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Macroeconomic Adjustment under Loose Financing Conditions in the Construction Sector

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Macroeconomic Adjustment under Loose Financing Conditions in the Construction Sector*

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Abstract

We provide a model with sector-specific debt-collateral constraints to analyse how asymmetric financing conditions across sectors affect the aggregate investment, credit and output composition. In our model, investments in the construction sector allow for higher leverage than investments in the non-durable consumption goods sector. When borrowing constraints bind in both sectors, unit returns in the construction sector are lower due to a positive pledgeability premium, and changes in interest rates have a non-monotonic effect in the sectoral composition of investment. Specifically, a fall in interest rates triggers a relative rise in investment in the consumption goods sector when rates are relatively high, whereas the opposite effect obtains when rates are sufficiently low. We argue that this prediction of the model, which depends critically on the asymmetries of financing conditions across sectors, is consistent with the evidence for a number of OECD countries during the decade before the 2007/08 crisis.

Keywords: nvestment and credit, pledgeability premium, collateral constraints, sectoral allocation, housing.

JEL: E22, E32, E44.

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1 Introduction

In the absence of financial market imperfections, the funding available should be allocated across different investment projects so that their marginal financing costs equal their marginal revenue. This allocation principle, however, need not hold in the presence of financial friction. This is the case, for instance, when some investors can not obtain as much financing as they would wish at the going rate. Under such circumstances, there may persist a positive gap between an investment project's marginal revenue and its marginal financing cost. As this happens, profit maximizing investors will optimally weight the return from each unit invested in a project against the financially-constrained size of the project, in which case nothing precludes that a sizeable volume of funds will be channeled to investment projects in sectors with low unit returns if such sectors enjoy relatively loose financing conditions that allow for large projects.

Based on the previous reflection, the objective of this paper is to explore the macroeconomic effects of asymmetries in the severity of collateral constraints across productive sectors. The underlying idea behind the assumption about sector-specific financing conditions is that the ability of a lender to liquidate and recover a loan in case of default is a key determinant of a loan's conditions, as argued by Shleifer and Visnhy (1992). In particular, borrowers generally obtain better financing conditions the higher is the resale value of the assets that they provide as collateral. Therefore, it is natural to face better external financing conditions when a firm invests in tangible assets, like real estate, than in projects that may lose a substantial fraction of their value if the original investor is forced to liquidate them.[1] Taking this reasoning at the sector-level, one could then argue that the construction sector would tend to face better financial conditions than the other main sectors in the economy given that, in relative terms, the construction sector consists on the exploitation of abundant tangible assets and standard production technologies.

To the extent that a firm's financing structure is shaped by its conditions of access to external funding, data on the financing mix between internal and external funds should be informative of the underlying financial conditions faced by firms operating in different sectors. Along these lines, Figure 1 shows the leverage ratio (defined as debt over total assets) for firms in the construction and manufacturing sectors in the main European economies over the period 1995–2006. Although both supply and demand factors are likely to influence the leverage ratios shown in this figure, the fact that construction firms have been substantially more leveraged than manufacturing firms in all countries and for the whole sample period may be seen as indicative

[1] Hart and Moore (1994) provide a foundation for the existence of borrowing limits based on the notion of strategic default, which follows in a context where investors can not commit to not withdraw their human capital from their investment projects. Holmstrom and Tirole (1997) also build a related theory of limits to external finance based on contract incompleteness and limited enforceability.

of a comparative advantage in the access to debt. More formally, several recent empirical studies have found support for the idea that firms that hold larger real estate portfolios face better financing conditions. For instance, Chaney, Sraer and Thesmar (forthcoming) estimate an elasticity of corporate investment with respect to the value of corporate real estate of 6 per cent for the typical U.S. firm over the period 1993–2007. They also find evidence that this link between collateral and investment operates through the positive effect of a rise in collateral on debt capacity. Similar effects have been recently found by Liu, Wang and Zha (2011), in the U.S., and by Gan (2007) in Japan over the 1990s. Of special interest for the arguments developed in this paper is the empirical analysis of Campello and Giambona (2012), who examine the relation between asset composition and capital structure by considering the effect of the degree of resaleability of tangible assets on leverage. Exploiting data drawn from firms operating in the U.S., they show that the presence of resaleable tangible assets in the balance-sheet is an important driver of leverage. Interestingly, across the several types of tangible assets, they find that land and buildings—which amount for the larger part of the assets of construction firms—have the highest explanatory power for leverage.

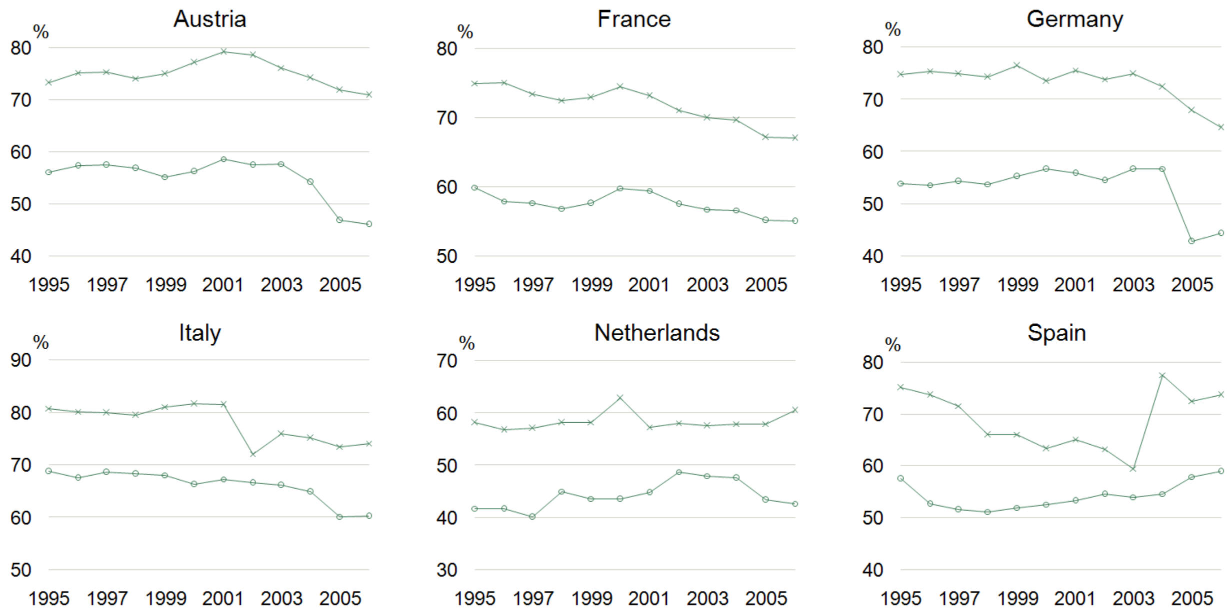

Figure 1. Debt to total assets for construction (-x-) and manufacturing firms (-o-)

Source: European Commission, BACH database (see Drudi et al., 2007).

In line with the previous evidence, we develop a model in which the construction sector—which produces a durable non-tradeable good, *housing*—faces looser collateral requirements vis-a-vis the sector of non-durable tradeable goods (*consumption goods*), and analyse how this financial asymmetry shapes the sectoral allocation of credit, investment and output in response to a persistent fall in the real interest rate, as observed in most developed economies over the years that preceded the bust of the crisis in 2007. In this model, investors decide in which sector to invest. In so doing, they face two types of restrictions: i) collateral constraints, which link the maximum amount of external financing available for a project to a fraction of the discounted resale value of its future output, and ii) minimum-scale restrictions, such that only projects of a minimum size can be executed. Along the lines of the reasoning above, we assume that investors in the construction sector can afford, *ceteris paribus*, a more leveraged financing structure.

A direct consequence of the financial asymmetry across sectors is that a *pledgeability premium*, in the form of a lower unit return in housing, arises in equilibrium. Indeed, as collateral constraints bind, optimizing investors face a trade-off between lower unit returns but larger projects in the housing sector and larger unit rents but smaller projects in the consumption sector.

The particular shape of the previous trade-off is strongly affected by the level of the interest rate. When interest rates are relatively high, leverage is low in both sectors and differences in the size of the largest project in each sector are small. Therefore, in this scenario, differences in total returns between both sectors are mainly driven by differences in unit returns (which are higher in the consumption goods sector due to the pledgeability premium). Then, investors who can overcome the minimum-scale restriction optimally decide to invest in the consumption goods sector. On the other hand, when interest rates are low, leverage is high in both sectors and, critically, differences in the sizes of the projects (and in leverage) become larger across sectors. Such differences in project sizes turn out to be crucial for the investors' decisions. Specifically, some investors for whom the minimum-scale restriction is not binding prefer to invest in the construction sector where they obtain higher total returns by running larger projects although with low unit returns.

Thus, in the aggregate, the effect of interest rates on the investors, investment and credit equilibrium allocations is non-monotonic. Starting with a relatively high interest rate, a fall in it, by raising the amount of collateral in hands of every investor, allows more investors to overcome the minimum-scale constraint and invest in the consumption goods sector, where unit returns are higher. Yet, for a sufficiently low interest rate, a further decline encourages some investors who could invest in the consumption goods sector to operate in the construction sector. In so doing, these investors give up some extra unit returns in the former sector in exchange for higher leverage and larger projects in the latter one. An additional prediction of the model is that the size of these interest rate regions depends on the intensity of the demand for housing. In particular, for a given interest rate, an economy is more (less) likely to be in the region where declines in the cost of external financing reallocate entrepreneurs towards the housing sector, the higher (lower) is the aggregate housing demand.

Taken together, the aforementioned implications of the model may help us understand the links between some of the most salient features of the macrofinancial environment that prevailed in some OECD countries that faced a housing boom before the subprime crisis, including the links between the rise in the global flow of savings and the subsequent fall in interest rates, the emergence of housing bubbles, and the strength of the construction sector in some of these countries, and the relative scarcity of assets perceived as safe. All these issues have been analysed in some previous papers, but, as far as we know, the present paper is the first attempt to connect them in the context of an equilibrium model that makes financial friction in the construction sector its centerpiece.[2] In particular, our model would be consistent with the idea that the perception of the real estate sector as a relatively "safe" sector, due to the tangibility and resaleability of its output, could have played a disproportionate role in shaping the investment mix in a context of abundant and inexpensive funding, biasing it towards that sector. According to the mechanisms implicit in the model, very low interest rates that fuel the demand for housing would have also tended to amplify the relative advantage of the real estate sector vis-a-vis other sectors to produce collateral, at a time at which high levels of indebtness make many investors borrowing-constrained and, hence, eager to pay an increasing price for that collateral. But, by devoting an increasing volume of funds to produce the most collateralizable good (houses), the economy also reduces the resources directed towards investment projects with higher unit value.

Empirics.– In the decade prior to the 2007/08 financial crisis, the sectoral allocation of investment showed quite distinct patterns across the main OECD economies, even though they all witnessed a similar substantial decline in real interest rates. While the share of investment allocated to the construction sector rose steadily in the U.S., the U.K., and Ireland over the 1995–2006 period, it fell almost uniformly in Germany and Japan, and exhibited a clear hump-shaped relationship for countries like Canada, France, Italy, the Netherlands, and Spain (see Figure 2).

[2] For instance, Arce and López-Salido (2011) provide a model that links the rise in global savings with the asset scarcity problem and the emergence of housing bubbles, but they do not consider the implications of these phenomena on the supply side.

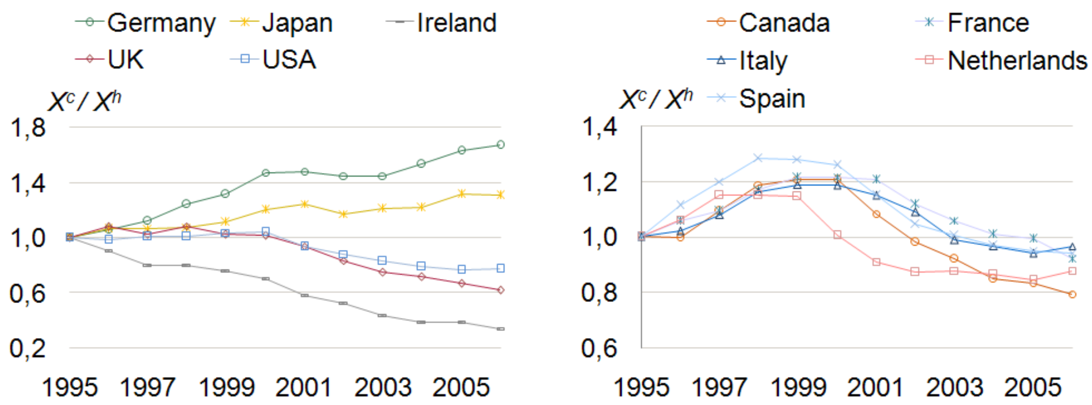

Figure 2. Sectoral allocation of investment

Source: OECD Annual National Accounts. Aggregate investment in the construction sector (X^h) is the sum of the items 'dwellings' and 'other buildings and structures' under the 'gross fixed capital formation' chapter. Aggregate investment in the consumption sector (X^c) is obtained as the difference between the total 'gross fixed capital formation' and X^h.

We argue that our model can help in understanding these diverging patterns. On the one hand, the hump-shaped pattern of sectoral investment ratios observed for the latter group of economies could be explained by our model as driven by the non-monotonic response of entrepreneurs' sectoral allocation to falling interest rates. Individual country regressions and panel regressions support this idea. Interestingly, our model can not generate these non-monotonic relationships if financial conditions are symmetric across sectors. On the other hand, controlling for the strong performance of the housing market in the U.S., the U.K., and Ireland, and the sluggishness in this market in Japan and Germany over the period of analysis, we may also rationalize in terms of our model the monotonic (and opposite) behaviour of the investment mix in these two sets of economies upon the basis of interest rate changes within a *single* interest rate region.

Related literature.– Our paper aims at contributing to the branch of the literature that incorporates financial friction into macroeconomic models to study their effects on investment.[3] One of the earliest and most influential contributions in this field is the *financial accelerator* theory developed by Bernanke and Gertler (1989), who show that a positive spread in the cost of external funding is a natural outcome in an environment with asymmetric information and conflicts of interest between borrowers and lenders. The financial friction emphasized in our paper, however, is inspired by the endogenous collateral constraint explored by Kiyotaki and Moore (1997). As in their model, we assume that only secured debt is available and only up to

[3]For a recent survey of this area, see e.g. Gertler and Kiyotaki (2010).

a fraction of the discounted resale value of the assets pledged by the borrowers.

Matsuyama (2007a) provides a general framework for studying the macroeconomic implications of investment project-specific financing conditions, showing that small departures from the baseline one sector model may give rise to a variety of nonlinear and non-monotonic dynamic phenomena like endogenous credit cycles, episodes of boom–bust, development traps, and reversed international flows. In a specific case analysed within this general framework, Matsuyama (2007b) focuses on the supply-side dynamics of an economy in which producers facing collateral constraints must choose among projects with different degrees of pledgeability. However, he considers an economy in which all projects deliver the same output and hence his model does not have any implications about the sectoral reallocation of investment induced by shocks in the presence of asymmetric financial conditions, which is one of the central objectives of our paper.

Antràs and Caballero (2009) also consider asymmetric financial conditions, across sectors and across countries, in a general equilibrium model featuring collateral constraints and analyse how they affect trade and capital flows between developed and emerging economies. In a similar vein, Manova (2008) studies the role of heterogeneous financing conditions across productive sectors in the pattern of specialization in international trade. Aghion, Angeletos, Banerjee and Manova (2010) investigate how differences in the maturity and liquidity of investments may affect both the short-run dynamics and the long-run economic growth in an environment in which firms face borrowing constraints.

Some of the modeling choices and questions treated in our paper are closely connected with the strand of the literature focused on occupational choice and investment decisions in the presence of financial friction. Cagetti and De Nardi (2006) provide a model of endogenous entrepreneurial entry and exit in which flows from the pool of workers towards entrepreneurship depend on individual wealth, as this determines the amount of external funding available. They use a calibrated version of such a model to account for some stylized facts regarding the wealth distribution for entrepreneurs and workers, firm size and aggregate capital in the U.S. economy. Buera (2009) also analyses how borrowing constraints may affect the relation between individual wealth and occupational choice in the context of a model calibrated with U.S. data. As in our model, Buera, Kaboski and Yongseok (2011) develop a two sector model with financial friction in which the interplay between non-convexities in the investment function and borrowing constraints gives rise to an endogenous segmentation of investors across sectors. They use this framework to analyse the power of financing constraints to account for cross-country and sector-level differences in output per worker.

Our paper shares with these papers a focus on the aggregate effects of asymmetric financing conditions across sectors and/or investment projects. We differ from them in the motivating question, as we are mostly interested in the macroeconomic impact that a persistent fall in the interest rate has on investment, credit and output composition, especially with regard to the real estate sector, and on the potential for non-monotonic responses in these variables, such as those witnessed in the years before the housing bubble bust that preceded the Great Recession in a number of OECD countries.

Finally, this paper is related to a number of recent articles analysing how a decline in the interest rate attracts more investment in the construction sector through the relaxation of credit-constrained housing buyers (see e.g. Kiyotaki, Michaelides and Nikolov 2011, and Iacoviello and Neri, 2010). Yet, in contrast to this literature, our focus is on the effects of borrowing constraints on the housing supply side and, more generally, on the aggregate output composition.

The rest of this paper is organized as follows. Section 2 presents the model. Section 3 describes how entrepreneurs optimally decide which sector to invest in. Section 4 analyses how changes in interest rates shape the output, investment and credit composition in this economy. Section 5 contains the results of our empirical analysis. Section 6 presents some conclusions.

2 The setting

We consider an open economy that produces two goods: one tradeable and one non-tradeable. The tradeable good is perishable and its price, which is taken as the numeraire and normalized to 1, is determined in the international markets and taken as given in the domestic economy. The non-tradeable good is durable and depreciates at a rate $\delta < 1$. Its price is determined in the domestic market. We henceforth refer to the tradeable and the non-tradeable goods as *consumption goods* and *housing*, respectively.

The economy is populated by two types of agents, who live for two periods: investors and consumers. At birth, investors are endowed with one unit of consumption goods and decide how to invest it to maximize their second period net worth which is entirely dedicated to purchasing consumptions goods. Consumers, instead, use their initial endowment to buy houses and consumption goods to maximize their lifetime utility.

2.1 Investment technologies and constraints

In every period, a measure 1 of domestic investors may allocate their first period endowment to one of the following three investment alternatives[4]: i) lending in the international credit market; ii) investing in the production of consumption goods; or iii) investing in the construction of new houses. The technology in the consumption and housing sectors (henceforth, the C and H

[4] For simplicity, we rule out the possibility of investors running different projects simultaneously.

sectors, respectively) has constant returns to scale. Specifically, investors obtain A^c units of consumption goods or A^h housing units in period $t+1$, per unit of consumption goods invested in the C and H sectors, respectively, in period t. The unit return of lending in the international capital markets alternative is the world gross risk-free interest rate, R_t, which is assumed to be exogenous. This latter assumption would be broadly consistent with a large strand of the literature which has argued that the interest rates and the volume of external savings available for investment have been largely exogenous over our period of analysis in the main advanced economies (even in large economies like the U.S.).[5]

Minimum investment requirements.– Lending does not require a minimum volume of investment. Instead, investment in the production of houses and consumption goods is subject to some minimum-scale requirements. Specifically, an investor can not run a project in the C or H sectors unless he is able to make an investment of size m or larger. Hence, the following *feasibility constraint* applies to investments in both sectors:[6]

$$x_t \geq m, \tag{1}$$

where x_t is the size of the investment projects, measured in units of consumption goods.

To rule out the trivial case in which (1) never binds, we further assume that $m > 1$. That is, investors' endowment is not sufficient to overcome the feasibility constraint in (1), which implies that investors must always rely on external funding. Borrowed funds are also paid at the international interest rate, R_t. The budget constraint for an investor born at t can be written as:

$$x_t = 1 + d_t, \tag{2}$$

where d_t denotes the amount of borrowed ($d_t > 0$) or lent ($d_t < 0$) funds.

Borrowing constraints.– Borrowing is subject to limits on the maximum volume of external funding that can be obtained for each project. In particular, we assume that investors in the H sector can not borrow at time t more than a fraction $\theta^h < 1$ of the discounted market value of

[5] As pointed out by this literature, the dominant phenomena underling the secular fall (rise) in interest rates (available funds) observed in the main advanced economies over our period of analysis are much more related to the output-savings-investment dynamics followed by the largest emerging markets economies and oil exporters than to internal factors in the advanced economies. The so-called savings-glut hypothesis.

[6] In order to focus on the effects of asymmetric financing conditions across sectors, we assume that the minimum investment requirement, m, is the same in the C and H sectors. None of the results of this paper concerning the macroeconomic effects of sectoral financial asymmetries depends on this assumption. Buera, Kaboski and Yongseok (forthcoming) analyse the effects of different minimum plant-size restrictions across sectors.

their production in period $t+1$. Formally,

$$d_t \leq \theta^h \frac{P_{t+1} A^h x_t}{R_t} \tag{3}$$

where P_{t+1} is the unit price of housing, in terms of consumption goods, in period $t+1$. Similarly, investors in the C sector face a borrowing limit of the form

$$d_t \leq \theta^c \frac{A^c x_t}{R_t} \tag{4}$$

where $\theta^c < 1$.

Financial asymmetry.– We assume that projects in the H sector allow investors to pledge a greater fraction of future output as collateral than projects in the C sector:

Assumption 1: $\theta^c < \theta^h$.

In addition, we introduce the following assumption:

Assumption 2: θ^c is investor-specific and is distributed across investors according to a continuous and smooth distribution function with support on the interval $\left[\underline{\theta}, \overline{\theta}\right]$, where $\underline{\theta} > 0$ and $\overline{\theta} < \theta^h$, and density function f.

This last assumption is made for technical reasons and, in particular, to avoid some (rather uninteresting) corner-type equilibria in which all investors in the economy choose to produce in the same sector. There are other ways to introduce heterogeneity across investors that produce a similar effect in the model (e.g., by making θ^h, A^h or A^c individual-specific).

2.2 Optimal intra-sectoral decisions

Investors born at t optimally pursue the investment alternative that delivers the highest net worth at period $t+1$, denoted by ϖ_{t+1}. The latter, in turn, depends on the particular investment project. In particular,

$$\varpi_{t+1} \begin{cases} R_t, & \text{if lending,} \\ A^c x_t - R_t d_t, & \text{if investing in the } C \text{ sector,} \\ P_{t+1} A^h x_t - R_t d_t, & \text{if investing in the } H \text{ sector.} \end{cases}$$

In the remainder of this section we characterize the optimal investment decision *within* the C and H sectors and postpone the question of how agents optimally decide in which sector to invest to Section 3.

2.2.1 Optimal investment in the C sector

At time t, investors who choose to produce in the C sector decide the size of their investment project so as to maximize consumption at $t+1$, c_{t+1}^c, subject to the feasibility constraint (1), the flow of funds constraints (2), the borrowing limit (4) and $c_{t+1}^c = \varpi_{t+1}$.

As our interest here is on interior equilibria, in which the economy produces both housing and consumption goods, we need to assume that investing in the C sector is always more profitable than lending:

Assumption 3: $A^c > R_t$.

This last assumption, however, is not sufficient to ensure the existence of such an interior equilibrium since, in principle, the minimum size constraint may deter *all* investors from investing in the C sector. On the other extreme, Assumption 3 together with a constant returns to scale technology imply that investors in that sector would ideally wish to undertake unboundedly large projects. To rule out both extremes, we impose the following additional assumption:

Assumption 4: $1 < \frac{R_t}{\overline{\theta} A^c} \leq \frac{m}{m-1}$.

The first inequality above ensures that the investor with the highest credit capacity, $\theta^c = \overline{\theta}$, can only borrow a finite amount, thus ruling out unboundedly large projects in this sector. The second inequality, instead, guarantees that, at least, that investor can finance the minimum investment, m.

Given the above assumptions, an investor who chooses to produce in the C sector must optimally put all his endowment as down payment and run a project with the maximum leverage so that the borrowing constraint (4) binds. Thus, the (investor-specific) optimal investment level in this sector is equal to:

$$x_t^* = \frac{R_t}{R_t - \theta^c A^c}. \tag{5}$$

2.2.2 Optimal investment in the H sector

Investors in the H sector maximize c_{t+1}^h subject to (1), (2), (3), and the constraint $c_{t+1}^h = \varpi_{t+1}$. It must be noticed that in any interior equilibrium in which some new houses are produced, the following two conditions must hold:

$$P_{t+1} A^h \geq R_t, \qquad \text{and} \tag{6}$$

$$1 < \frac{R_t}{\theta^h P_{t+1} A^h} \leq \frac{m}{m-1}. \tag{7}$$

Condition (6) ensures that the return to a project in this sector is not lower than the interest rate. The inequalities in (7) ensure that the minimum investment condition is not binding for a project with the maximum leverage and that projects in this sector have a finite size. Thus, as regards to their intuition, conditions (6) and (7) resemble assumptions 2 and 3, respectively. There is, however, an important difference between them. While assumptions 2 and 3 are conditions on parameters only, conditions (6) and (7) involve the price of housing, which is an endogenous variable. In this sense, the latter are *interior equilibrium conditions*, not assumptions. Then, the investors' optimal project size in the H sector is given by:

$$x_t^* = \begin{cases} \in \left[m, \frac{R_t}{R_t - \theta^h P_{t+1} A^h}\right], & \text{if} \quad P_{t+1}A^h = R_t, \\ \\ \frac{R_t}{R_t - \theta^h P_{t+1} A^h}, & \text{if} \quad P_{t+1}A^h > R_t. \end{cases} \tag{8}$$

The investment equation (8) differs from its C sector counterpart (5) in one important respect. While projects in the C sector are always run with the maximum leverage, i.e. the borrowing constraint (4) is always binding, depending on the housing price, optimal projects in the H sector may not lead investors to exhaust their credit capacity. The latter happens when $P_{t+1} = R_t/A^h$ (top line of equation (8)). In this case, investors are indifferent between investing in the H sector and lending their endowment. Then, any level of investment lying between m and the one consistent with (3) being binding, i.e. $R_t/\left(R_t - \theta^h P_{t+1} A^h\right)$, yields the same net profit. If, on the contrary, $P_{t+1} > R_t/A^h$, then the cost of external funds falls strictly below the return of investing in the H sector. In this case, it is optimal to invest (and borrow) as much as possible and, hence, constraint (3) binds.

2.3 Consumers' choices

In every period, a measure 1 of identical consumers is born. Like investors, consumers live for two periods. A consumer born at t is endowed with e units of consumption goods and has to decide how much housing, h_t, and consumption goods, c_t, to buy and how much to borrow, d_t. In his second period of life, he sells the non-depreciated fraction of his stock of housing to the young generation of consumers, repays debts and buys consumption goods. Specifically, we assume that consumers born at t maximize the following utility function:

$$U_t = \gamma \log h_t + \log c_t + \log c_{t+1}, \tag{9}$$

subject to the following flow of funds constraints

$$P_t h_t + c_t \leq e + d_t, \tag{10}$$

$$c_{t+1} + R_t d_t \leq (1-\delta) P_{t+1} h_t, \tag{11}$$

where $\gamma > 0$ captures the relative weight placed by consumers on housing relative to consumption goods and δ is the depreciation rate of the stock of houses.

The solution of the former maximization problem delivers the following optimal demand for housing:

$$h_t = \frac{\gamma e}{2+\gamma} \frac{1}{P_t - (1-\delta) P_{t+1}/R_t}. \tag{12}$$

2.4 Equilibrium

For a given sequence of interest rates $\{R_t\}_{t=0}^{\infty}$, a competitive equilibrium for this economy is an allocation $\{C_t, C_t^c, C_t^h, X_t^c, X_t^h, M_t, D_t, D_t^c, D_t^h, H_t, H_t^s\}_{t=0}^{\infty}$, a vector of investors measures $\{\phi_t^c, \phi_t^h\}_{t=0}^{\infty}$, and a vector of prices $\{P_t\}_{t=0}^{\infty}$, such that investors and consumers solve their respective utility maximization problems and all markets clear, i.e.

$$\text{(goods):} \qquad C_t + C_t^c + C_t^h + X_t^c + X_t^h = A^c X_{t-1}^c + M_t + (1+e), \tag{13}$$

$$\text{(housing)} \;:\; \frac{\gamma e}{2+\gamma} \frac{1}{P_t - (1-\delta) P_{t+1}/R_t} = (1-\delta) H_{t-1}^s + A^h X_{t-1}^h, \tag{14}$$

where C_t, C_t^c and C_t^h are, respectively, the aggregate consumption of consumers, time $t-1$ investors in the C sector and time $t-1$ investors in the H sector; X_t^c and X_t^h are the aggregate volume of invested goods by time t investors in the C and H sectors, respectively; M_t is the external balance, in terms of net imports; D_t, D_t^c and D_t^h represent aggregate loans (if positive) or lending (if negative) by the group of consumers, time t investors in the C sector and investors in the H sector; H_t is the aggregate demand for housing and H_t^s is the total housing stock; ϕ_t^c and ϕ_t^h are the measure of investors in the C and H sectors, respectively.

3 Endogenous investors segmentation

In this section we analyse how investors optimally decide in which sector to invest. For this purpose, we focus on interior stationary equilibria in which both housing and consumption goods are domestically produced. In this type of equilibrium, the housing price must satisfy the steady state versions of equations (6) and (7). Thus,

$$P \geq \max\left\{\frac{R}{A^h}, \frac{m-1}{m}\frac{R}{\theta^h A^h}\right\}. \tag{15}$$

We next introduce the following assumption:

Assumption 5: $1 - \theta^h < 1/m$.

This assumption, together with (15), implies that the relevant lower bound for the steady state housing price in (15) is $P \geq R/A^h$. In particular, assumption 5 adds to the generality of the forthcoming arguments because it allows for two potential types of stationary equilibria. One where the borrowing limits in the housing sector are binding ($P > R/A^h$) and another one where they are not ($P = R/A^h$). If, on the contrary, $1 - \theta^h > \frac{1}{m}$, then all interior stationary equilibria in this economy would imply a housing price $P > \frac{R}{A^h}$ and, hence, a financially constrained H sector.

We next deal separately with the optimal investor segmentation across sectors under the two types of equilibrium outlined above (i.e., with and without binding borrowing constraints in the H sector). Then, in Section 4, we discuss how the level of interest rates determines which type of equilibrium obtains.

3.1 An unconstrained housing sector

Consider a situation in which the unit return in the H sector equals the interest rate, i.e. $PA^h = R$. In that case, the borrowing constraint (3) does not bind and any investor in the H sector is indifferent between investing in that sector and lending his endowment in the international capital market. As a result, the aggregate supply of houses is completely elastic and the equilibrium volume of production is determined by the demand.

In the absence of returns above the interest rate in the H sector, an excess return above the interest rate in the C sector, $A^c - R > 0$, implies that it is optimal to invest there if feasible, i.e. investors whose θ^c is sufficiently high so that their project satisfies (1) optimally produce in the C sector. We denote by θ^F, for *feasibility*, the lowest θ^c such that the feasibility constraint (1) is satisfied. Combining (1), holding as an equality, with (5) we find that

$$\theta^F = \frac{m-1}{m}\frac{R}{A^c}. \tag{16}$$

The intuition behind this expression is as follows. The higher is the minimum project scale, m, the higher is the volume of credit required to carry on feasible projects and, therefore, the higher is θ^F. Likewise, higher interest rates go hand in hand with a lower collateral value of investment projects, and, hence, tend to raise θ^F too. Finally, a lower value of projects in the C sector, in terms of a low A^c, also increases θ^F because, given everything else, projects in this sector produce less collateral.

Summing up, in an equilibrium in which $P = R/A^h$, investors with pledgeability rates $\theta^c \geq \theta^F$ optimally invest in the C sector while investors with $\theta^c < \theta^F$ are indifferent between investing in the H sector and lending their endowment. In the aggregate, the allocation of this pool of indifferent investors is driven by the demand for housing.

3.2 A constrained housing sector

In contrast to the scenario analysed in the previous section, in an equilibrium in which $PA^h > R$, investors in the H sector obtain returns strictly above the interest rate and, hence, their borrowing constraint is binding. As a consequence, no investor is indifferent between producing in the H sector and lending his endowment. Further, there is also the possibility that some investors who may afford to run projects in the C sector (i.e. those with $\theta^c \geq \theta^F$) optimally choose to run a project in the H sector. This last decision depends on the *total return* that can be obtained in either sector, that is, on the *unit returns* and the *project size* that each investor can afford in each sector.

As for sector *unit returns*, we note that a positive *pledgeability premium*, defined as the difference $A^c - PA^h$, is a necessary condition for the existence of interior equilibria. In other words, for consumption goods to be domestically produced in equilibrium, unit returns in the C sector must be greater than those in the H sector, i.e. $A^c > PA^h$.

Intuitively, this pledgeability premium is similar to the well-known liquidity premium (see e.g. Kiyotaki and Moore (2008)), in the sense that more liquid assets must necessarily offer lower expected returns, given everything else. Analogously, the pledgeability premium, as defined above, states that projects that allow for higher leverage must necessarily offer lower unit returns in any interior equilibria in which borrowing constraints are binding. To see this, consider, by contradiction, that unit rents are the same in both sectors ($A^c = PA^h$). This, together with the higher degree of pledgeability of housing investments (assumption 1), would imply greater total rents in the H sector than in the C sector for *every* investor. Thus, no one would optimally choose to produce consumption goods domestically, which goes against the initial assumption of interior equilibrium.

With respect to the *project size*, we note that *ceteris paribus* the higher degree of pledgeability of projects in the H sector allows for larger projects there than in the C sector. Thus, a clear trade-off emerges as regards the final effect on total returns. Whereas unit returns are higher in the C sector, projects can be larger in the H sector. Faced with this trade-off, some investors (those with lower pledgeability rates θ^c) find it optimal to give up higher unit returns in the C sector and run larger projects with lower unit returns in the H sector.

Below, we investigate further the previous trade-off, which lies at the heart of the central mechanism of this model.

The marginal investor.– Let us define the marginal investor as the one with the lowest θ^c among those who optimally invest in the C sector, and denote by θ^* his pledgeability rate. Since total returns in the C sector are increasing in θ^c, it follows that all investors with $\theta^c \geq \theta^*$ must optimally invest in the C sector while the rest choose to produce in the housing sector.

In order to characterize θ^*, it is useful to define θ^P, for *profitability*, as the pledgeability rate for which $\varpi^c(\theta^P) = \varpi^h$, where $\varpi^c(\theta^P)$ is the second-period of life net worth for an investor with a pledgeability rate θ^P that invests in the C sector (i.e., $\varpi^c(\theta^P)$ is individual specific), and ϖ^h is the net worth for an investor in the H sector (which is common to all investors in that sector). In words, the investor for whom $\theta^c = \theta^P$ is the one who would obtain the same total return in both sectors. This (unique) rate is then implicitly defined by the following expression:

$$\frac{A^c - R}{R - \theta^P A^c} = \frac{PA^h - R}{R - \theta^h PA^h}. \tag{17}$$

To the extent that, by definition, the previous marginal investor must be able to afford the minimum investment requirement in the C sector, equation (17) meaningfully characterizes this investor as long as $\theta^P \geq \theta^F$. Thus, putting things together, the marginal investor is identified by $\theta^* = \max\{\theta^F, \theta^P\}$.

Summing up, there are three different scenarios depending on whether θ^P is less than, equal to, or greater than θ^F. First, if $\theta^P < \theta^F$, then $\theta^* = \theta^F$ and $\varpi^c(\theta^*) > \varpi^h$. Second, if $\theta^P = \theta^F$, then $\theta^* = \theta^F$ and $\varpi^c(\theta^*) = \varpi^h$. In both cases, the allocation of investors across sectors is similar to that in the unconstrained housing sector equilibrium described in the previous section. In particular, in both cases the marginal investor is the one who meets exactly the minimum investment requirement. Yet, now all investors with $\theta^c < \theta^F$ strictly prefer producing in the H sector rather than lending. Finally, if $\theta^P > \theta^F$, then $\theta^* = \theta^P$ and $\varpi^c(\theta^*) = \omega^h$. In this case, the trade-off faced by investors is clear. Investors with $\theta^c \in [\theta^F, \theta^P)$, who may afford to run projects in the C sector, optimally choose to produce in the H sector, thus giving up higher unit returns in the former sector to run larger projects in the latter. In this sense, from equation (17) we learn that, given a positive *pledgeability premium*, the marginal investor is indifferent between both sectors if and only if his investment project with the maximum leverage in the H sector is larger than the corresponding investment project in the C sector, i.e. $\theta^h PA^h > \theta^P A^c$.

4 The effect of interest rates on investment composition

In the previous section we have analysed the equilibrium allocation of investors across sectors taking as given different combinations of housing prices and interest rates (namely, when $PA^h = R$ and $PA^h > R$). In this section, we analyse how the particular type of equilibrium depends on the interest rate. In particular, we study how this economy can move from an equilibrium with an unconstrained H sector to the other types of equilibria analysed before, in which investors in that sector are constrained, as the interest rate falls. The macroeconomic implications of these shifts are also analysed and compared (in an Appendix available online) to those that would take place in an economy with symmetric financial conditions across both sectors.

4.1 Interest rate regions

To maintain the ongoing interior equilibrium assumption, in what follows we restrict the analysis to the interest rate interval $\left(\underline{R}, \overline{R}\right)$. The upper bound of this interval, $\overline{R}$, is defined as the highest R for which an interior stationary equilibrium exists. Thus, $\overline{R}$ is the interest rate that satisfies (1) as an equality in the C sector for the investor with the highest pledgeability rate $\theta^c = \overline{\theta}$. For any $R > \overline{R}$, no domestic investor can afford the minimum investment size in the C sector. The lower bound, $\underline{R}$, is defined as the lowest R for which the investor with the highest pledgeability rate is indifferent between both sectors. Hence, $\underline{R}$ is the rate that satisfies (17) when $\theta^P = \overline{\theta}$.

Within the above interval, it is useful to distinguish the following three regions: $R \in \left(R^*, \overline{R}\right)$, $R \in (R^{**}, R^*)$, and $R \in (\underline{R}, R^{**})$. We next define R^* and R^{**} and explore these regions in detail.

Region 1 (High rates): $R \in \left(R^*, \overline{R}\right)$. In this region, interest rates are relatively high and this implies that few investors can afford the minimum investment requirement in the C sector. At the same time, the demand for housing is relatively low, as it depends negatively on the interest rates (see (12)). Both a low demand for housing and a large amount of resources available for investment in the housing sector imply a zero excess return in the H sector. Thus, in this region, the equilibrium of the economy entails an unconstrained H sector, with $\theta^* = \theta^F$.

Given that $\frac{d\theta^F}{dR} > 0$,[7] a fall in R within this region reallocates investors towards the C sector. In particular, lower interest rates alleviate the feasibility constraint (1) and allow some investors to reach the minimum investment size in the C sector and, thus, to jump into this latter sector to obtain a positive excess return.

As discussed above, lower interest rates also raise the demand for housing. To satisfy it, the demand for funds of investors in the H sector must rise and/or the number of lenders must decrease (recall that in this region lenders and investors in the H sector obtain the same total returns), for these are the two channels through which the economy may end up producing more houses. Thus, a lower R in this region triggers an expansion in the *intensive margin* of the supply of housing (i.e. the investors' individual production), which tends to push the credit capacity of investors in the H sector towards its limit, or in the *extensive margin* (i.e. the number of investors) or in both.

It then becomes intuitive that for a sufficiently low R both the extensive and intensive margins of the housing supply must reach their limits.[8] When this happens, the scenario is such that (i) there are no domestic lenders and (ii) all investors in the H sector are credit

[7] See equation (16). A higher R reduces the net present value of projects in the C sector which, in turn, reduces the amount of external funding available. This implies that fewer investors can reach the minimum investment size in the C sector, i.e. $\frac{d\theta^F}{dR} > 0$.

[8] Recall that, since the number of investors in the C sector increases following a fall in R, a rise in the extensive margin of the housing supply comes through a contraction in the measure of existing lenders.

constrained.

In order to solve for R^*, we first write down the following housing market clearing condition

$$\frac{\gamma e}{2+\gamma} \frac{R^*}{R^* - (1-\delta)} \frac{1}{P} = \frac{1}{\delta} \int_{\underline{\theta}}^{\theta^*} \frac{A^h}{1-\theta^h} f(\theta) d\theta, \tag{18}$$

The left-hand side of (18) is the stationary aggregate counterpart of the individual demand for housing in (12), whereas the right-hand side corresponds to the supply of houses in the steady state. In deriving the expression for the supply of houses we have exploited the stationary version of the following law of motion of the aggregate stock of houses, $H_t^s = (1-\delta) H_{t-1}^s + Y_t^h$, where Y_t^h is the aggregate production (i.e. the flow) of new houses. Given that, by definition, the production of new houses at $R = R^*$ is performed by investors who are at their borrowing limit, the aggregate production of houses in the steady state is given by the integral in the right-hand side of (18).

Now, we combine (18) with the non-arbitrage condition $PA^h = R$ (which pins down the price of housing) and the expression for θ^F in (16) to arrive at the following expression that can be readily solved for a unique R^*:

$$\frac{\gamma e}{2+\gamma} \frac{1}{R^* - (1-\delta)} = \frac{1}{\delta} \int_{\underline{\theta}}^{R^*(m-1)/(mA^c)} \frac{1}{1-\theta^h} f(\theta) d\theta, \tag{19}$$

Region 2 (Intermediate interest rates): $R \in (R^{**}, R^*)$. Once R falls below R^*, investors in the H sector are credit-constrained and earn positive excess returns (i.e., $PA^h > R$). Yet, as the interest rates within this region are still relatively high, projects in both sectors are relatively small. In terms of the existing trade-off between the size of the projects (larger in the H sector) and their unit return (higher in the C sector), the latter implies that the differences in unit returns between both sectors dominate the differences in the size of the projects. Hence, within this region, the C sector produces higher total returns and investors who can satisfy the minimum investment requirement optimally decide to invest there. Thus, the equilibrium allocation of investors across sectors in this region is driven by the *feasibility* condition. Formally, $\theta^* = \theta^F > \theta^P$. Note also that, as in *Region 1*, a fall in R within this region induces a shift of investors towards the C sector.

Naturally, the lower the interest rate, the larger the projects that investors may afford in both sectors. Due to looser credit limits in the H sector, however, the impact of a fall in the interest rate on the size of the project is larger in the H sector than in the C sector. Intuitively, due to differences in θ, the multiplier effect of a change in R is, *ceteris paribus*, stronger in the

H sector (see equations (5) and (8) that determine the optimal project sizes in both sectors). Taking forward the previous argument, for a sufficiently low R, the differences in project sizes across sectors are sufficiently high so that, in spite of producing lower unit returns, investment in the H sector may yield higher total returns. More formally, we denote such a limiting interest rate by R^{**}, which is determined by the following expression:

$$\theta^P(R^{**}) = \frac{m-1}{m}\frac{R^{**}}{A^c}, \tag{20}$$

where $\theta^P(R^{**})$ is implicitly defined in equation (17) and the term in the right hand side of (20) is θ^F evaluated at $R = R^{**}$. In words, R^{**} is the interest rate for which the investor who can marginally afford the minimum investment requirement in the C sector is indifferent to between investing in the H and C sectors.

The existence of a unique R^{**} within the interval $\left(\underline{R}, \overline{R}\right)$ is guaranteed under some weak conditions. To begin with, note that, given the definition of $\underline{R}$ and $\overline{R}$ at the beginning of this section, we know that $\theta^* = \theta^P$ when $R = \underline{R}$ and that, necessarily, $\theta^* = \theta^F$ when interest rates are sufficiently close (from the left) to $\overline{R}$. Hence, since θ^F is a monotonic function of R (i.e., $\frac{d\theta^F}{dR} > 0$), a sufficient condition for the existence of R^{**} within the interval $\left(\underline{R}, \overline{R}\right)$ is that $\frac{d\theta^P}{dR} < 0$. In turn, a sufficient condition for $\frac{d\theta^P}{dR} < 0$ is that $\frac{dP}{dR} < 0$ outside of *Region 1*. To ensure that such a condition holds in the model, we make the following assumption:

Assumption 6: $\sqrt{\frac{\gamma}{2+\gamma}\frac{(1-\delta)\delta}{\theta^h}e} > A^c\frac{R-1+\delta}{R-A^c\theta^h}$.

The above condition on the parameters of the model is sufficient to guarantee that $\frac{dP}{dR} < 0$ outside of *Region 1* and, therefore, to ensure that $\frac{d\theta^P}{dR} < 0$ and to guarantee the existence of a unique R^{**}. This condition is satisfied for sufficiently high values of γ or e, for in either case the positive effects of a fall in R on the housing demand dominate the positive effects on the supply of houses. In imposing assumption 6 we note that the negative relation between interest rates and housing prices has been extensively documented in the empirical literature on housing (e.g., Himmelberg, Mayer and Sinai (2005)).

Region 3 (Low rates): $R \in (\underline{R}, R^{**})$. Once R falls below R^{**}, the differences in the size of investment projects between the two sectors are relatively large and some investors for whom it is feasible to invest in the C sector find optimal to invest in the H sector as they obtain larger total returns due to higher leverage in the H sector. Formally, in this region the equilibrium implies a constrained H sector with $\theta^* = \theta^P > \theta^F$. Notice also that, to the extent that $\frac{d\theta^P}{dR} < 0$, a fall in R in this region shifts investors towards the H sector. Interestingly, this effect of interest rates on the incentives of investors to choose between sectors is exactly of the opposite sign to the one present in *Regions 1* and *2*.

4.2 Moving across interest rate regions

Putting together the results in the previous section, the model predicts a hump-shaped relationship between the interest rate and the measure of investors who invest in the C sector, i.e. $\frac{d\theta^*}{dR} > 0$ if $R > R^{**}$ while $\frac{d\theta^*}{dR} < 0$ if $R < R^{**}$. This non-monotonic relationship is illustrated in Figure 3, which shows how θ^*, and hence the equilibrium mass of investors in the C sector, is determined through the relative value of θ^P and θ^F, for a given R.

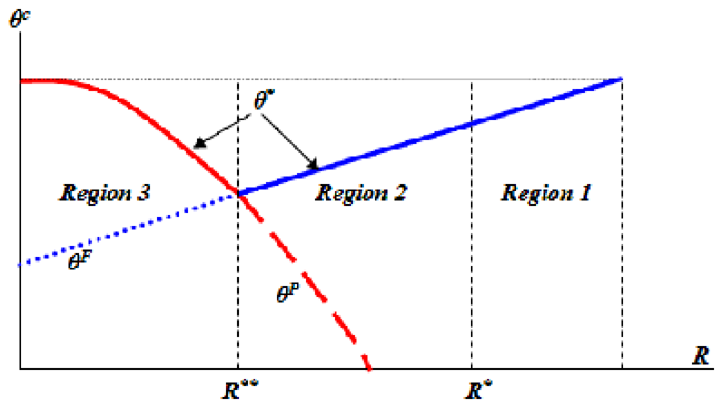

Figure 3. Investor segmentation

Figure 4 shows how investors optimally adjust their level and type of investment according to their pledgeability rate θ^c for different levels of interest rate. Specifically, when R is high and the economy is in *Region 1*, only investors with a sufficiently high θ^c can overcome the minimum investment constraint, hence, $\theta^* = \theta^{F,1}$ (herein, the numerical superscript stand for the corresponding interest rate region). Those with $\theta^c < \theta^{F,1}$ optimally choose to lend their endowment in the international capital market, hence, do not invest in any productive sector, or invest in the H sector, in which case they may choose any investment level between 1 (the endowment) and $1/(1-\theta^h)$, which corresponds to the investment with maximum leverage. The fact that the borrowing constraint (4) does not bind implies that any investment level between these two limits (the shadowed area in Figure 4) is optimal. As R falls and the economy gets into *Region 2*, investors with $\theta^h < \theta^{F,2} < \theta^{F,1}$ can not overcome the minimum investment constraint and optimally invest in the H sector with full leverage. Finally, for sufficiently low R, in *Region 3*, the relevant limiting θ is $\theta^{P,3}$, which may well lie above $\theta^{F,2}$, thus implying that more investors than in *Region 2*, some of whom can afford an investment above the minimum scale in the C sector, decide to run relatively large projects in the H sector.

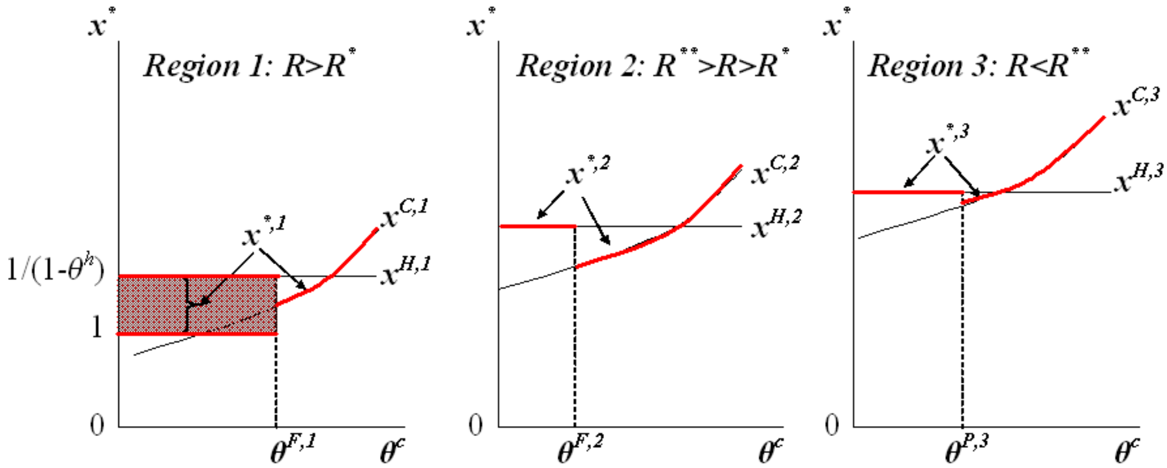

Figure 4. Investment level and composition

Figure 5 represents the housing price as a function of the interest rate. The most interesting feature of this function is that within Region 1 the housing price is positively related to the interest rate, reflecting the fact that over that range of interest rates, the equilibrium housing price is determined according to the non-arbitrage condition $PA^h = R$, whereas the equilibrium quantity of houses is demand driven.[9] Given this last observation, it is natural to examine how shifts in the demand for housing may affect the relative sizes of the different interest rate regions. In particular, we note that a positive shift in the demand for housing, say, due to a rise in γ, would shift the θ^P-schedule upwards in the left panel of Figure 6 without altering the θ^F-schedule. The former effect readily obtains by combining (17) with the steady state version of housing market clearing condition (14), whereas (16) clearly shows that θ^F is unaffected by changes in the location of the demand for housing schedule. Hence, putting things together, we learn that $\frac{dR^{**}}{d\gamma} > 0$, i.e. a stronger demand for housing implies, *ceteris paribus*, a wider region within which lower interest rates fuel higher investment in the H sector, as shown in Figure 6. Likewise, from expression (19), it can be readily verified that $\frac{dR^{*}}{d\gamma} > 0$. These last features of the model are exploited below in the empirical analysis.

[9] Incidentally, we notice that close to the left of R^{**}, the slope of the function falls in absolute value. This feature (which has been corroborated by some numerical exercises) reflects that as R crosses R^{**} from above, there is a discontinuous increase in the elasticity of the supply of houses, due to the reversal of the optimal decision of investors, some of which choose to leave the C sector and produce houses as the interest rate falls below that threshold.

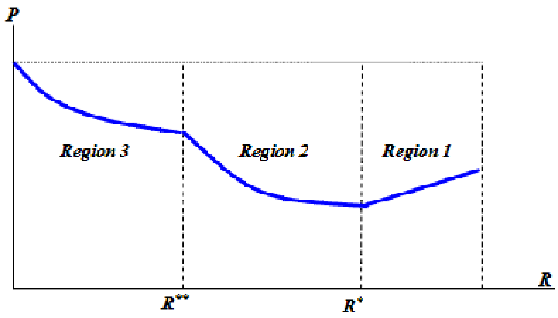

Figure 5. Housing price

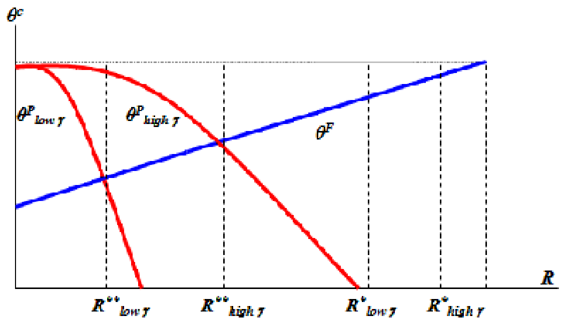

Figure 6. Shifts in housing demand

5 Empirical analysis

In the decade prior to the 2007/08 global financial crisis, the sectoral allocation of investment showed quite distinct patterns across the main OECD economies (see Figure 2). For a first set of countries, the share of investment allocated to non-construction activities relative to construction ones decreased almost monotonically over the period 1995–2006. The U.S., the U.K., and Ireland belong to this group. Instead, in a second set of countries, which includes Germany and Japan, the investment share in the non-construction sector exhibited exactly the opposite trend and grew steadily over the same period. Finally, for a third group of countries (Canada, France, Italy, the Netherlands, and Spain) the sectoral allocation of investment followed a clear hump-shaped dynamic pattern. It increased during the first years of the period, reaching its peak at the beginning of the current century, and decreased smoothly afterwards. In this section, we present some formal empirical evidence showing that the previous patterns in the investment mix can be rationalized in the context of the model presented above.

As shown before, our model predicts that a reduction in interest rates moves investors towards the C sector when external financing is relatively expensive, while it reallocates them towards the H sector when interest rates are relatively low. Over the period of analysis there was a widespread fall in interest rates in all regions (see Table 1).

Table 1. Ex-post real long-term interest rates

	Average 1995 - 2000	Average 2001- 2006
Canada	4.58	2.47
Germany	4.18	2.60
Spain	4.00	0.99
France	4.37	2.34
United Kingdom	4.72	3.09
Ireland	3.57	0.62
Italy	4.37	2.03
Japan	2.10	1.75
Netherlands	3.45	1.93
United States	3.52	1.84

Source: OECD Economic Outlook.

In light of these developments, the hump-shaped pattern of sectoral investment ratios observed for the third group of economies reported above could be explained by our model as driven by the non-monotonic response of entrepreneurs' sectoral allocation to falling interest rates. Table 2 documents a significant hump-shaped relationship between interest rates and investment ratios for Canada, France, Italy, the Netherlands, and Spain. In the first five columns we estimate the following equation for each of these countries separately,

$$\left(\frac{X^c}{X^h}\right)_t = \alpha + \beta R_t + \gamma R_t^2 + \varepsilon_t. \tag{21}$$

Consistently with the theoretical model insights, in all five regressions the estimated coefficient on R is positive and that on R^2 is negative. Except for the Netherlands, all these estimates are highly significant. Figure 7 shows how the data is fitted by equation (21) in each of these countries. In addition, the last two columns of Table 2 exploit the panel dimension of our data and estimate two versions of equation (21) including country and year fixed-effects. In particular, to control for omitted permanent country characteristics, we include country fixed-effects in column Panel (1). In column Panel (2) we also allow for year fixed-effects to capture time trends affecting all countries. These panel regressions reinforce the main findings of the individual country regressions and, consistently with the model, confirm the existence of a non-monotone relation between interest rates and sectoral investment ratios for these five countries.

Table 2. The response of sectoral investment allocation to interest rates

Dependent variable: Ratio of investment in the consumption sector (X^c) to investment in the construction sector (X^h)

	Canada	France	Italy	Netherlands	Spain	Panel (1)	Panel (2)
Constant	0.0173	0.3189	0.6714	0.6152	0.6650	0.6260	0.6618
	[0.1628]	[0.0891]***	[0.1157]***	[0.1528]***	[0.0323]***	[0.0069]***	[0.0081]***
Interest rate	0.3624	0.2223	0.2208	0.1236	0.1440	0.0557	0.0368
	[0.0909]***	[0.0543]***	[0.0666]***	[0.1106]	[0.0251]***	[0.0176]***	[0.0176]**
(Interest rate)^2	-0.0422	-0.0294	-0.0265	-0.0143	-0.0200	-0.0118	-0.0068
	[0.0115]***	[0.0077]***	[0.0080]***	[0.0185]	[0.0037]***	[0.0026]***	[0.0030]**
R-squared	0.6782	0.6644	0.5524	0.2536	0.7856	0.3110	0.7998
N	12	12	12	12	12	55	55

Note: Annual 1995-2006 data. Investment in the construction sector (X^h) is measured as the sum of *Gross fixed capital formation - Dwellings* and *Gross fixed capital formation - Other buildings and structures* as reported in OECD Annual National Accounts. Investment in the consumption sector (X^c) is the difference between *Gross fixed capital formation - Total* and X^h. Interest rate data come from the OECD Economic Outlook and measure ex-post real long-term interest rates. The column Panel (1) estimates a panel for Canada, France, Italy, Netherlands and Spain including country fixed effects. The column Panel (2) estimates the same panel controlling for country and year fixed effects. ***, ** and * imply statistical significance at the 1%, 5% and 10% level, respectively. In all panel regressions standard errors are corrected for autocorrelation.

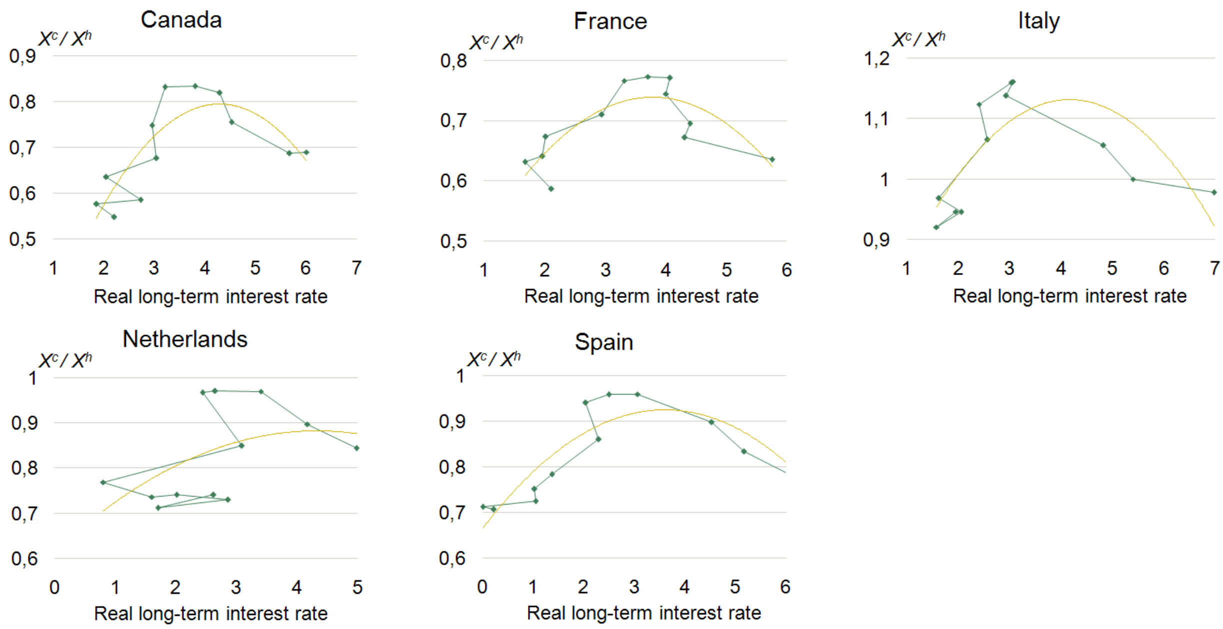

Figure 7. Sectoral allocation of investment and interest rate

We next deal with the other two sets of countries in Figure 2. As mentioned above, the share of investment allocated to the consumption sector fell steadily in the U.S., the U.K., and Ireland over the 1995–2006 period, while it grew almost constantly in Germany and Japan. In all these countries, interest rates declined monotonically over time, much in line with those included in the third group. Within the logic of the model, a monotonic response of the investment mix in face of a prolonged fall in the interest rate can be rationalized on the basis of movements within a given interest rate region, say either *Region 2* or *3* in Figure 3. Specifically, we note that the evolution of the investment ratios observed in the U.S., the U.K., and Ireland could be rationalized by our model as the equilibrium outcome of a fall in interest rates in an economy which, over the period of analysis, remains within the limits of *Region 3*. Importantly, as shown before, the size of the interest rate regions depends, among other things, on the parameters governing the demand for housing (as measured by γ), with $\frac{\partial R^{**}}{\partial \gamma} > 0$. Then, we conjecture that the fact that the housing markets in the U.S., the U.K., and Ireland were particularly dynamic during the period under study, with strong price increases, could indicate that these economies were within *Region 3* during this period, so that reductions in interest rates reallocated investment monotonically towards the construction sector. In the same vein, the developments observed in Germany and Japan could be rationalized in terms of the model as the response to cheaper credit in economies which operate outside of *Region 3*. Again, this seems reasonable, especially taking into account the anemic behaviour of the housing market in these two countries in recent times (see Figure 8). In particular, housing prices fell by around 18% and 30% in Germany and Japan, respectively, over the period 1995–2006, which may be indicative of a relatively weak housing demand. Indeed, the positive correlation between housing prices and interest rates in these two countries would be consistent with their economies being located in *Region 1* (i.e., low R^*).

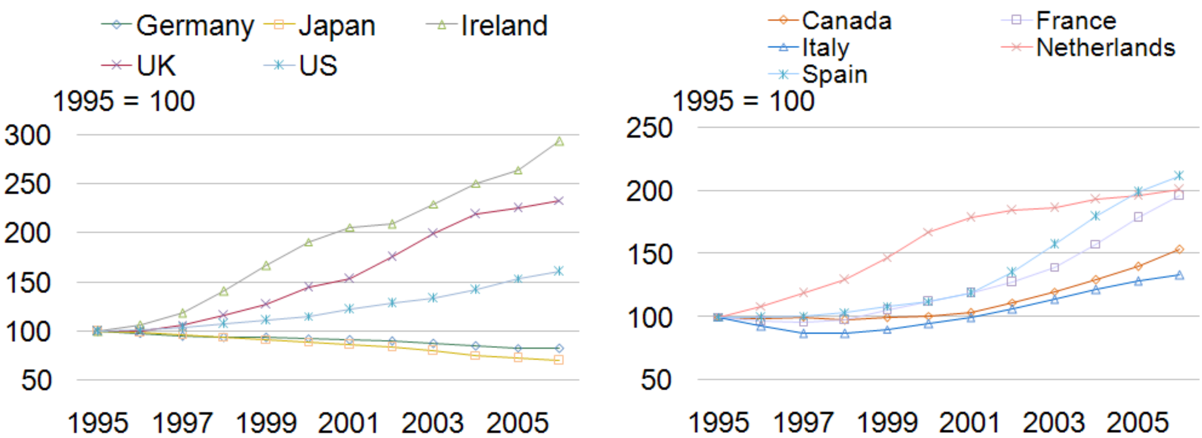

Figure 8. Housing prices

Table 3 shows the outcome of our empirical strategy followed to control for the effects of changes in the determinants of housing market conditions (others than the interest rate) on the size of *Region 3*. For robustness, we first estimate a version of equation (21) for a panel with all the countries that includes country fixed-effects (column Panel (1)) and both country and year fixed-effects (column Panel(2)). These results show that a global non-monotonic relation between the investment composition ratio and the interest rates still obtains when the sample includes countries for which such relation is monotonic during the sample period, although, naturally, the concavity of the estimated relationships (i.e., the coefficient on R^2) is considerably less intense than in Table 2.

Table 3. The response of sectoral investment allocation to interest rates. Extended panel

Dependent variable: Ratio of investment in the consumption sector (X^c) to investment in the construction sector (X^h)

	Panel (1)	Panel (2)	Panel (3)
Constant	0.6213	0.6162	1.1522
	[0.0046]***	[0.0036]***	[0.0183]***
Interest rate	0.0346	0.0227	0.06418
	[0.0114]***	[0.0103]**	[0.0279]**
(Interest rate)^2	-0.0080	-0.0044	-0.0158
	[0.0019]***	[0.0018]**	[0.0057]***
Price			-0.0025
			[0.0005]***
Interest rate * Price			-0.0004
			[0.0002]**
(Interest rate)^2 * Price			0.0001
			[0.0000]**
R-squared	0.1562	0.5317	0.6690
N	110	110	110

Note: Annual 1995-2006 data. Investment in the construction sector (X^h) is measured as the sum of *Gross fixed capital formation - Dwellings* and *Gross fixed capital formation - Other buildings and structures* as reported in OECD Annual National Accounts. Investment in the consumption sector (X^c) is the difference between *Gross fixed capital formation - Total* and X^h. Data on interest rates and housing prices come from the OECD Economic Outlook. Interest rates are ex-post real long-term interest rates and housing prices are real (nominal house prices deflated by the private consumption deflator). The column Panel (1) estimates a panel for Canada, France, Germany, Italy, Ireland, Japan, Netherlands, Spain, U.K. and U.S. controlling for country fixed effects. The columns Panel (2) and (3) estimate the same panel including also year fixed effects. In all regressions standard errors are corrected for autocorrelation. ***, ** and * imply statistical significance at 1%, 5% and 10% level, respectively.

In column Panel (3) we include housing prices in the empirical analysis. The idea is to use the evolution of these prices in each of the countries in the panel as a proxy for the different behaviours of housing demand. Thus, we aim to control for the different sizes of *Regions 1*, *2* and *3* in these countries.[10] The main insight of this empirical exercise is that the estimated hump-shaped relation between the investment ratio and the interest rate is robust to including housing demand effects. More importantly, the concavity of this relationship becomes stronger when these effects are taken into account. Also, as expected, house prices have a negative impact on the share of investment allocated to the consumption sector.

All in all, the empirical analysis presented in this section suggests that our model, by highlighting the existence of financial asymmetries across sectors that lead to a non-monotone relationship between interest rates and the sectoral allocation of resources, may be very helpful for understanding some features of the recent macroeconomic behaviour of the main OECD economies.

6 Final remarks

How aggregate investment is allocated across different productive sectors is a key determinant of economic fluctuations and long run growth. This paper analyses how investment is allocated when investors in the construction sector may pledge a higher fraction of their projects as collateral than investors in the non-durable consumption goods sector.

In our setting, when collateral constraints bind in both sectors, unit returns in the construction sector are lower due to a positive *pledgeability premium.* This goes hand in hand with a form of oversupply in that sector that is due to the relatively higher leverage allowed in construction investment projects. From the point of view of investors, such a pledgeability premium gives rise to a trade-off between lower unit returns but larger projects in the construction sector, and larger unit rents but smaller projects in the consumption sector. Which of these forces dominates depends on the interest rate. Specifically, a fall in interest rates triggers a relative rise in investment in the consumption goods sector when rates are relatively high, whereas the opposite effect obtains when rates are sufficiently low. That is, when interest rates are already low, a further reduction triggers a shift of investors towards the construction sector in search for large projects (with high leverage) even at the expense of lower unit profitability. In the end, the aggregate effect of interest rates on investors' decisions and on investment and

[10] In our stylized model, the interest rate is the only exogenous variable and it jointly determines $\frac{X^c}{X^h}$ and the relative price of housing. By including housing prices as an explanatory variable in the empirical analysis, together with the interest rate, we acknowledge that in the data, housing prices may contain some relevant information about the behaviour of $\frac{X^c}{X^h}$ beyond that provided by R. In this regression we also control for country and year fixed-effects. Note that, as long as the intensity of housing demand in each country (as proxied by housing prices) is not constant over time, the aforementioned demand effects can not be fully captured by the country fixed-effects.

credit equilibrium allocations is non-monotonic. We further find that the previous effects of the interest rate on the aggregate investment mix are strongly affected by the level of the demand for housing. In particular, for a given interest rate, an economy is more (less) likely to be in the region where declines in the cost of external financing reallocate entrepreneurs towards the housing sector, the higher (lower) is the aggregate housing demand.

Using data from a number of OECD countries for the period 1995–2006, we show that the core predictions of the model—the potential for a non-monotonic response of macro aggregates given a sustained fall in interest rates and the cross-effects between interest rates and housing demand—are consistent with the evidence.

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