% increase in local house prices leads to a 13% raise in the investment rate for the average firm, in a context of a housing boom where average local house prices rises yearly at 14%.[24]

The potential causal heterogeneous impact of local house price shocks on the accumulation of capital can be illustrated examining the different investment elasticities according to the firms' distribution of the tangibility rate. For instance, given the same local house price shock, manufacturing firms located in the 75th percentile of the distribution of the share of tangible fixed assets would invest 98 pp more than manufacturing firms in the bottom 25th percentile of this distribution. At the same time, the elasticity of house prices growth to the investment rate is close to 0 for manufacturing firms with the median tangibility rate (0.234). This results points out that firms with relatively low tangibility rates, in the presence of the collateral channel, could be forced to cut investment during housing booms.

The results discussed in this section can be interpreted as a first evidence of capital misallocation through the lens of our model. Indeed, once we control for unobserved fixed firms' characteristics as well as different industry, time and location fixed effects, firms' investment rates within manufacturing industries should not depend neither on the composition of fixed assets nor on the specific geographic location of firms. In contrast, the results discussed in this section point out that a positive local house price shock creates differential investment rates within an industry that are positively related with the tangibility rate of the firms. At the same time, considering the share of real estate assets across firms, the investment rates in a given industry depend on the location of firms across the geography, i.e. firms located in land-constrained municipalities experiencing a larger house price boom accumulate more capital that firms with the same tangibility rate operating in the same industry.

5.3 The credit channel

In this subsection, we explore the potential financial mechanism that can fuel the heterogeneous investment patterns associated to the collateral channel documented in the previous section. In the presence of financial frictions, our model predicts that borrowing capacity of firms depends on the value of their collateral. In this framework, the connection of house prices and credit allocation is a source of capital misallocation through the collateral channel. In order to empirically explore these predictions, we first examine the impact of local house price shocks in the intensive margin of credit following the empirical strategy discussed in subsection 5.1. Then, we provide some suggestive evidence on the potential impact of the collateral channel on different measures that can proxy the extensive margin of credit, as would be discussed below.

[24] In order to put this result in the context of the literature, we consider the main estimate reported in Chaney, Sraer and Thesmar (2012) that situates the house price - investment elasticity at 6% for the average firm in the U.S. The larger magnitude of the elasticity for Spanish manufacturing firms could be consistent with an economy with larger financial frictions where small and medium firms are more dependent to collateralizable assets to obtain credit in order to fund their investment projects (see discussion in subsection 5.3)

Table 4 presents OLS and 2SLS estimates of the equation 4, for the baseline sample of manufacturing firms that have outstanding debt with the banking sector, using now net credit growth as the dependent variable instead of the investment rate. The net credit growth is measured as the log yearly difference of total banking outstanding credit in real terms.

The OLS estimates (reported in columns 1 to 3 of Table 4) cannot reject the prediction of the model that relates the allocation of credit by the banking sector with the tangibility of firms' collateral. In all the OLS specifications, the coefficients on the interaction term between the tangibility rate and the local house price growth are positive and significant at the 1% level. The OLS estimates of the house price elasticity for credit in the manufacturing sector are quantitatively similar to the ones obtained for the investment rate. For instance, the relative scarcity of real estate assets that can be used as collateral (e.g. a tangibility rate in the first quartile of the distribution) is correlated with a reduction in the allocation of credit among manufacturing firms by the banking sector.

The endogeneity concerns on house prices, discussed above with detail, can also downward bias the price elasticity of credit. In order to overcome this bias, the 2SLS estimates reported in Table 4 (columns 4 to 6) result from the instrumental variables strategy discussed in subection 5.1. This empirical strategy aims to examine the causal relationship between local house price shocks and corporate credit. The results on the F-tests show, in the first place, the relevance of the proposed instrument also in the sample of manufacturing firms that have outstanding debt with the banking sector. Second, the second-stage estimates on the interaction term, once we control for firm fixed effects and different sets of industry-location-time fixed effects, point out that firms within an industry located in municipalities that experience higher house price appreciations receive more banking credit the larger the tangibility of their collateral. In particular, the estimates reported in our preferred specification (column 6) show a quantitatively and statistically significant house price-credit elasticity for the average manufacturing firm of 0.29. The elasticity for the median manufacturing firm is also relevant and stands at 0.21.

The 2SLS estimates indicate that the magnitude of the impact of local house prices shocks on credit is slightly larger than the impact on investment discussed above. The larger impact is noticeable in terms of comparing the house price elasticity of the average manufacturing firm (0.29 for credit versus 0.13 for investment). This sizeable elasticity of credit at firm level in a context of high house price appreciations is compatible with the quick rise in the leverage ratio observed in the Spanish manufacturing sector over these years.

The heterogeneous impact of local house prices on corporate credit is also relevant in terms of the distribution of collateralizable real estate assets. For instance, the effect of moving a firm from the 25th to the 75th percentile of the tangibility rate distribution implies an additional credit growth rate of 53pp for the same local house price shock. Taking together, this evidence on the differential allocation of credit related to the relative value of real estate assets is consistent with the hypothesis that the collateral channel is a relevant mechanism through which house prices distort the allocation of capital. In particular, the results point out a misallocation of banking credit within manufacturing industries toward i) firms located in areas with larger local house prices shocks; and ii) firms with a larger share of collateralizable real estate assets.

As a complementary result, in Table 5 we provide suggestive evidence on the potential impact of local house price shocks on the extensive margin of credit. To examine this channel, we focus on firms that had a credit relation with at least one bank in the years of the housing boom, and then examine whether the collateral channel affects the probability of having new bank relationships. We consider the baseline specification in equation 4 but now we use three alternative discrete dependent variables. In particular, dependent variable in columns 1 and 2 is a dummy that takes value 1 for firm i when at least one new loan application is accepted by a bank; dependent variable in columns 3 and 4 is the number of new loan applications of firm i that are accepted by banks; and dependent variable in columns 5 and 6 is the proportion of new loans over the total number of loans granted by banks to firm i.

The OLS estimates of the coefficient on the interaction term in linear probability model (LPM)[25] in Table 5 (column 1) is positive and statistically significant at the 5% level. This results suggest that firms in booming municipalities and with more tangible assets had higher likelihood of starting a new loan relationship with a bank. The 2SLS of the LMP (column 2) aims to deal with the potential downward bias in the estimated coefficient created by the endogeneity of house prices. In spite of the relevance and significant predictive capacity of the instrument, as revealed by the F-tests associated to the first-stage coefficients, the increase in the standard errors makes the larger coefficient of the interaction term not statistically significant. However, the 2SLS estimates of the interaction term in specifications that use alternative measures of the extensive margin of credit are quantitatively and statistically significant at 5% (columns 4 and 6). The estimates show that local house price shocks had increase more both the number of new loans and the proportion of new loans over total loans for firms that had a larger proportion of real estate assets that are collateralizable. Thus, even though the picture is more nuanced, the results are consistent with an impact of the collateral channel on misallocation of credit also at the extensive margin.

5.4 Robustness

In this subsection we present estimates of our reduced form regressions that address some specific sources of endogeneity that could bias the 2SLS estimates of the house price elasticities discussed in subsections 5.2 and 5.3. The sensitivity analysis focuses on the preferred specification of equation 4 that includes firm fixed effects and industry-region-year fixed effects. We first explore the heterogeneity of the collateral channel among firms that can be concealed in the average estimates. Then, we address specific sources of endogeneity and expand our baseline specification in order to control for other confounding factors that can bias our results. Finally, we undertake further robustness tests.

[25]The adoption of a linear probability model has the advantage, compared with other discrete choice models, that estimates would not be affected by an incidental parameters problem when controlling for a wide range of fixed effects, as is the case in our preferred specification.

5.4.1 Heterogeneous responses

In this subsection, we explore the potential heterogeneity of our main results depending on firm size, as well as the differential effect depending on the legal nature of banks that provided credit to manufacturing firms.

Firm size. Financial constraints and investment decisions can be related with firm size and, thus, the relevance of the collateral channel on capital misallocation can be heterogeneous across firms depending on their size. In this case, pooling firms together without considering their size might conceal the potential heterogeneity of the collateral channel across firms. We undertake three empirical exercises that consider different measures of firm size in order to explore the impact of these potential heterogeneous responses of investment and credit to local house price shocks.

In the first place, we examine the relevance of the firm size as an additional confounder that can explain the dynamics of investment and credit over the life cycle of the firm. In Tables 6 and 7 we report our baseline specifications for investment and credit, respectively, but adding as control firm-specific yearly measures of the log firm size during the housing boom. The log firm size is computed using three alternative measures: the average employment (columns 1 and 2), total sales in real terms (columns 3 and 4) and total assets in real terms (columns 5 and 6). As expected, these controls have a significant and positive effect on investment and credit growth. However, when introducing these firm size controls, our OLS and 2SLS estimates are very robust with minor changes in the house price elasticities of investment and credit.

In the second place, the aggregate relevance of the collateral channel depends on their prevalence beyond the segment of the smallest firms that may be more financially constrained but have a lesser impact on capital accumulation in the economy. In order to explore this relevance, we examine whether our main results in Tables 3 and 4 change if we use weighted least squares (WLS) to estimate the reduce-form equations. We weight firms according to the three firm size measures discussed above but now taking the log of the average firm size (employment, sales and assets) during the housing boom (2003-2007). The WLS and the 2SLS estimates, using the same weights, reported in Tables 8 and 9, indicate that the weighting of observations has a small quantitative impact on the coefficients of interest, as well as maintaining statistical significance and, thus, not being able to reject the predictions of the model on the collateral channel.

Finally, as additional robustness test, included in Appendix C.2, we divide the sample of manufacturing firms in three subsamples depending on their size, as measured by their average employment during the housing boom. In particular, we label as small firms those that have between 1 and 20 employees; as medium firms the ones between 21 and 49 employees; and as large firms when they have 50 or more employees. The 2SLS estimates reported in Tables C.2 and C.3 seem to indicate a stronger collateral channel on the segment of medium firms that, compared to the average response, exhibit significantly larger house price elasticities of both investment and credit. The 2SLS estimates of the coefficient associated to the interaction term for large firms maintain the positive sign, but they do not have statistical significance. Nevertheless, the estimates on this segment of firms should be considered with caution given the F-tests associated to the first-stage that point out to a weak instruments problem that lead to unreliable point estimates.

The main provider of credit. According to influential research on the determinants of the Spanish housing boom (see Fernández-Villaverde, Garicano and Santos, 2013, Santos, 2014), politically-oriented saving banks played a prominent role in shaping the credit cycle. In particular, the mismanagement of savings banks could explain to a large extent extent the buildup and bust of the credit boom because these financial institutions had allocated credit to riskier borrowers (households and firms) due to the connection between house prices dynamics and their lending capacity. Thus, a potential concern is that our findings on credit misallocation across firms may be mainly driven by the lending policies of the savings banks that could have allocated credit to a particular segment of manufacturing firms. In order to address this potential concern, Table 10 reports OLS and 2SLS estimates on the credit channel separating our baseline sample of manufacturing firms into two subsamples of firms according to whether their main source of credit comes from commercial banks (columns 1 and 2) or savings banks (columns 3 and 4). The 2SLS estimates in columns (2) and (4) indicate that in both subsamples the coefficient of the interaction term is positive and statistically significant and, most relevant, it is only marginally different and not statistically different between the two subsamples. In addition, the 2SLS estimates show that we cannot reject the hypotheses that the house price elasticity of credit for the average firm whose main provider of credit is a commercial bank is larger than the mean elasticity for the whole sample of manufacturing firms. These results imply that neither the significance nor the magnitude of the credit misallocation of the manufacturing sector seems to come from a particular lending policy of the savings banks on this segment of the credit market.[26]

5.4.2 Controlling for additional confounding factors

One potential concern with the main estimates discussed in subsections 5.2 and 5.3 is that time-varying firm variables that are not constant at the industry-region-year level could be associated with both investment (or credit) and tangibility (the valuation of collateral) of firms in both positive and negative ways. In addition, the existence of these unobserved determinants of investment and credit could also be related with our instrument, thus creating biases in our 2SLS estimates. Indeed, not considering these confounding factors in our baseline specification could create an omitted bias that would raise questions on the consistency of our estimates. In order to address these concerns, we add several covariates into our baseline specification aiming to control for additional confounding factors. In particular, among the potential time-varying characteristics, that are not captured with firm fixed effects, we separately add three covariates

[26]This evidence refers to manufacturing industries and therefore does not reject the potential role of savings banks in the salient credit boom of the construction and real estate sectors, as well as in the household mortgage market during the period 2003-2007.

at firm-level: i) the log of the leverage ratio, measured as the ratio of total outstanding debt over the book value of assets; ii) the log of financial costs, computed as the ratio of financial expenditures over total outstanding debt; and iii) the log productivity of the firm, measured as the TFP-sales estimated adopting the procedure proposed by Levinsohn and Petrin (2003).

Tables 11 and 12 report OLS and 2SLS estimates of the investment and the credit reduced-form equations, respectively, for our preferred specification once we include, separately, these confounding factors. The results show that, conditional on firms' financial conditions and productivity shocks, the relevant coefficient associated with the interaction term remains positive and statistically significant at the 1% level in all specifications.

The inclusion of controls that proxy for time-varying firms' financial conditions (leverage ratio and financial costs) has a modest impact on the average house-price elasticities of investment and credit, but the dispersion of capital accumulation significantly increases. Indeed, including these confounding factors broadens the gap of the differential impact of house price shocks on both credit and investment between firms located at the top and the bottom of the distribution of collateralizable real estate assets. For instance, once we control for the log leverage ratio, the effect of moving a firm from the 25th to the 75th percentile of the tangibility rate distribution implies an additional investment (credit) growth rate of 124pp (80pp) for the same local house price shock.[27] In addition, considering the financial conditions of the firms, the results reinforce the possibility that, in the presence of the collateral channel, firms with relatively low tangibility rates could be forced to cut investment and may face credit rationing during housing booms. The coefficients associated to these financial covariates are statistically significant at the 1% level in all specifications. The impact of the leverage ratio on both investment and credit growth rates is positive, indicating a conditional positive correlation between capital accumulation and the relative indebtedness of the firm during the housing boom. The sign of the coefficient associated to financial costs in the investment equation is negative, as would be theoretically expected given that a higher cost of funding should be negatively correlated with investment dynamics. Instead, the conditional correlation between financial costs and credit growth is positive suggesting a higher pricing (spread) of the banking sector on firms that expand their credit to a greater extent. Nevertheless, the size of these coefficients is small, pointing out a modest contribution of this potential confounding factors to explain the average dynamics of investment and credit among manufacturing firms.[28]

[27] The differential gap of the same quantitative exercise, controlling for the log of financial costs, reaches 121pp for investment and 62pp for credit. Instead, the incremental growth rates for investment and credit, without additional controls are, respectively, 98pp and 53pp.

[28] The results on the modest impact on financial costs on firms' accumulation of capital are consistent with the suggestive evidence on the reduced heterogeneity in the interest rates of new loans granted to firms reported in Figure 3. This figure shows that the banking sector charged on average similar rates to corporate loans when the borrower provided real estate assets as a guarantee, regardless of the geographic conditions of the municipalities where firms were located. As discussed in previous subsections, this geographic conditions are a good predictor of house price dynamics and, thus, this evidence suggests that local house price shocks are weakly correlated with the pricing of corporate credit by the banking sector.

The introduction of productivity shocks at firm-level aims to control for supply determinants of firms' marginal costs that should have an impact on investment decisions and the allocation of credit by the banking sector. Our main results are significantly robust to the introduction of this control, that has a minor impact on the point estimates of the relevant coefficients, as well as in the house price elasticities of both investment and credit. In spite of the marginal impact of this covariate on the main estimates, it is worthy to note the significant negative conditional correlation between firms' productivity with both investment and credit. The sign and size of the productivity coefficients could be considered as suggestive evidence consistent with misallocation of capital among manufacturing firms.

5.4.3 Other sources of endogeneity

Our empirical strategy focuses on the potential bias created by the endogeneity of house prices, given that these prices can proxy for local demand shocks. In this subsection, we examine the potential impact of other sources of endogeneity in our main results.

Endogeneity of the tangibility rate. An additional potential source of bias in the estimates of the baseline equation 4 could emerge due to the endogeneity of the firms' decisions on the acquisitions of real estate assets over time. The decision to acquire these assets is not random and this decision can bias our main estimates when the tangibility rate of firms' assets is related with the investment prospects of firms and their credit demand. For instance, in case that firms anticipate that accumulating real estate assets ease their financial constraints, firms could decide to change the composition of their assets increasing their tangibility in order to facilitate the allocation of credit by banks and, thus, to expand their investment capacity. In this case, firms that own a larger proportion of tangible fixed assets could be more responsive to local demand shocks, upward biasing the estimates of coefficient β_3.

In order to deal with the potential source of bias created by the endogeneity of the tangibility decision, we adapt the empirical approach followed by Chaney, Sraer and Thesmar (2012) to consider the endogeneity created by the real estate ownership decision. In the first place, we examine the potential role of total assets value as predictor of the tangibility rate of firms in pre-housing boom years. Table C.4 in Appendix C.2 reports estimates of a cross-sectional regression of the firms' tangibility rate in 2002 on five quintiles of the log valuation of their total assets in 2002, as well as industry-region fixed effects. Considering the fact that the estimation sample is restricted to manufacturing firms that have information on the volume of total assets for the year 2002, the estimates show that the initial level of total assets is a good predictor of the tangibility rate of firms in the pre-housing boom period. Larger firms, when size is measured in terms of asset value, have lower tangibility rates.

We, therefore, expand our baseline regression adding controls for initial characteristics of the firm (quintiles of initial log assets value) interacted with the log change in house prices. This empirical strategy aims to control for observed predictors of the tangibility decision, and it would allow us to identify the collateral channel when these predictors also make firms more sensitive to changes in house prices.[29] Table 13 shows that our main results are robust to the inclusion of the observed predictors of firms' initial tangibility rate interacted with changes in local house prices. Indeed, OLS and 2SLS estimates of the coefficients of interest are significant at the 1% level, and the house prices elasticities of investment and credit have a similar magnitude than the ones reported in our baseline specifications in Tables 3 and 4.

Firm size and the municipality dimension. The geographic location of large firms in certain areas can raise concerns of reverse causality that could bias our estimates. For instance, the economic activity and the house prices of a small municipality can be highly impacted by the investment decisions of large firms. This fact would affect the consistency of our 2SLS estimates when capital accumulation of these firms drives house price dynamics in these municipalities. In order to deal with this potential source of bias, we restrict our sample to small and medium firms (defined in terms of yearly average employment and computed as the mean of this measure for the housing boom period) located in municipalities that overcome certain population thresholds in the pre-boom year 2002. Tables 14 and 15 report OLS and 2SLS estimates for investment and credit reduced-form equations for firms with less than 50 employees located in municipalities whose population exceeds, respectively, a) 5,000 inhabitants; b) 10,000 inhabitants; and c) 50,000 inhabitants. The estimates of our main parameter of interest, β_3, and the house price elasticities are robust to these sample restrictions that aim to focus on firms that do not have capacity to affect with their input decisions the dynamic of local house prices. The estimated coefficients of the interaction term between the change in house prices and the tangibility rate remain economically and statistically significant at the 1% level. The only exception is the 2SLS estimate of the relevant coefficient in the credit equation (column 6 in Table 15) where, even though the size of the coefficient is close to the baseline estimate, the increase in the standard errors makes the coefficient statistically significant at the 10% level.

5.4.4 Additional robustness tests

Finally, we undertake several further robustness tests of our main estimates that are reported in Appendix C.2. These robustness consider an alternative definition of the investment rate, different estimation samples and the clustering of the standard errors at different levels.

Investment and the capital-labor ratio. In our baseline specification we have defined the investment rate as the log difference of the capital stock. As a robustness, we estimate equation 4 considering now the log change in the capital-labor ratio as the dependent variable. The variance of this ratio is the main driver of the industry-level TFP and, thus, the estimates of this specification can be considered as a further evidence on the impact of the collateral channel on capital misallocation. The estimates reported in Table C.5 are qualitatively similar to those in

[29]This suggestive empirical approach to deal with the endogeneity of the tangibility decision is justified by the fact, stressed in Chaney, Sraer and Thesmar (2012), that it is hard to find instruments that predict firms' real estate ownership and, thus, the tangibility rate of firms. The approach thus would be incomplete in the presence of unobserved relevant determinants of this decision that respond to changes in local house prices and that also determine investment and credit decisions.

Table 3. In particular, consistent with the theoretical predictions of the model, the coefficient of the interaction term is positive and statistically significant at 1% in all specifications. Using the 2SLS estimates to compute the house price elasticity for the capital-labor ratio, the dispersion of this measure, as a function of the tangibility rate, is similar to the elasticity of the capital stock. For instance, given the same local house price shock, the capital-labor ratio would increase in 92pp for firms moving from the bottom 25th percentile of the distribution of tangible fixed assets to the 75th percentile of this distribution. This evidence points out an increasing dispersion of the capital-labor ratio associated to local house price shocks.

Domestic companies. In order to mitigate the potential biases created by the composition of the sample, we exclude from our sample of manufacturing firms the subsidiaries of foreign multinationals operating in Spain. This can be justified because the investment and credit decisions of these firms could react differently than domestic companies to specific local demand shocks and, also, because the decisions of the subsidiaries could be related with the unobserved collateral value of the multinational group. The results in Table C.6 show that OLS and 2SLS estimates on the impact of house prices on both investment and credit are not significantly affected by the exclusion of these firms that just represent 5% of the estimation sample.

Clustering. In Table C.7, we analyze how our main results on investment and credit from Tables 3 and 4 are affected by clustering of the standard errors at different levels. In this table, we depart from our baseline level of clustering (municipality) and we show our baseline OLS and 2SLS estimates for investment and credit for our preferred specification with province clustering, two-way clustering by province and sector, and two-way clustering by municipality and sector. Focusing on the coefficient of the interaction term related with the main prediction of the model, the standard errors are somewhat larger when we use province clustering, and very similar or smaller when we use two-way clustering by province and sector and two-way clustering by municipality and sector. In all cases, the coefficient of interest remains statistically significant at 1% level.

Non-financial market economy. Throughout this article, the analysis has been restricted to manufacturing firms due to the technical limitations identified in the literature that are associated with the difficulties to estimate production functions for industries other than manufacturing and, thus, the measurement of capital misallocation in these industries. For completeness, we include as a robustness the main estimates of the paper considering in the estimation sample firms that are active in the non-financial market economy. This sample includes all sectors of activity excluding the ones related with the activity of the public sector, mining industries and the financial sector. We also exclude from the sample firms in the construction and the real-estate sector. The results on the main estimates of the reduced-form equations of investment and credit (Tables C.8 to C.9) are qualitatively robust when including these industries, suggesting that our main finding on the impact of the collateral channel as a mechanism that creates capital misallocation could apply to the whole non-market economy.

6 Aggregate Effects

In this section, we provide suggestive evidence on the aggregate effects of local house price booms on the misallocation of capital within manufacturing industries using the suitable case of the Spanish housing boom. We use this evidence to provide a back of the envelope calculation on the contribution of the collateral channel on investment, identified in the previous section, to explain the fall of aggregate manufacturing TFP in Spain between 2003 and 2007.

In section 5, estimates from reduced-form regressions show the significant impact of local house price shocks on capital and credit allocation across manufacturing firms. Indeed, firms that received larger local shocks to the valuation of their real estate assets experienced a greater accumulation of capital. These results point out to capital misallocation across firms through this collateral channel as illustrated, for instance, in Table C.5 that informs us on the causal positive relationship between the size of local house price booms and the dispersion of the capital-labor ratio among firms within manufacturing industries. In this section, we focus on the aggregate effects on productivity of this source of capital misallocation testing the empirical predictions 3 and 4 as stated in theoretical section 3. These predictions indicate that capital allocation within industries is less efficient in the presence of local house price shocks such as the ones created by a housing boom. The differential house price paths across municipalities, where the real estate assets of firms are located, cause an increase in the variance of the log capital-labor ratio within industries revealing capital misallocation. The model predicts that this measure of misallocation, the variance in the capital-labor ratio in an industry, is a sufficient statistic on TFP, which implies that an increase of capital dispersion translates into a decline of aggregate productivity. These theoretical predictions on the relationship between capital dispersion and productivity are consistent with misallocation models *à la* Hsieh and Klenow (2009). At the same time, the collateral channel affects the allocation of capital in the geographical space. Municipalities that experience a higher house price appreciation accumulate more capital because of the larger increase in the valuation of collateralizable real estate assets owned by firms located in those municipalities. This spatial channel of capital misallocation is in line with the geographic dimension of misallocation in Hsieh and Moretti (2019), that showed the significant impact of local restrictions to housing supply to create spatial misallocation of labor across metropolitan areas in the United States.

In order to test these predictions, we first divide the sample of manufacturing firms in municipality-industry pairs for each year included in the panel 2003-2007. For each pair, we compute the variance in the log capital-labor ratio in real terms. We then run the following baseline regression,

$$logVar(K/L)_{mst} = \beta_0 + \beta_1 logHP_{mt} + \delta_{srt} + \epsilon_{mst}, \tag{6}$$

where $Var(K/L)_{mst}$ is the variance in the log capital-labor ratio in real terms in municipality m, industry s and year t, HP_{mt} is the average house price index in real terms in municipality

m at year t, and δ_{srt} is a set of industry s, region r and year t fixed effects. Standard errors are clustered at the municipality level. The model predicts $\beta_1 > 0$.

Table 16 reports the coefficient estimates of running equation 6 including different sets of fixed effects. In column 1 we consider year fixed effects to capture aggregate macro conditions that commonly affect municipality-industries pairs. In column 2 we include industry-year fixed effects, which allow us to control for industry-specific shocks that affect industries regardless of their geographic location. In column 3 we add industry-region-year fixed effects, in order to also consider common shocks within industries that can be location (region) specific. The sign of the house price coefficient is positive and statistically significant in all columns. The magnitude of the coefficient ranges from 0.39 to 0.53 depending on the set of fixed effects included in the specification. A one percent increase in house prices at municipality level is thus associated with an increase in the dispersion of the capital-labor ratio of manufacturing-industries at municipality level of about 0.4-0.5 percent. The specification that includes industry-region-year fixed effects is our preferred one to examine the relation between local housing booms and capital misallocation within manufacturing industries. Indeed, these estimates show the existence of a positive correlation between local house price booms and the dispersion across the geographical space of the log capital-labor ratio within manufacturing industries. This suggestive evidence is consistent with the view that the average dispersion of capital in a given manufacturing industry increased more in municipalities that experienced a larger increase in house prices, revealing misallocation of resources.[30]

Considering these reduced-form estimates, we undertake a simple back-of-the-envelope calculation of the impact of the housing boom on aggregate productivity, through the effect of these prices on the dispersion of capital within industries. In order to simplify the analysis, we assume a counterfactual economy where local house prices grow according to their fundamental level. In this economy, consistent with our theoretical framework, we consider that local housing booms emerge when in a given municipality housing demand increases above its fundamental level. The effect of this increase in demand on local house prices depends on local geographical conditions. In particular, the size of the local house price shock is inversely related with the housing supply elasticity of the municipality, which depends on its initial geographical constraints. At empirical level, an important challenge to compute the aggregate effect of heterogeneous local housing booms is the difficulty to measure the actual size of the house price shock in the economy. To mitigate this limitation, we follow Glaeser, Gyourko and Saiz (2008) and Mian and Sufi (2011) that examine the heterogeneous nature of local house booms classifying municipalities in quartiles according to the distribution of initial housing supply constraints. In our setting, we make the conservative assumption that the average size of the house price shock in the economy can be proxied by the differential average growth rate in the average

[30] As a robustness, Table C.10 in appendix C reports the same estimates for the sample of firms in the non-financial market economy that includes industries non-included in the manufacturing sector. The magnitude of the coefficient estimates is very similar, ranging from 0.34 to 0.50, suggesting that the misallocation of capital across the space also increased within industries beyond the ones in the manufacturing sector.

price of houses located in the first and the fourth quartile of the pre-boom buildable urban land ratio distribution of municipalities in Spain. Indeed, when there is a housing boom the path of house prices located in municipalities in the first quartile should be closer to its fundamental level, meanwhile prices should grow more in land-constrained areas. Thus, we assume that the differential on average house prices of these two groups is the proxy of the aggregate average effect of the housing boom on house prices.

According to the data, the differential growth in average house prices among the first and the fourth quartile between 2003 and 2007 was of 9% in real terms. Using the coefficients reported in columns 1 to 3 in Table 16, that measure the increase of the capital-labor ratio variance associated to 1% increase in log house prices, we compute the increase of this variance due to the housing boom. In particular, the coefficients in Table 16 imply that the housing boom can explain an increase in the variance of the capital-labor ratio that ranges from 3.5% to 4.8%, being the latter the increase inferred from our preferred specification (column 3). The actual increase in the variance of the log capital-labor ratio with manufacturing industries in Spain between 2003 and 2007 was 9.8%. Therefore, the housing boom could account for between 35% and 50% of the increase in the dispersion of capital among Spanish manufacturing industries during this period. Given the one-to-one mapping between changes in the variance of log capital-labor ratio and TFP changes, this back-of-the-envelope computation indicates that the differential local house price growth (created by the housing boom) can account for between one-third and half of the total decline in aggregate productivity in the Spanish manufacturing sector during the housing boom.

7 Concluding Remarks

In this paper, we provided empirical evidence on the contribution of local house price booms to create capital misallocation within manufacturing industries. Spain experienced a salient housing boom in the late 2000s that coincided in time with an outstanding expansion of corporate non-financial investment and banking credit in the manufacturing sector. Empirical evidence indicates that during the peak of this housing boom (2003-2007), Spanish manufacturing firms that had a larger proportion of tangible fixed assets able to be collateralized obtained more credit from the banking system and their investment grew more intensively. Using geographical variation at municipality level on house prices and urban land supply, we show that this collateral channel on investment and credit was exacerbated when firms were located in land-constrained geographical areas, which experienced a larger house price appreciation.

This paper points out the geographical conditions that shape real estate markets as a potential source that creates industry misallocation of resources through the heterogeneous impact of local house prices on the collateral value of manufacturing firms. Indeed, we document an increasing dispersion of the capital-labor ratio within manufacturing industries over the Spanish housing boom due to the differential local shocks to housing prices that affected the relative valuation of assets owned by firms in a heterogeneous way. Our empirical findings are consistent with the collateral channel on corporate investment created by real estate shocks documented for the United States by Chaney, Sraer and Thesmar (2012). The novelty of the paper relies on linking this channel with geographical conditions on local housing markets where collateralizable real estate assets locate as a source of capital misallocation within industries. This geographical dimension of misallocation could be a channel that contributes to create aggregate TFP losses during housing booms. Using our reduced-form estimates, we undertake a simple counterfactual calculation showing that during the Spanish housing boom the misallocation generated by the collateral channel in different local real estate markets could account for between one-third and half of the fall in TFP experienced in the Spanish manufacturing sector.

The results on the relationship between house prices and capital misallocation do not depend on the nature or mechanism that originates the housing boom. However, one potential interpretation of our results is that we would have identified one micro-mechanism through which capital inflows are able to create aggregate capital misallocation within industries when these inflows are associated to local housing booms. In this sense, we would provide a micro-mechanism to the aggregate misallocation generated by capital inflows documented in Gopinath et al. (2017) for Spain during the late 2000s. Finally, in a context of secular stagnation with downward pressure to global interest rates, it may be interesting to explore the interdependencies between the collateral channel created by housing booms and the potential exacerbation that low interest rates create. Declining global interest rates may be conducive to housing booms (search for yield) and, in addition, the reduction in borrowing cost may be biased towards collateralized loans. In principle, both effects should be conducive to create misallocation but we leave a quantitative analysis of this question for future research.

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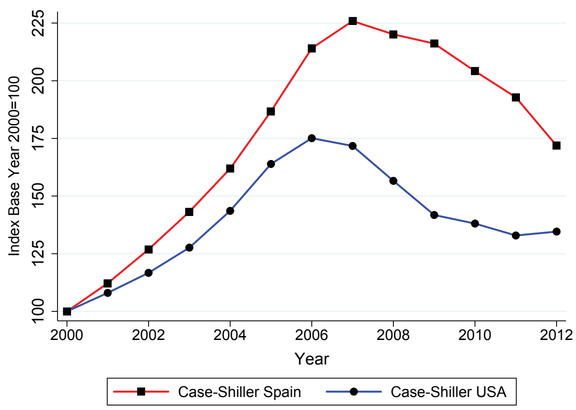
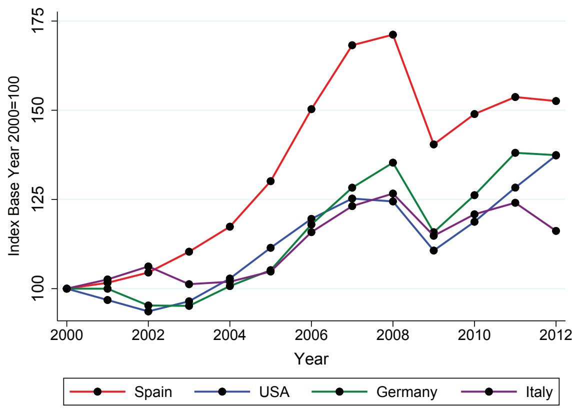
Figures

Figure 1: House Prices, Investment, Leverage and Collateralized Credit

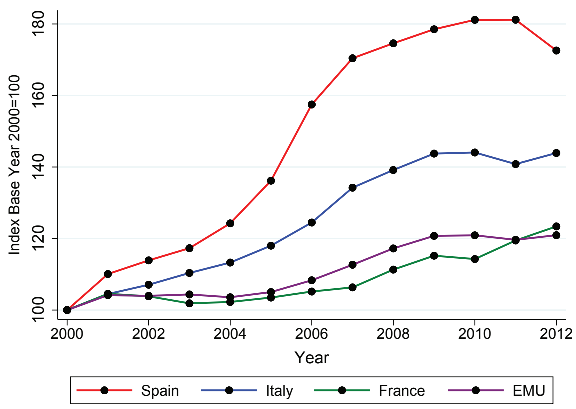
(a) House Prices



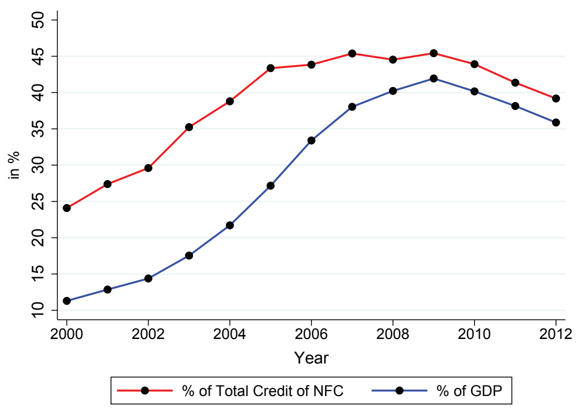
(b) Non-Residential Investment



(c) Leverage

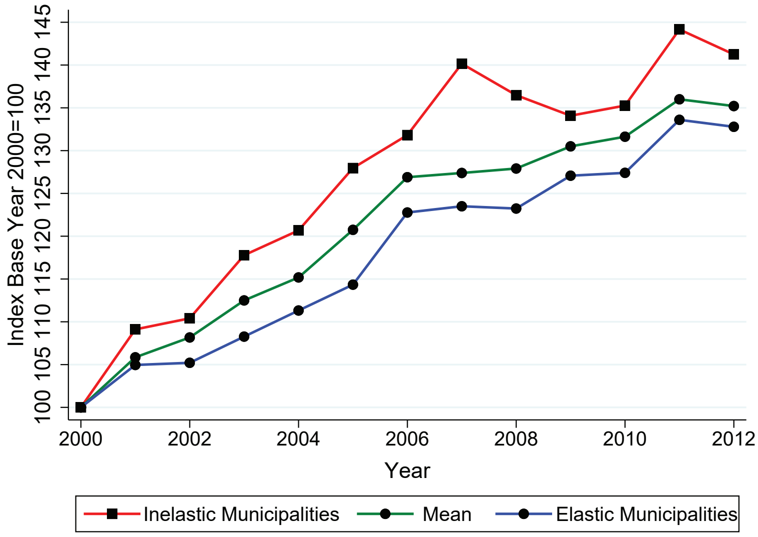


(d) Collateralized Credit



Note: Panel (a) plots the seasonally adjusted Case-Shiller home price index in nominal terms for Spain and the U.S. from 2000 to 2012, using 2000 as base year. Data for Spain come from the Spanish Ownership Registry, and data for the U.S. come from the Federal Reserve Bank of St. Louis. Panel (b) plots gross fixed capital formation, using 2000 a as base year, excluding investment in dwellings and other buildings and structures (roads, bridges, airfields or dams) in order to proxy non-residential investment by the private sector. Data come from the OECD database on Investment by asset. Panel (c) plots the aggregate leverage ratio of non-financial corporations defined as the ratio of debt (banking credit and corporate bonds) as a share of GDP, using 2000 as the base year. Data come from the Eurosystem. Panel (d) plots the collateralized granted credit to non-financial corporations as a share of total granted credit and as a share of GDP. Data come from the Bank of Spain.

Figure 2: Misallocation of Capital



Note: Figure plots the yearly weighted averages of the variance of the log real capital-labor ratio for firms in the non-financial market economy from 2000 to 2012. The averages are reported for both elastic and inelastic municipalities, as well as for the mean of Spanish municipalities with population over 1000 inhabitants. Elastic (inelastic) municipalities are those being above the 75th (below the 25th) percentile in the municipalities' distribution of the ratio of buildable urban land in Spain in 1997. The averages are obtained weighting the variance of the log real capital-labor ratio of each firm by the firm production's share in the aggregate production of firms located in either elastic or inelastic municipalities. The mean for Spain weights firms' variance of the log real capital-labor ratio by the firms' share in the aggregate production of Spanish municipalities with population over 1000 inhabitants. Data come from the Bank of Spain and the Spanish Cadastre.

Figure 3: Interest Rates and Buildable Urban Land Ratio

Note: Figure plots the monthly average initial nominal interest rate of loans with maturity higher than 1 year granted to firms by the banking sector when the borrowers provides real estate assets as a guarantee of the loan. The averages are reported for firms located in either elastic or inelastic municipalities. Elastic (inelastic) municipalities are those being above the 75th (below the 25th) percentile in the municipalities' distribution of the ratio of buildable urban land in Spain in 1997. Data come from the Ownership Registry of Spain and the Spanish Cadastre.

Tables

Table 1: Summary Statistics

	Mean	SD	25th	Median	75th	Observations
Panel A. Firm Dataset						
Share of Tangible Fixed Assets	28.03	21.10	10.59	23.35	41.60	255,855
Capital-Labor Ratio	1.62	2.51	0.38	0.89	1.91	255,763
Leverage Ratio	0.64	0.30	0.42	0.66	0.85	241,608
Employment	16.85	24.81	4	9	19	239,976
Financial Costs	4.23	6.78	1.07	2.62	4.89	243,213
Yearly Investment Rate	0.09	0.60	-0.16	0.00	0.10	255,855
Yearly Credit Growth	0.16	0.70	-0.18	-0.03	0.25	207,506
Cumulative Investment Rate	0.79	5.26	-0.32	-0.03	0.62	36,950
Cumulative Credit Growth	1.16	7.09	-0.25	-0.18	0.99	31,245
Panel B. Municipality Dataset						
Yearly House Prices Growth	0.14	0.33	0	0.10	0.22	7,824
Cumulative House Prices Growth	0.55	0.58	0.27	0.48	0.71	1,567
Buildable Urban Land Ratio	0.75	1.11	0.31	0.55	0.88	2,309

Note: Panel A presents summary statistics for the sample of manufacturing firms that are located in municipalities for which data on house prices and the pre-boom ratio of buildable urban land are available. This panel first reports summary statistics of the annual data of the firms in the period 2003-2007 on i) the share of tangible fixed assets, calculated as the proportion of the book value on physical property (real estate assets, factories and equipment) over the book value of total assets; ii) the capital-labor ratio, measured as the ratio of the book value of fixed assets over the wage bill; iii) the leverage ratio, computed as the ratio of total outstanding debt to the book value of total assets; iv) the average number of employees (full-time equivalent); and v) financial costs, computed as the proportion of financial expenditures to total outstanding debt. The panel then presents summary statistics of firms on the yearly investment rate and the yearly credit growth, that refers to the annual growth rate of, respectively, the real book value of fixed assets and the credit exposure with the banking system over the period 2003 and 2007. The panel also presents the cumulative growth rate of credit and investment rate from 2003 to 2007 for those firms included in the sample during those specific years. Panel B presents summary statistics for those municipalities whose population exceeds 1,000 inhabitants and that have manufacturing firms included in the sample. Yearly house price growth refers to the annual growth rate of the municipal house price indices in real terms over the period 2003 and 2007. Cumulative house price growth denotes the growth rate of municipal house price indices in real terms from 2003 to 2007 for those municipalities that have manufacturing firms in the sample during those specific years. Buildable urban land ratio refers to the ratio of available buildable urban land to urban land with already built structures in 1997.

Table 2: Buildable Urban Land and House Prices

Dependent variable:	Δ Ln(House Prices)			
	(1) 1995	(2) 1996	(3) 1997	(4) 1998
Buildable Urban Land Ratio ×	-0.023***	-0.023***	-0.026***	-0.031***
Δ Real Interest Rate of Mortgages	(0.007)	(0.007)	(0.008)	(0.008)
Year FE	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes
F-Statistic	11.94	9.79	11.54	15.73
Municipalities	1,854	1,854	1,854	1,854
Observations	6,594	6,594	6,594	6,594

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes municipalities where i) manufacturing firms are active in at least one year in the period 2003-2007; and ii) there are available both residential house price indices and measures of pre-boom housing supply elasticites. Dependent variable is the municipality's yearly house prices growth that is measured by the log difference of the average price index in real terms of residential housing prices between years $t-1$ and t in municipality m. The buildable urban land ratio is the proxy of the pre-boom housing supply elasticity in a municipality m, and it is built in Basco, Lopez-Rodriguez and Elias (2021). The change in the real interest rate of mortgages is computed using the average yearly rate of the flow of mortgage loans granted to households for the purchase of a house with an initial mortgage term of more than 10 years, provided by the Bank of Spain from 2003 to 2007. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 3: House Prices and Investment

Dependent variable:	Investment					
	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Δ Ln(House Prices)	-0.044***	-0.044***	-0.045***	-0.657***	-0.737***	-0.760**
	(0.016)	(0.016)	(0.016)	(0.219)	(0.232)	(0.297)
Tangibility	0.927***	0.927***	0.929***	0.659***	0.634***	0.631***
	(0.025)	(0.025)	(0.025)	(0.043)	(0.045)	(0.045)
Δ Ln(House Prices) ×	0.131***	0.133***	0.134***	2.878***	3.143***	3.181***
Tangibility	(0.038)	(0.038)	(0.038)	(0.412)	(0.438)	(0.439)
Observations	186,650	186,650	186,602	186,650	186,650	186,602
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	No	Yes	No	No
Industry-Year FE	No	Yes	No	No	Yes	No
Industry-Region-Year FE	No	No	Yes	No	No	Yes
1st Stage F-Stat. on IV-1				16.46	16.14	10.48
1st Stage F-Stat. on IV-2				45.93	45.60	47.33

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 to 3 report Ordinary Least Squares (OLS) estimates, and columns 4 to 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 4: House Prices and Banking Credit

Dependent variable:	ΔLn(Credit)					
	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Δ Ln(House Prices)	-0.040**	-0.039**	-0.045**	-0.111	-0.135	-0.185
	(0.019)	(0.019)	(0.018)	(0.372)	(0.386)	(0.459)
Tangibility	0.246***	0.245***	0.248***	0.090*	0.081	0.094*
	(0.029)	(0.029)	(0.029)	(0.054)	(0.056)	(0.056)
Δ Ln(House Prices) $\times$ Tangibility	0.116**	0.116**	0.123***	1.751***	1.826***	1.711***
	(0.046)	(0.046)	(0.047)	(0.445)	(0.462)	(0.460)
Observations	158,522	158,522	158,477	158,522	158,522	158,477
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	No	Yes	No	No
Industry-Year FE	No	Yes	No	No	Yes	No
Industry-Region-Year FE	No	No	Yes	No	No	Yes
1st Stage F-Stat. on IV-1				13.82	13.63	9.06
1st Stage F-Stat. on IV-2				42.04	42.12	43.66

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have outstanding debt with the banking sector. For any X, ΔLn(X) is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 to 3 report Ordinary Least Squares (OLS) estimates, and columns 4 to 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 5: House Prices and Extensive Margin of Credit

Dependent variable:	Acceptance of a New Loan Application					
	Acceptance Dummy		Number of Loans		Proportion of Loans	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Δ Ln(House Prices)	-0.018	-0.218	-0.011	-0.129	-0.008	-0.149
	(0.012)	(0.268)	(0.016)	(0.373)	(0.005)	(0.104)
Tangibility	0.044***	0.026	0.044**	-0.023	0.026***	0.009
	(0.015)	(0.027)	(0.021)	(0.039)	(0.007)	(0.011)
Δ Ln(House Prices) ×	0.064**	0.241	0.065	0.750**	0.031**	0.201**
Tangibility	(0.032)	(0.223)	(0.041)	(0.345)	(0.013)	(0.091)
Observations	186,602	186,602	186,602	186,602	186,602	186,602
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		10.48		10.48		10.48
1st Stage F-Stat. on IV-2		47.33		47.33		47.33

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable in columns 1 and 2 is a dummy that takes value 1 for firm i when at least one new loan application is accepted by a bank. Dependent variable in columns 3 and 4 is the number of new loan applications of firm i that are accepted by banks. Dependent variable in columns 5 and 6 is the proportion of new loans over the total number of loans granted by banks to firm i. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1, 3 and 5 report Ordinary Least Squares (OLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 6: House Prices and Investment - Firm Size Controls

Dependent variable:	Investment					
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Δ Ln(House Prices)	-0.041**	-0.719**	-0.044***	-0.759**	-0.041***	-0.705**
	(0.016)	(0.307)	(0.016)	(0.299)	(0.015)	(0.287)
Tangibility	0.934***	0.632***	0.956***	0.654***	1.064***	0.773***
	(0.026)	(0.047)	(0.025)	(0.046)	(0.024)	(0.046)
Δ Ln(House Prices) × Tangibility	0.128***	3.217***	0.133***	3.224***	0.128***	3.102***
	(0.039)	(0.463)	(0.038)	(0.446)	(0.036)	(0.450)
Ln(Employment)	0.019***	0.022***				
	(0.005)	(0.005)				
Ln(Sales)			0.093***	0.095***		
			(0.006)	(0.006)		
Ln(Assets)					0.410***	0.410***
					(0.008)	(0.008)
Observations	175,258	175,258	185,910	185,910	186,452	186,452
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		11.19		10.33		10.33
1st Stage F-Stat. on IV-2		45.69		47.39		47.41

Note: Standard errors clustered at the municipality level in parenthesis. The baseline specification for the investment equation includes as additional controls firm-specific yearly measures of the log firm size during the housing boom. The log firm size is computed using three alternative measures: the average employment (columns 1 and 2), total sales in real terms (columns 3 and 4) and total assets in real terms (columns 5 and 6). The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007.Dependent variable is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1, 3 and 5 report Ordinary Least Squares (OLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 7: House Prices and Credit - Firm Size Controls

Dependent variable:	Credit					
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Δ Ln(House Prices)	-0.042**	-0.152	-0.045**	-0.191	-0.043**	-0.134
	(0.019)	(0.488)	(0.018)	(0.448)	(0.018)	(0.454)
Tangibility	0.256***	0.090	0.298***	0.138**	0.356***	0.213***
	(0.031)	(0.059)	(0.029)	(0.056)	(0.027)	(0.055)
Δ Ln(House Prices) × Tangibility	0.118**	1.837***	0.126***	1.780***	0.119***	1.599***
	(0.048)	(0.488)	(0.046)	(0.461)	(0.046)	(0.452)
Ln(Employment)	0.052***	0.054***				
	(0.008)	(0.008)				
Ln(Sales)			0.178***	0.180***		
			(0.009)	(0.009)		
Ln(Assets)					0.352***	0.353***
					(0.010)	(0.010)
Observations	149,005	149,005	158,157	158,157	158,432	158,432
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		9.62		8.96		8.99
1st Stage F-Stat. on IV-2		42.26		43.64		43.79

Note: Standard errors clustered at the municipality level in parenthesis. The baseline specification for the investment equation includes as additional controls firm-specific yearly measures of the log firm size during the housing boom. The log firm size is computed using three alternative measures: the average employment (columns 1 and 2), total sales in real terms (columns 3 and 4) and total assets in real terms (columns 5 and 6). The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1, 3 and 5 report Ordinary Least Squares (OLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 8: House Prices and Investment - Weighted Least Squares

Dependent variable:	Investment					
Weighting variable:	Ln(Av.Employment)		Ln(Av.Sales)		Ln(Av.Assets)	
	(1) WLS	(2) 2SLS	(3) WLS	(4) 2SLS	(5) WLS	(6) 2SLS
Δ Ln(House Prices)	-0.044***	-0.837***	-0.046***	-0.750**	-0.046***	-0.766***
	(0.016)	(0.295)	(0.016)	(0.297)	(0.015)	(0.295)
Tangibility	0.905***	0.583***	0.928***	0.629***	0.920***	0.619***
	(0.028)	(0.050)	(0.025)	(0.045)	(0.025)	(0.045)
Δ Ln(House Prices) ×	0.139***	3.450***	0.138***	3.204***	0.137***	3.228***
Tangibility	(0.040)	(0.496)	(0.038)	(0.445)	(0.038)	(0.445)
Observations	175,158	175,158	186,380	186,380	186,596	186,596
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		9.97		10.05		10.21
1st Stage F-Stat. on IV-2		37.37		45.34		45.42

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta \text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. We use weighted least squares to estimate the regression parameters and weight firms according to three firm size measures computed as means over the housing boom period (2003-2007): i) the log average employment; ii) the log mean of real sales; and ii) the log mean of assets in real terms. Columns 1, 3 and 5 report Weighted Least Squares (WLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates using the same weights. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 9: House Prices and Credit - Weighted Least Squares

Dependent variable:	Credit					
Weighting variable:	Ln(Av.Employment)		Ln(Av.Sales)		Ln(Av.Assets)	
	(1) WLS	(2) 2SLS	(3) WLS	(4) 2SLS	(5) WLS	(6) 2SLS
Δ Ln(House Prices)	-0.039*	-0.366	-0.044**	-0.181	-0.045**	-0.198
	(0.021)	(0.550)	(0.019)	(0.479)	(0.019)	(0.474)
Tangibility	0.235***	0.033	0.245***	0.089	0.248***	0.088
	(0.033)	(0.064)	(0.029)	(0.056)	(0.029)	(0.057)
Δ Ln(House Prices) ×	0.109**	2.198***	0.122**	1.742***	0.120**	1.771***
Tangibility	(0.053)	(0.542)	(0.048)	(0.465)	(0.048)	(0.469)
Observations	149,841	149,841	158,365	158,365	158,475	158,475
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		8.45		8.62		8.81
1st Stage F-Stat. on IV-2		33.99		41.50		41.63

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta \text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. We use weighted least squares to estimate the regression parameters and weight firms according to three firm size measures computed as means over the housing boom period (2003-2007): i) the log average employment; ii) the log mean of real sales; and ii) the log mean of assets in real terms. Columns 1, 3 and 5 report Weighted Least Squares (WLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates using the same weights. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 10: Credit and Banks

Dependent variable:	ΔLn(Credit)			
	Commercial Banks		Savings Banks	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Δ Ln(House Prices)	-0.046**	-0.138	-0.077**	-0.741
	(0.022)	(0.533)	(0.038)	(0.747)
Tangibility	0.187***	0.025	0.399***	0.228**
	(0.033)	(0.064)	(0.055)	(0.097)
Δ Ln(House Prices) ×	0.109*	1.816***	0.197**	1.893**
Tangibility	(0.059)	(0.559)	(0.083)	(0.816)
Observations	108,287	108,287	43,650	43,650
Firm FE	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		6.29		5.33
1st Stage F-Stat. on IV-2		30.17		24.74

Note: Standard errors clustered at the municipality level in parenthesis. Firms are classified depending on the type of bank that is their main provider of credit (Commercial or Savings Banks). The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have outstanding debt with the banking sector. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 and 3 report Ordinary Least Squares (OLS) estimates, and columns 2 and 4 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 11: House Prices and Investment - Additional Confounding Factors

Dependent variable:	Investment					
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Δ Ln(House Prices)	-0.046***	-1.041***	-0.044**	-0.977***	-0.046***	-0.740**
	(0.017)	(0.308)	(0.018)	(0.314)	(0.016)	(0.301)
Tangibility	0.958***	0.571***	0.979***	0.600***	0.904***	0.608***
	(0.027)	(0.057)	(0.029)	(0.059)	(0.024)	(0.045)
Δ Ln(House Prices) ×	0.135***	4.025***	0.123***	3.907***	0.136***	3.174***
Tangibility	(0.041)	(0.571)	(0.043)	(0.582)	(0.038)	(0.438)
Ln(Leverage Ratio)	0.032***	0.040***				
	(0.003)	(0.003)				
Ln(Financial Costs)			-0.044***	-0.047***		
			(0.003)	(0.003)		
Ln(TFP)					-0.180***	-0.183***
					(0.017)	(0.018)
Observations	174,022	174,022	162,100	162,100	186,357	186,357
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		9.86		9.70		10.31
1st Stage F-Stat. on IV-2		40.95		36.88		47.26

Note: Standard errors clustered at the municipality level in parenthesis. The baseline specification for the investment equation adds, separately, three additional firm-specific yearly covariates: i) the log leverage ratio, measured as the ratio of total outstanding debt over the book value of assets (columns 1 and 2); ii) the log financial costs, computed as the ratio of financial expenditures over total outstanding debt (columns 3 and 4); and iii) the log productivity of the firm, measured as the TFP-sales estimated adopting the procedure proposed by Levinsohn and Petrin (2003) (columns 5 and 6). The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007.Dependent variable is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1, 3 and 5 report Ordinary Least Squares (OLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 12: House Prices and Credit - Additional Confounding Factors

Dependent variable:	Credit					
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Δ Ln(House Prices)	-0.059***	-0.682*	-0.055***	-0.422	-0.044**	-0.173
	(0.018)	(0.411)	(0.019)	(0.402)	(0.018)	(0.457)
Tangibility	0.239***	-0.001	0.233***	0.047	0.237***	0.083
	(0.030)	(0.063)	(0.031)	(0.063)	(0.029)	(0.056)
Δ Ln(House Prices) ×	0.155***	2.592***	0.134***	2.002***	0.123***	1.718***
Tangibility	(0.046)	(0.530)	(0.046)	(0.525)	(0.047)	(0.462)
Ln (Leverage Ratio)	0.056***	0.062***				
	(0.005)	(0.005)				
Ln(Financial Costs)			0.028***	0.027***		
			(0.004)	(0.004)		
Ln(TFP)					-0.083***	-0.085***
					(0.023)	(0.023)
Observations	149,197	149,197	143,614	143,614	158,307	158,307
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		9.18		8.85		9.03
1st Stage F-Stat. on IV-2		40.84		37.71		43.57

Note: Standard errors clustered at the municipality level in parenthesis. The baseline specification for the credit equation adds, separately, three additional firm-specific yearly covariates: i) the log leverage ratio, measured as the ratio of total outstanding debt over the book value of assets (columns 1 and 2); ii) the log financial costs, computed as the ratio of financial expenditures over total outstanding debt (columns 3 and 4); and iii) the log productivity of the firm, measured as the TFP-sales estimated adopting the procedure proposed by Levinsohn and Petrin (2003) (columns 5 and 6). The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1, 3 and 5 report Ordinary Least Squares (OLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 13: Endogeneity of Tangibility Rate

Dependent variable:	Investment		ΔLn(Credit)	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Δ Ln(House Prices)	-0.029	-0.587	-0.021	0.568
	(0.024)	(0.393)	(0.032)	(0.590)
Tangibility	0.941***	0.616***	0.261***	0.104*
	(0.028)	(0.047)	(0.032)	(0.060)
Δ Ln(House Prices) ×	0.133***	3.511***	0.130**	1.822***
Tangibility	(0.039)	(0.482)	(0.053)	(0.501)
2nd Quantile Ln(Assets 2002) ×	-0.014	-0.377*	-0.020	-0.659**
Δ Ln(House Prices)	(0.026)	(0.227)	(0.039)	(0.318)
3rd Quantile Ln(Assets 2002) ×	0.008	-0.582***	-0.035	-0.930***
Δ Ln(House Prices)	(0.025)	(0.222)	(0.036)	(0.304)
4th Quantile Ln(Assets 2002) ×	-0.020	-0.578***	-0.029	-1.132***
Δ Ln(House Prices)	(0.024)	(0.215)	(0.038)	(0.342)
5th Quantile Ln(Assets 2002) ×	-0.031	-0.743***	-0.032	-1.340***
Δ Ln(House Prices)	(0.021)	(0.223)	(0.036)	(0.351)
Observations	157,202	157,202	135,402	135,402
Firm FE	Yes	Yes	Yes	Yes
Industry-Region-Year FE	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		13.55		11.58
1st Stage F-Stat. on IV-2		55.72		56.86

Note: Standard errors clustered at the municipality level in parenthesis. The baseline specification for both the investment and credit equations adds controls for initial characteristics of the firm (an identifier that corresponds to the location of the firm in one of the five quintiles of the distribution of the log valuation of their total assets in 2002) interacted with the log change in house prices. The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have outstanding debt with the banking sector. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable in columns 1 and 2 is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. Dependent variable in columns 3 and 4 is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 and 3 report Ordinary Least Squares (OLS) estimates, and columns 2 and 4 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 14: House Prices and Investment - Small and Medium Firms and Big Municipalities

Dependent variable:	Investment					
Sample of firms:	Small and Medium Firms					
Sample of municipalities:	>5.000 inhabitants		>10.000 inhabitants		>50.000 inhabitants	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Δ Ln(House Prices)	-0.063***	-0.494	-0.082***	-0.886**	-0.165***	-0.209
	(0.022)	(0.383)	(0.028)	(0.404)	(0.047)	(3.177)
Tangibility	0.940***	0.670***	0.935***	0.678***	0.854***	0.649***
	(0.030)	(0.046)	(0.034)	(0.048)	(0.052)	(0.069)
Δ Ln(House Prices) ×	0.175***	3.028***	0.218***	2.968***	0.491***	2.889***
Tangibility	(0.055)	(0.445)	(0.073)	(0.455)	(0.142)	(0.671)
Observations	147,129	147,129	125,489	125,489	64,262	64,262
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		9.13		5.89		0.15
1st Stage F-Stat. on IV-2		61.94		56.89		20.00

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes manufacturing firms that i) have an average employment during the housing boom below 50 employees; and ii) are located in municipalities whose population in year 2002 exceeds, respectively, a) 5,000 inhabitants; b) 10,000 inhabitants; and c) 50,000 inhabitants. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1, 3 and 5 report Ordinary Least Squares (OLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 15: House Prices and Credit - Small and Medium Firms and Big Municipalities

Dependent variable:	Credit					
Sample of firms:	Small and Medium Firms					
Sample of municipalities:	>5.000 inhabitants		>10.000 inhabitants		>50.000 inhabitants	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS
Δ Ln(House Prices)	-0.057**	-0.025	-0.054**	-0.268	-0.150***	3.551
	(0.022)	(0.500)	(0.026)	(0.483)	(0.049)	(14.463)
Tangibility	0.241***	0.098	0.239***	0.113*	0.183***	0.114
	(0.033)	(0.061)	(0.036)	(0.061)	(0.051)	(0.189)
Δ Ln(House Prices) × Tangibility	0.165***	1.713***	0.170**	1.549***	0.400***	1.621*
	(0.061)	(0.496)	(0.071)	(0.485)	(0.129)	(0.920)
Observations	124,216	124,216	105,557	105,557	52,937	52,937
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		8.51		6.06		0.09
1st Stage F-Stat. on IV-2		61.87		60.82		23.68

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes manufacturing firms that i) have an average employment during the housing boom below 50 employees; and ii) are located in municipalities whose population in year 2002 exceeds, respectively, a) 5,000 inhabitants; b) 10,000 inhabitants; and c) 50,000 inhabitants. For any X, $\Delta \text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1, 3 and 5 report Ordinary Least Squares (OLS) estimates, and columns 2, 4 and 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table 16: Misallocation at the municipality level

Manufacturing Sector

Dependent variable:	Variance of log capital-labor ratio		
	(1)	(2)	(3)
Ln(Housing Prices)	0.388***	0.503***	0.534***
	(0.039)	(0.053)	(0.056)
Observations	35,041	35,039	34,878
Year FE	Yes	No	No
Region-Year FE	No	Yes	No
Industry-Region-Year FE	No	No	Yes

Note: Standard errors clustered at the municipality level in parenthesis. Dependent variable is the log variance in the capital-labor ratio in real terms in municipality m, industry s and year t. House prices denote the log of the average price index in real terms of residential housing in municipality m and year t. The estimation sample includes all industry-municipality pairs active in the manufacturing sector in one year over the period 2003-2007. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Online Appendix
Not Intended for Publication

”House Prices and Misallocation:

The Impact of the Collateral Channel on Productivity”

Sergi Basco (Universitat de Barcelona and MOVE)

David Lopez-Rodriguez (Banco de España)

Enrique Moral-Benito (Banco de España)

A Data Appendix

A.1 Data Coverage

Table A.1: Employment, Wage Bill and Firms Coverage 2003-2007

(a) Manufacturing Sector

	Employment	Wage Bill	Firms
Panel Data			
2003-2007	77.7	85.5	84.6
Annual Data			
2003	75.7	86.3	83.2
2004	76.5	86.8	85.2
2005	77.1	85.7	83.1
2006	79.7	85.6	84.5
2007	79.3	82.9	86.9

Note: Each cell corresponds to the coverage, expressed as a percentage with respect to the official census, of full-time equivalent employment, wage-earners remuneration and number of firms, respectively, of the manufacturing sector in the Bank of Spain (BdE) database relative to the data publicly reported by the Spanish National Institute of Statistics (INE). Official data on employment and wage bill come from Production and Generation of Income Accounts by Branches of Activity and the number of firms data come from DIRCE Census on Business that is the one reported in Eurostat Structural Business Statictics.

Table A.2: Firm Size Distribution by Employment Categories 2003-2007

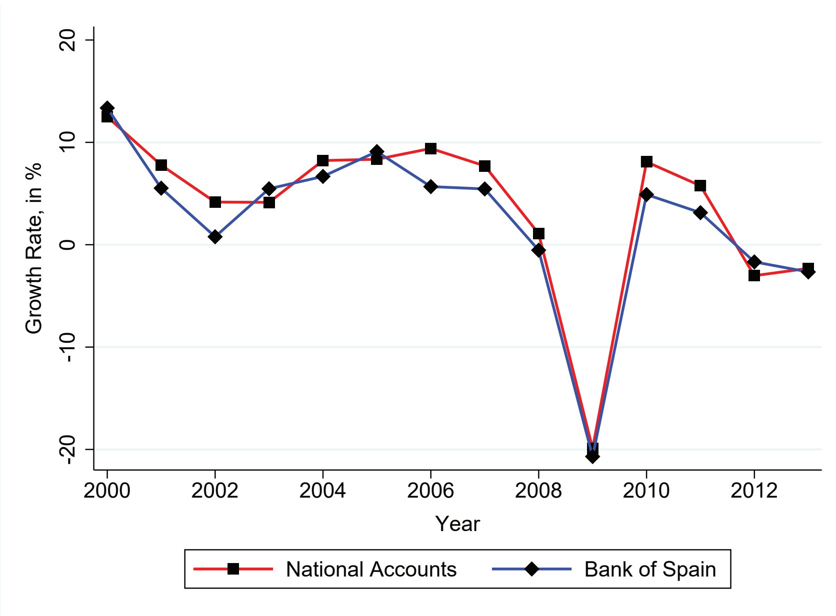
(a) Manufacturing Sector

	0 to 9	10 to 19	20 to 49	50 to 200	¿ 200
Panel Data					
2003-2007	72.9	88.9	90.7	87.5	93.4
Annual Data					
2003	68.3	85.6	89.4	87.5	92.1
2004	71.8	87.9	91.8	89.0	90.3
2005	74.3	89.1	90.2	83.3	95.2
2006	73.8	91.4	90.5	85.0	94.9
2007	76.3	90.5	91.5	92.7	94.5

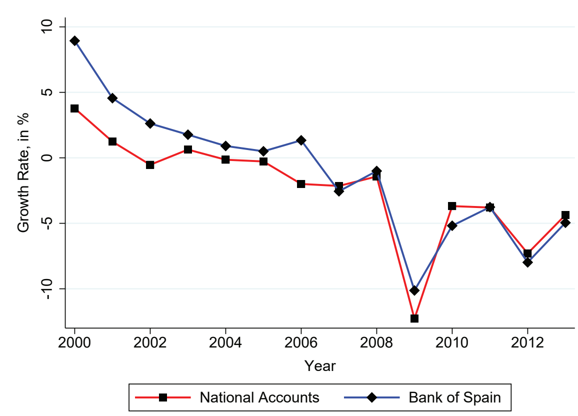
Note: Each cell corresponds to the coverage of the number of firms by employment size-category, expressed as a percentage with respect to the official census of firms in that size-category, of the manufacturing sector in the Bank of Spain (BdE) database relative to the data publicly reported by the Spanish National Institute of Statistics (INE). Official data on the number of firms come from the DIRCE Census on Business that is the one reported in Eurostat Structural Business Statictics.

Figure A.1: Manufacturing Sector Dynamics

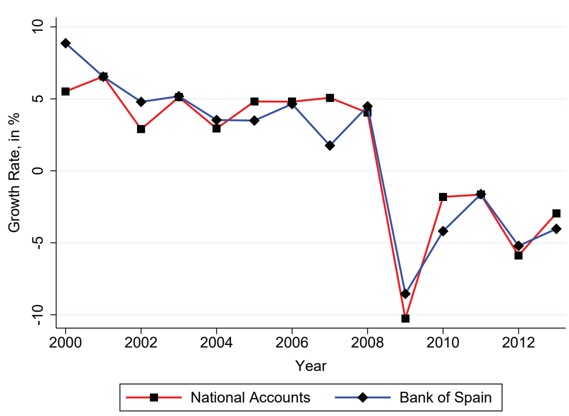
(a) Output Dynamics



(b) Employment Dynamics



(c) Wage Bill Dynamics

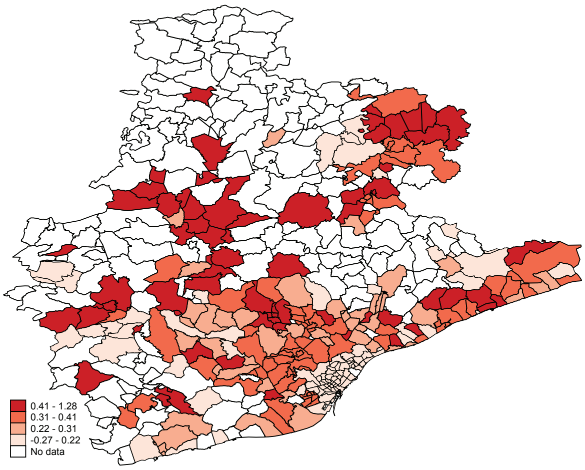


Note: Figures compare the yearly average growth rates in the firm-level Bank of Spain (BdE) dataset with respect to the yearly aggregate growth rates reported in the Production and Generation of Income Accounts by Branches of Activity from National Accounts as of a) production; b) full-time equivalent employment of wage earners; and c) wage-earners remuneration, in the manufacturing sector from 2000 to 2013. The micro-aggregates in the BdE dataset are computed as the sum of firms' reported, respectively, a) net operating revenue; b) average employment; and c) labor expenditures (wages and social security contributions). The correlation rate among micro and macro aggregates is 0.91 for employment and 0.96 for both production and the wage bill.

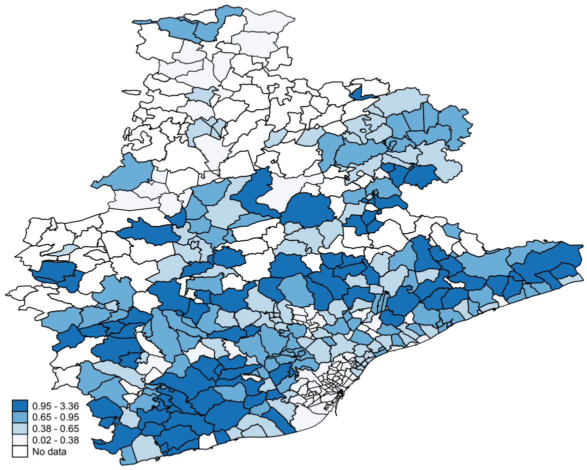
B Appendix Figures

Figure B.1: The House Price Boom in Spain. Variation Across Municipalities

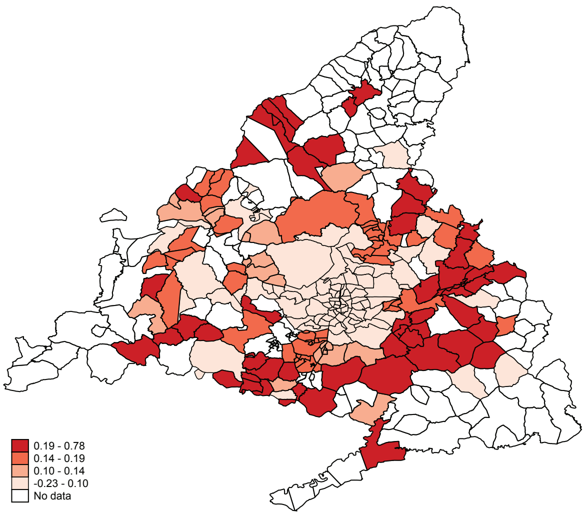
(a) Change in House Prices (Barcelona)



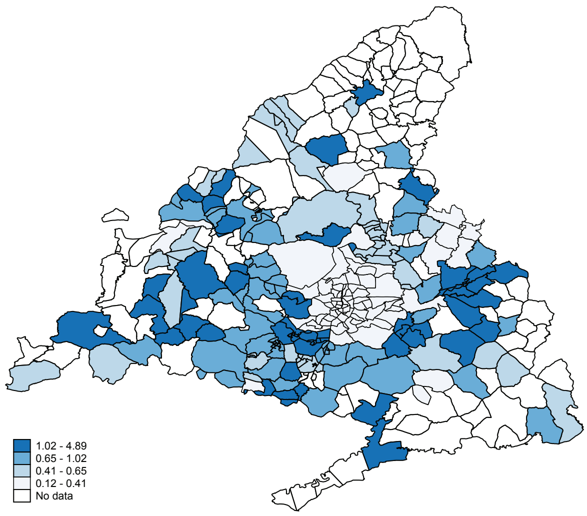
(b) Ratio of Buildable Urban Land (Barcelona)



(c) Change in House Prices (Madrid)

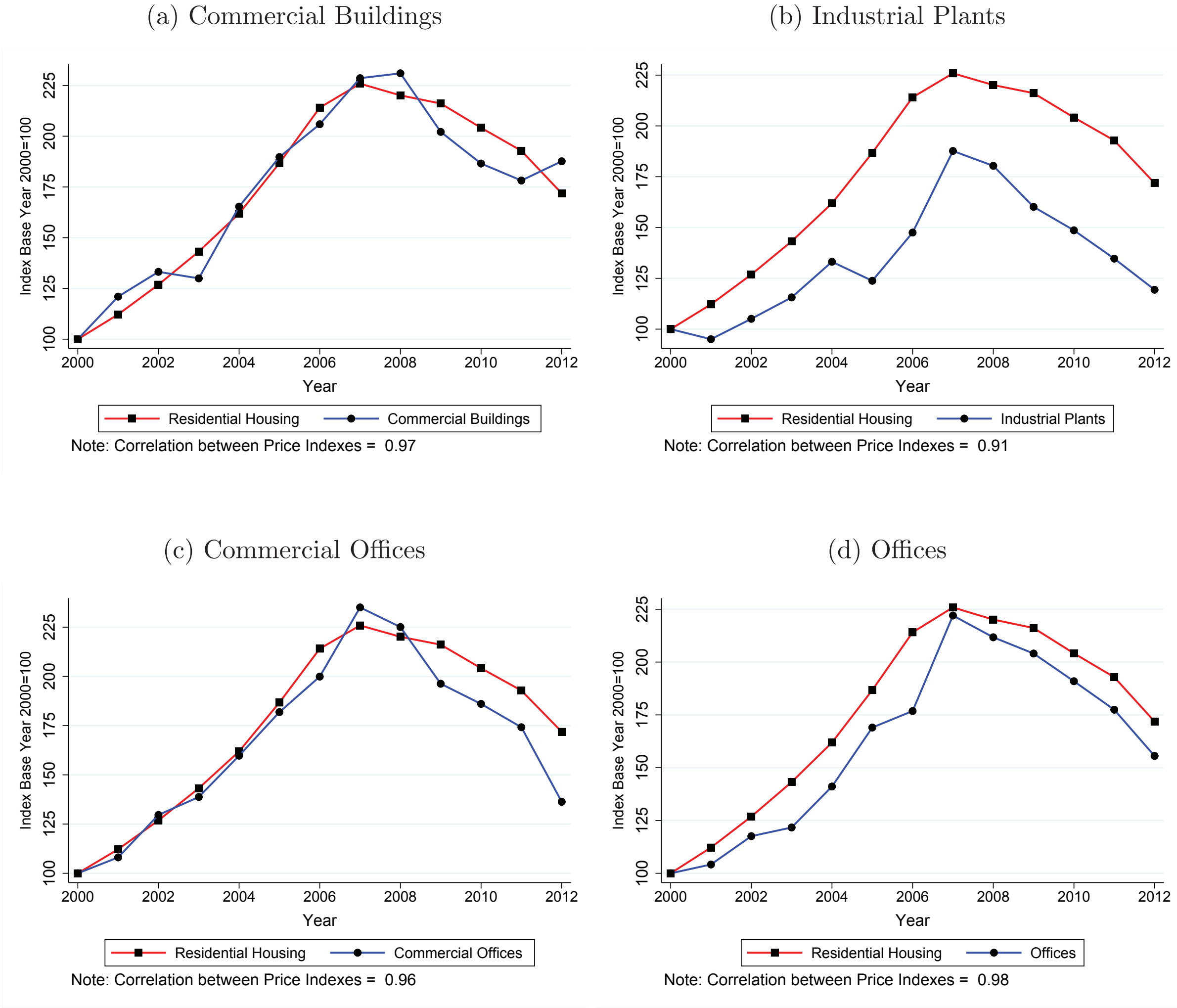


(d) Ratio of Buildable Urban Land (Madrid)



Note: Panels (a) and (c) illustrate the cumulative growth rate from 2003 to 2007 of the average house price index in real terms for municipalities in the provinces of Barcelona (Panel a) and Madrid (Panel c). Panels (b) and (d) report the Buildable Urban Land Ratio of a municipality in 1997 in the provinces of Barcelona (Panel b) and Madrid (Panel d). The Buildable Urban Land Ratio refers to the ratio of potential plot surface over the built urban surface in 1997 in the municipalities included in the sample. The municipality distribution at province level of the cumulative house price growth rates and the urban land ratio is divided in quartiles. Larger house price growth rates are reported with more intense red colors, meanwhile greater urban land supply is reflected with more intense blue colors. Municipalities without information appear in white, with the label "No data".

Figure B.2: Residential Prices vs Non-Residential Real Estate Prices



Note: Figures compare the evolution of the residential house price index in nominal terms for Spain from 2000 to 2012, using 2000 as the base year, with the dynamics of the non-residential real estate price indices of a) commercial buildings; b) industrial plants; c) commercial offices; and d) offices. Data come from the Spanish Ownership Registry and the Bank of Spain (BdE).

C Appendix Tables

C.1 House Prices and Local Geographical Conditions

Table C.1 shows that the there is a negative cross-sectional correlation between the ratio of buildable urban land (computed for different years) and housing price growth across Spanish municipalities during the housing boom years (2003-2007).

Table C.1: House Prices and Buildable Urban Land

Dependent variable:	House Prices Cumulative Growth (2003-2007)			
	(1) 1995	(2) 1996	(3) 1997	(4) 1998
Buildable Urban Land Ratio	-0.014***	-0.016**	-0.014**	-0.017**
	(0.005)	(0.006)	(0.006)	(0.007)
Observations	1,653	1,676	1,683	1,665
R-squared	0.122	0.118	0.118	0.119
Province FE	Yes	Yes	Yes	Yes

Note: Standard errors clustered at the municipality level in parenthesis. Dependent variable is the cumulative growth rate of real house prices of residential housing in municipalities with firms included in the estimation sample during the housing boom period (2003-2007). Buildable Urban Land Ratio refers to the ratio of potential plot surface over the built urban surface for the years 1995, 1996, 1997 and 1998 in Spanish municipalities included in the sample. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

C.2 Additional Robustness Tests

Heterogeneous Responses: Firm Size

We explore the potential heterogeneous responses of investment and credit to local house price shocks sassociated to firm size. In order to do that, we divide the sample of manufacturing firms in three subsamples depending on their size as measured by their average employment during the housing boom. In particular, we label as small firms the firms that have between 1 and 20 employees; as medium firms the ones between 21 and 49 employees; and as large firms when they have 50 or more employees. The 2SLS estimates reported below in Tables C.2 and C.3 seem to indicate a stronger collateral channel on the segment of medium firms that, compared to the average response, exhibit significantly larger house price elasticities of both investment and credit.

Table C.2: Investment and Firm Size

Dependent variable:	Investment					
	OLS			2SLS		
	(1) Small	(2) Medium	(3) Large	(4) Small	(5) Medium	(6) Large
Δ Ln(House Prices)	-0.038**	-0.048	-0.089*	-0.784**	-0.145	-1.218*
	(0.017)	(0.035)	(0.053)	(0.329)	(0.746)	(0.720)
Tangibility	0.951***	0.890***	0.620***	0.664***	0.539***	0.438***
	(0.030)	(0.052)	(0.095)	(0.048)	(0.102)	(0.150)
Δ Ln(House Prices) ×	0.117***	0.156*	0.227	3.022***	4.251***	2.166*
Tangibility	(0.042)	(0.087)	(0.142)	(0.445)	(1.015)	(1.228)
Observations	136,631	32,278	10,057	136,631	32,278	10,057
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1				10.66	3.21	5.25
1st Stage F-Stat. on IV-2				48.99	32.55	6.28

Note: Standard errors clustered at the municipality level in parenthesis. Firms are divided in three subsamples depending on their size as measured by their average employment during the housing boom. In particular, we label as Small firms the firms that have between 1 and 20 employees; as Medium firms the ones between 21 and 49 employees; and as Large firms when they have 50 or more employees. The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 to 3 report Ordinary Least Squares (OLS) estimates, and columns 4 to 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table C.3: Banking Credit and Firm Size

Dependent variable:	ΔLn(Credit)					
	(1) Small	(2) Medium	(3) Large	(4) Small	(5) Medium	(6) Large
Δ Ln(House Prices)	-0.046**	-0.042	-0.074	0.144	-0.679	-1.864
	(0.021)	(0.042)	(0.099)	(0.511)	(0.994)	(2.034)
Tangibility	0.267***	0.158**	0.141	0.138**	-0.124	0.009
	(0.031)	(0.078)	(0.144)	(0.058)	(0.146)	(0.260)
Δ Ln(House Prices) ×	0.110**	0.150	0.168	1.429***	3.325***	1.894
Tangibility	(0.051)	(0.113)	(0.262)	(0.478)	(1.195)	(2.457)
Observations	112,885	29,974	9,188	112,885	29,974	9,188
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1				9.32	3.11	4.08
1st Stage F-Stat. on IV-2				46.74	30.60	5.63

Note: Standard errors clustered at the municipality level in parenthesis. Firms are classified by size depending on their average number of employees such that Small refers to firms between 1 and 20 employees; MediumFirms are divided in three subsamples depending on their size as measured by their average employment during the housing boom. In particular, we label as Small firms the firms that have between 1 and 20 employees; as Medium firms the ones between 21 and 49 employees; and as Large firms when they have 50 or more employees. The estimation sample includes manufacturing firms that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have outstanding debt with the banking sector. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 to 3 report Ordinary Least Squares (OLS) estimates, and columns 4 to 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Endogeneity of the tangibility rate

Table C.4 reports estimates of a cross-sectional regression of the firms' tangibility rate in 2002 on five quintiles of the log valuation of their total assets in 2002, as well as industry-region fixed effects. Considering the fact that the estimation sample is restricted to manufacturing firms that have information on the volume of total assets for the year 2002, the estimates show that the initial level of total assets is a good predictor of the tangibility rate of firms in the pre-housing boom period. Larger firms, when size is measured in terms of asset value, have lower tangibility rates.

Table C.4: Predictors of the Tangibility Rate

Dependent variable:	Tangibility Rate (1) 2002
2nd Quintile Ln(Assets 2002)	-0.003
	(0.003)
3rd Quintile Ln(Assets 2002)	-0.001
	(0.004)
4th Quintile Ln(Assets 2002)	-0.011***
	(0.003)
5th Quintile Ln(Assets 2002)	-0.014***
	(0.004)
Observations	55,457
Industry-Region FE	Yes

Note: Standard errors clustered at the municipality level in parenthesis. Dependent variable is the tangibility rate in 2002 computed as the share of tangible fixed assets to total assets. Firms have an identifier that corresponds to their location in one of the five quintiles of the distribution of the log valuation of their total assets in 2002. Significance levels: ***p¡0.01, **p¡0.05, *p¡0.1.

Investment as the change in the Capital-Labor Ratio

We estimate our main specification on the investment equation considering now the log change in the capital-labor ratio as the dependent variable. The estimates reported in this table are qualitatively similar to those reported in the main text when using the log difference of the capital stock as dependent variable (Table 3). In particular, consistent with the theoretical predictions of the model, the coefficient of the interaction term is positive and statistically significant at 1% in all specifications. These estimates point out an increasing dispersion of the capital-labor ratio associated to local house price shocks and, thus, they can be considered as a further evidence on the impact of the collateral channel on capital misallocation.

Table C.5: House Prices and Capital-Labor Ratio

Dependent variable:	ΔLn(Capital/Wage Bill)					
	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Δ Ln(House Prices)	-0.028*	-0.030*	-0.033*	-0.854***	-0.864***	-0.953***
	(0.017)	(0.017)	(0.017)	(0.245)	(0.255)	(0.318)
Tangibility	1.000***	0.999***	1.000***	0.766***	0.739***	0.719***
	(0.028)	(0.029)	(0.029)	(0.044)	(0.046)	(0.047)
Δ Ln(House Prices) ×	0.092**	0.097**	0.102**	2.472***	2.741***	2.966***
Tangibility	(0.042)	(0.042)	(0.042)	(0.410)	(0.430)	(0.447)
Observations	186,526	186,526	186,478	186,526	186,526	186,478
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	No	Yes	No	No
Industry-Year FE	No	Yes	No	No	Yes	No
Industry-Region-Year FE	No	No	Yes	No	No	Yes
1st Stage F-Stat. on IV-1				16.35	16.02	10.41
1st Stage F-Stat. on IV-2				45.88	45.57	47.26

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes firms in the non-financial market economy, excluding the construction and the real estate sectors, that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the firm's yearly investment rate that is measured by the log difference of the stock of capital over the wage bill between years $t-1$ and t measured in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 to 3 report Ordinary Least Squares (OLS) estimates, and columns 4 to 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Robustness to excluding subsidaries of multinational groups

In this table, we exclude from our sample of manufacturing firms the subsidiaries of foreign multinationals operating in Spain. This can be justified because the investment and credit decisions of these firms could react differently than domestic companies to specific local demand shocks and, also, because the decisions of the subsidiaries could be related with the unobserved collateral value of the multinational group. The results reported below show that OLS and 2SLS estimates on the impact of house prices on both investment and credit are not significantly affected by the exclusion of these firms that just represent 5% of the estimation sample.

Table C.6: Robustness: sample of domestic manufacturing firms

Sample:	Excluding subsidiaries of multinationals			
Dependent variable:	Investment		Credit	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Δ Ln(House Prices)	-0.042***	-0.810***	-0.040**	-0.336
	(0.016)	(0.295)	(0.019)	(0.404)
Tangibility	0.922***	0.626***	0.249***	0.090
	(0.027)	(0.046)	(0.030)	(0.056)
Δ Ln(House Prices) ×	0.128***	3.153***	0.120**	1.762***
Tangibility	(0.038)	(0.443)	(0.048)	(0.459)
Observations	177,246	177,246	150,536	150,536
Firm FE	Yes	Yes	Yes	Yes
Industry-Region-Year	Yes	Yes	Yes	Yes
1st Stage F-Stat. on IV-1		9.82		8.52
1st Stage F-Stat. on IV-2		45.61		42.01

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample of manufacturing firms excludes the subsidiaries of foreign multinationals operating in Spain. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable in columns 1 and 2 is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. Dependent variable in columns 3 and 4 is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 and 3 report Ordinary Least Squares (OLS) estimates, and columns 2 and 4 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Robustness to clustering of standard errors at different levels

In this table, we depart from our baseline level of clustering (municipality) and we show our baseline OLS and 2SLS estimates for investment and credit for our preferred specification with province clustering, two-way clustering by province and sector, and two-way clustering by municipality and sector. Focusing on the coefficient of the interaction term related with the main prediction of the model, the standard errors are somewhat larger when we use province clustering, and very similar or smaller when we use to-way clustering by province and sector and two-way clustering by municipality and sector. In all cases, the coefficient of interest remains statistically significant at 1% level.

Table C.7: Robustness to different levels of clustering

Dependent variable:	Investment		Credit	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Δ Ln(House Prices)	-0.045	-0.760	-0.045	-0.185
Clustering: province	(0.018)	(0.272)	(0.014)	(0.409)
Clustering: prov. and ind.	(0.012)	(0.254)	(0.014)	(0.313)
Clustering: mun. and ind.	(0.011)	(0.282)	(0.016)	(0.353)
Tangibility	0.929	0.631	0.248	0.094
Clustering: province	(0.050)	(0.043)	(0.029)	(0.056)
Clustering: prov. and ind.	(0.063)	(0.064)	(0.042)	(0.054)
Clustering: mun. and ind.	(0.055)	(0.066)	(0.042)	(0.055)
Δ Ln(House Prices) × Tangibility	0.134	3.181	0.123	1.711
Clustering: province	(0.046)	(0.504)	(0.040)	(0.543)
Clustering: prov. and ind.	(0.034)	(0.373)	(0.033)	(0.379)
Clustering: mun. and ind.	(0.029)	(0.319)	(0.034)	(0.313)
Observations	186,602	186,602	158,477	158,477
Firm FE	Yes	Yes	Yes	Yes
Industry-Region-Year FE	Yes	Yes	Yes	Yes

Note: For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable in columns 1 and 2 is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. Dependent variable in columns 3 and 4 is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 and 3 report Ordinary Least Squares (OLS) estimates, and columns 2 and 4 report Two-Stage Least Squares (2SLS) estimates. The significance level of the coefficient of the interaction term is under 1% for all the specifications when clustering standard errors at different levels.

Non-Financial Market Economy

In this subsection, we report the main estimates for the reduced-form equations of investment and credit considering in the estimation sample all firms that are active in the non-financial market economy, beyond the firms included in the manufacturing sector. The non-financial market economy includes all sectors of activity excluding the ones related with the activity of the public sector (e.g. health, education, public security or administration), mining industries and the financial activity (e.g. banking or insurance activities). We also exclude from the sample firms in the construction and real estate sectors. The results on the main investment and credit estimates reported below are qualitatively robust when including these industries, suggesting that our main finding on the impact of the collateral channel as a mechanism that creates capital misallocation could apply to the whole non-market economy.[31]

Table C.8: House Prices and Investment in the Non-Financial Market Economy

Dependent variable:	Investment					
	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Δ Ln(House Prices)	-0.036***	-0.037***	-0.039***	-0.478***	-0.581***	-0.619***
	(0.011)	(0.011)	(0.011)	(0.172)	(0.187)	(0.202)
Tangibility	0.968***	0.970***	0.972***	0.768***	0.725***	0.727***
	(0.020)	(0.021)	(0.021)	(0.025)	(0.029)	(0.029)
Δ Ln(House Prices) $\times$ Tangibility	0.110***	0.113***	0.112***	2.207***	2.709***	2.695***
	(0.030)	(0.032)	(0.032)	(0.238)	(0.290)	(0.285)
Observations	662,563	662,563	662,388	662,563	662,563	662,388
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	No	Yes	No	No
Industry-Year FE	No	Yes	No	No	Yes	No
Industry-Region-Year FE	No	No	Yes	No	No	Yes
1st Stage F-Stat. on IV-1				12.86	14.78	11.35
1st Stage F-Stat. on IV-2				59.55	56.84	57.31

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes firms in the non-financial market economy, excluding the construction and the real estate sectors, that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have positive stock of capital in the years included in the sample. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the firm's yearly investment rate that is measured by the log difference of the stock of capital between years $t-1$ and t measured in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 to 3 report Ordinary Least Squares (OLS) estimates, and columns 4 to 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

[31] See Almunia, Lopez-Rodriguez and Moral-Benito (2018) for details on the cleaning process and construction of the database as well as an exhaustive representativeness analysis of this micro dataset with respect to official statistics of the Spanish economy.

Table C.9: House Prices and Banking Credit

Dependent variable:	ΔLn(Credit)					
	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) 2SLS	(6) 2SLS
Δ Ln(House Prices)	-0.020*	-0.019	-0.023**	0.181	0.191	0.100
	(0.012)	(0.012)	(0.011)	(0.318)	(0.322)	(0.319)
Tangibility	0.283***	0.283***	0.286***	0.175***	0.173***	0.183***
	(0.019)	(0.019)	(0.019)	(0.029)	(0.030)	(0.031)
Δ Ln(House Prices) ×	0.062*	0.057*	0.058*	1.234***	1.256***	1.146***
Tangibility	(0.032)	(0.032)	(0.031)	(0.233)	(0.252)	(0.243)
Observations	524,320	524,320	524,140	524,320	524,320	524,140
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	No	Yes	No	No
Industry-Year FE	No	Yes	No	No	Yes	No
Industry-Region-Year FE	No	No	Yes	No	No	Yes
1st Stage F-Stat. on IV-1				10.77	12.43	9.55
1st Stage F-Stat. on IV-2				57.58	54.26	55.99

Note: Standard errors clustered at the municipality level in parenthesis. The estimation sample includes firms in the non-financial market economy, excluding the construction and the real estate sectors, that i) are active in at least one year in the period 2003-2007; ii) are located in municipalities where both residential house price indices and measures of pre-boom housing supply elasticites are available; and iii) have outstanding debt with the banking sector. For any X, $\Delta\text{Ln}(X)$ is the log difference in X between year $t-1$ and year t for the period 2003-2007. Dependent variable is the yearly growth rate of firm's credit defined the log difference of firm's outstanding credit with the banking system in real terms. House prices denote the average price index in real terms of residential housing in municipality m and year t. Tangibility refers to the proportion of the book value on physical property (real estate, factories and equipment) owned by a firm over the book value of its total assets in year t as reported in firm's balance sheet. Columns 1 to 3 report Ordinary Least Squares (OLS) estimates, and columns 4 to 6 report Two-Stage Least Squares (2SLS) estimates. F-statitics denote the Sanderson-Windmeijer (SW) weak identification tests in the presence of multiple endogenous regressors. F-statistic on IV-1 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $HSE_m * \Delta R_t$ equals zero. F-statistic on IV-2 denotes the corresponding test statistic for the null hypothesis that the first-stage coefficient on $Tang_{imt} * (HSE_m * \Delta R_t)$ equals zero. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

Table C.10: Misallocation at the municipality level

Non-Financial Market Economy

Dependent variable:	Variance of log capital-labor ratio		
	(1)	(2)	(3)
Ln(Housing Prices)	0.345***	0.420***	0.497***
	(0.026)	(0.034)	(0.037)
Observations	78,987	78,987	78,478
Year FE	Yes	No	No
Region-Year FE	No	Yes	No
Industry-Region-Year FE	No	No	Yes

Note: Standard errors clustered at the municipality level in parenthesis. Dependent variable is the log variance in the capital-labor ratio in real terms in municipality m, industry s and year t. House prices denote the log of the average price index in real terms of residential housing in municipality m and year t. The estimation sample includes all industry-municipality pairs active in the non-financial market economy in one year over the period 2003-2007. Significance levels: ***p<0.01, **p<0.05, *p<0.1.

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