Capital Pledgeability and Credit Misallocation

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ABSTRACT

This paper examines how heterogeneous capital pledgeability shapes capital allocation. I first document, using French firm-level data, that firms holding more pledgeable capital are structurally more leveraged and display greater sensitivity of investment to credit supply shocks. I then incorporate heterogeneous capital pledgeability into a general equilibrium model with collateral constraints. This feature creates sectoral capital misallocation: high-pledgeability capital is less costly to accumulate and thus yields lower expected returns than low-pledgeability capital, both in steady state and in response to credit supply shocks. I estimate the model based on a simple distinction between commercial real estate and other types of capital goods, the former being more pledgeable. I then show that capital misallocation is substantial over the credit cycle. Because these capital goods are imperfect substitutes and firms face a unique interest rate, redistributive credit policies taxing debt issued by high-pledgeability firms while subsidizing that of less pledgeable firms raise welfare, particularly when implemented during a credit expansion.

Keywords: Capital Pledgeability, Capital Misallocation, Credit Policies

JEL classification: E44, E58, E61

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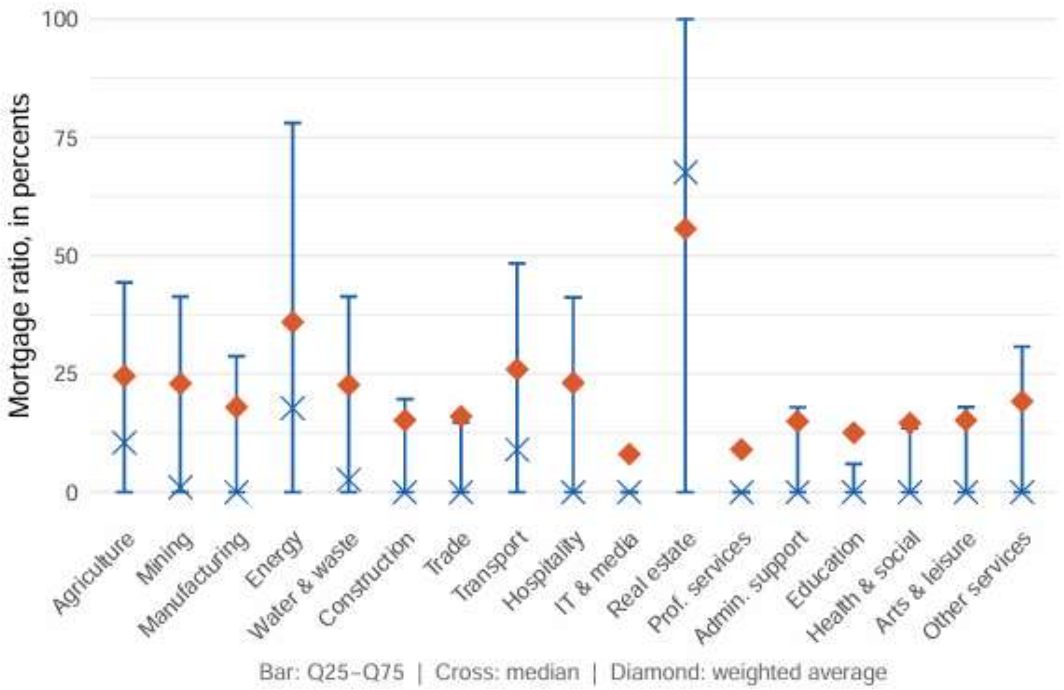
NON-TECHNICAL SUMMARY

The role of financial frictions in shaping investment dynamics has been a long-standing question in economics. This paper contributes to this strand of research by highlighting that capital goods differ in their pledgeability. In the event of default, some of these goods, such as office buildings, can be readily redeployed by other firms, thereby preserving their resale value and making them effective collateral in credit contracts. By contrast, firm-specific capital, such as machines or patents, suffer large liquidation discounts and are therefore less widely used as collateral. Figure 1 illustrates this heterogeneity by plotting the mortgage ratio — the share of bank credit explicitly collateralized — of French non-financial firms. Commercial Real Estate (CRE) investors, *i.e.* firms specializing in supplying real estate to other firms, stand out as owning particularly pledgeable capital: their median mortgage ratio exceeds 50%, far above that of most other non-financial sectors. Within other sectors, such as energy or transport, a sizeable share of firms reaches comparable mortgage ratios. This paper exploits this variation to study how differences in pledgeability shape capital accumulation and its allocation across firms.

Mortgage ratio of French non-financial firms (2019-2024)



Note: The mortgage ratio is defined as the share of bank credit that is explicitly collateralized. Bars represent the interquartile range, the horizontal line the median, and the diamond the average, weighted by the log of total assets. Source: AnaCredit France.

Leveraging the French firm-level data underpinning the figure above, I document that firms holding more pledgeable assets are structurally more leveraged and display greater sensitivity of investment to credit supply shocks. I then develop a macroeconomic model in which firms can borrow against different types of capital that vary in their pledgeability. I show that this feature generates persistent differences in expected returns across capital types. As these capital types cannot be easily substituted, these differences lead to an inefficient capital allocation. I estimate the model based on a simple distinction between CRE and other types of capital goods, the former being more pledgeable. I then show that misallocation is sizable:

credit policies that redirect borrowing capacity from firms with more pledgeable assets (such as CRE) toward other firms can improve welfare. Although these policies decrease the overall level of capital, they improve its allocation. This is particularly beneficial in the expansion phase of a credit cycle but less so in a contraction phase.

These findings have two important policy implications. First, they underline the importance of *sectoral* misallocation, while the literature has been mostly focused on misallocation across individual firms. Although both phenomena can coexist and be equally important, policy implications are more straightforward for the former, as targeted firms are more easily identifiable by the pledgeability of their assets. Second, these findings highlight that designing credit policies requires considering heterogeneity in capital pledgeability, so as not to reinforce structural credit misallocation. This includes unconventional monetary policy aimed at boosting credit supply when policy rates are at their lower bound, as well as macroprudential and fiscal policies affecting borrowing costs.

Capital, collatéral et mésallocation du crédit

RÉSUMÉ

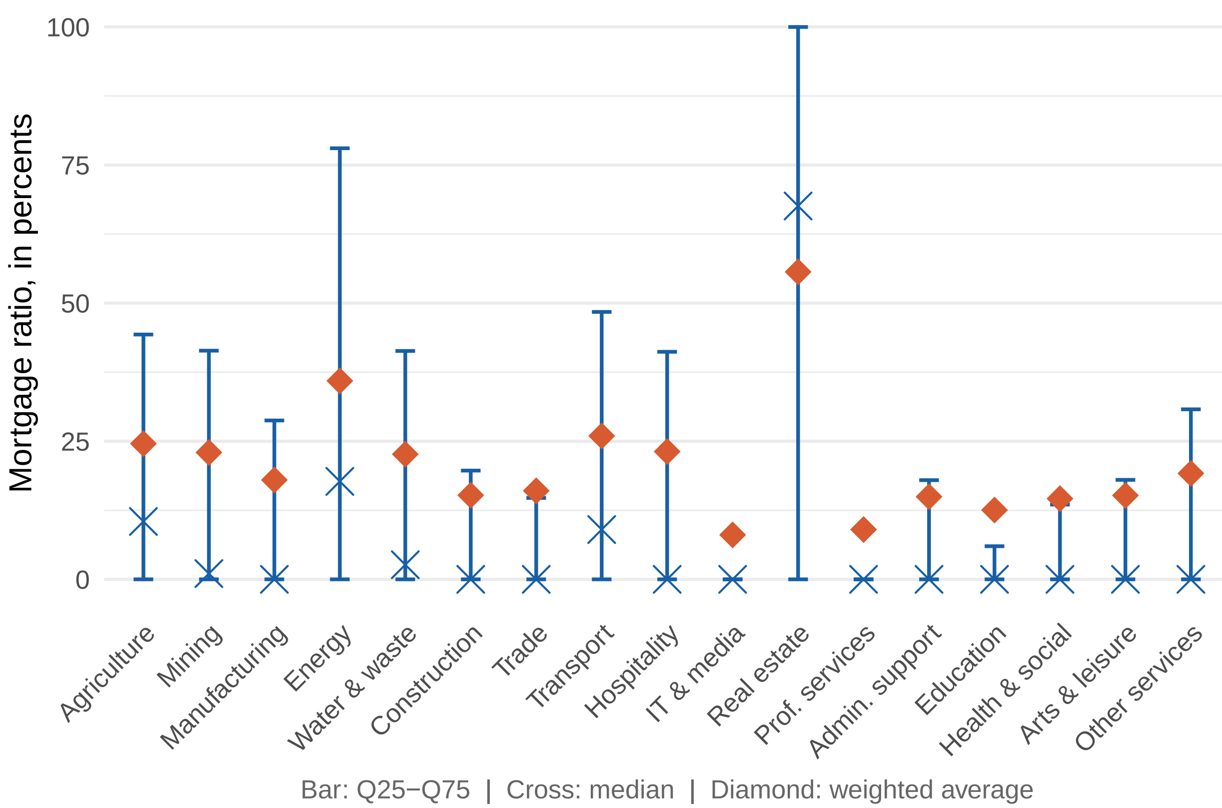
Cet article étudie comment la capacité du capital à être mobilisé comme collatéral façonne son allocation. L'article montre, d'abord à partir de données françaises, que les entreprises qui détiennent un capital utilisé comme collatéral sont structurellement plus endettées. L'investissement de ces entreprises est également plus sensible aux chocs d'offre de crédit. L'analyse intègre ensuite cette hétérogénéité dans un modèle d'équilibre général avec des contraintes d'endettement. Cette caractéristique engendre une allocation inefficiente du capital entre secteurs : les actifs les plus aisément mobilisables comme collatéral coûtent moins cher à accumuler, et présentent donc un rendement espéré plus faible que les autres, tant à l'état stationnaire qu'en réponse à des chocs d'offre de crédit. Le modèle est estimé en distinguant l'immobilier commercial des autres types de capitaux, le premier étant plus facilement mobilisable comme collatéral. Cette estimation montre que l'allocation du capital est inefficiente tout au long du cycle du crédit. Parce que ces capitaux sont des substituts imparfaits et que les entreprises font face à un taux d'intérêt unique, des politiques de crédit redistributives améliorent le bien-être, en particulier lorsqu'elles sont mises en œuvre au cours d'une phase d'expansion du crédit.

Mots-clés : collatéral, allocation du capital, politiques de crédit.

1 Introduction

The role of financial frictions in shaping investment dynamics has been a long-standing question in economics. This paper contributes to this strand of research by highlighting that capital goods differ in their pledgeability. In the event of default, some of these goods, such as office buildings, can be readily redeployed by other firms, limiting liquidation discounts and making them effective collateral in credit contracts. By contrast, firm-specific capital, such as machines or patents, suffer large liquidation discounts and are therefore less widely used as collateral. Figure 1 illustrates this heterogeneity by plotting the mortgage ratio — the share of bank credit explicitly collateralized — of French non-financial firms. Commercial Real Estate (CRE) investors, *i.e.*, firms specializing in supplying real estate to other firms, stand out as owning particularly pledgeable capital: their median mortgage ratio exceeds 50%, far above that of most other non-financial sectors. Within other sectors, such as energy or transport, a sizeable share of firms reaches comparable mortgage ratios. This paper exploits this variation to study how differences in pledgeability shape capital accumulation and its allocation across firms.

Figure 1: Mortgage ratio of French non-financial firms (2019–2024)



Note: The mortgage ratio is defined as the share of bank credit that is explicitly collateralized. Bars represent the interquartile range, the horizontal line the median, and the diamond the average, weighted by the log of total assets. Source: AnaCredit France.

Leveraging the French firm-level data underpinning Figure 1, I document that firms holding more pledgeable assets are structurally more leveraged and display greater sensitivity of investment to credit supply shocks. I then introduce heterogeneous capital pledgeability in a general equilibrium model with two types of capital goods producers who borrow, subject to collateral constraints. I show that this feature creates dispersion in expected capital returns both at the steady state and along the credit cycle, which—because capital types are imperfect substitutes—translates into sectoral misallocation. I estimate the model based on a simple distinction between CRE and other types of capital goods, the former being more pledgeable. I then show that misallocation is sizable. Because these capital goods are imperfect substitutes and firms face a unique interest rate, redistributive credit policies taxing debt issued by high-pledgeability firms while subsidizing that of less pledgeable firms raise welfare. Although these policies decrease the overall level of capital, they improve its allocation. This is particularly beneficial in the expansion phase of a credit cycle but less so in a contraction phase.

I proceed in four steps. I first present stylized facts on firms' balance sheet structure and credit-sensitivity depending on the capital pledgeability. To do so, I construct a dataset documenting French firms' balance sheet structure and credit conditions. The first source for this dataset is Fiben, a database gathering financial accounts, financial links, and credit ratings of a large sample of French non-financial firms collected by the French central bank. The second source is AnaCredit France, a loan-level credit register of French banks provided by the French central bank. I aggregate this data at the firm level and merge it with Fiben data. Using the resulting dataset, I show that the mortgage ratio is positively correlated with leverage across firms and sectors. Moreover, firms with more pledgeable assets display a stronger correlation between investment and credit supply shocks than other non-financial firms.

Second, building on these stylized facts, I construct a simple general equilibrium model with two types of capital goods producers. In the model, final goods producers combine three inputs that are imperfect substitutes: *(i)* labor that they rent from households, *(ii)* low-pledgeable capital, and *(iii)* high-pledgeable capital. These two types of capital are accumulated by distinct capital goods producers, subject to investment adjustment cost. Both types of capital goods producers are owned by households, finance capital accumulation through retained earnings and debt, yet face financial frictions: lenders impose a borrowing constraint in which firms' capital stock serves as collateral (Kiyotaki and Moore, 1997). These types of capital goods producers differ in the tightness of the borrowing constraint, which can be rationalized by the liquidation discount carried by the type of capital they accumulate. I then show analytically that this heterogeneity in pledgeability generates a spread in expected marginal products of capital—both at the steady state and in response to credit supply shocks—thereby creating sectoral misallocation.

I then estimate a quantitative version of the above model, based on a simple distinction between CRE and other types of capital goods. The difference in capital pledgeability generates sizable capital misallocation, as measured by spreads between capital-specific expected marginal products. At the steady state, the overall funding cost of CRE producers is lower than that of other types of capital goods producers, because looser financial constraints allow them to finance a larger share of capital accumulation with debt rather than with costly equity, enabling them to sustain a larger capital stock at a lower expected return. In addition, in the face of an exogenous increase in credit supply, the spread in expected returns widens further. Recovering estimated credit supply shocks, I simulate a realistic credit cycle. This exercise matches well historical evidence on sectoral heterogeneity in asset prices and credit allocation (Ivashina et al., 2024; Müller and Verner, 2024).

Because the two types of capital are imperfect substitutes and firms face a unique interest rate, I finally show that these heterogeneous sectoral dynamics are not efficient. In particular, I compute welfare gains associated with redistributive taxes on debt across capital production sectors. Taxing debt issued by CRE producers to subsidize debt issued by other types of capital goods producers is welfare-improving, as it reallocates resources toward the most financially constrained sector, thereby increasing the consumption-to-labor ratio. Welfare gains are maximized for a tax equivalent to an 80-basis-point increase in the interest rate charged to CRE producers, which enables a subsidy of around 40 basis points to other capital goods producers. Considering different transition scenarios, welfare gains are maximized when the policy is implemented during a credit expansion: it leans against the rise in misallocation and thus ensures a more efficient use of resources, on top of moving the economy toward a more efficient steady state.

These findings have two important policy implications. First, they underline the importance of *sectoral* misallocation, while the literature has been mostly focused on *idiosyncratic* misallocation—see for instance David and Venkateswaran (2019). Although both phenomena can coexist and be equally important, policy implications are more straightforward for the former, as targeted firms are more easily identifiable by the pledgeability of their assets. Second, these findings highlight that designing credit policies requires considering heterogeneity in capital pledgeability, so as not to reinforce structural credit misallocation. This includes notably unconventional monetary policy implemented when deposit interest rates were at their effective lower bound to boost credit supply, as well as macroprudential policies or fiscal programs, such as tax rebates on interest payments.

Literature review. This paper contributes to three strands of literature. It first contributes to the literature on the financial accelerator and the role of collateral in shaping investment dynamics (Kiyotaki and Moore, 1997; Bernanke et al., 1999; Chaney et al., 2012; Liu et al., 2013; Hericourt et al., 2024). Existing work typically considers a representative corporate sector subject to collateral shocks (Jermann and Quadrini, 2012; Iacoviello, 2015; Becard and Gauthier, 2022). I depart from this framework by introducing sectoral heterogeneity in capital pledgeability and focusing on credit supply shocks, following Justiniano et al. (2019) and Ferrero et al. (2024). In doing so, the paper also relates to a broader literature emphasizing the role of firm heterogeneity in the transmission of financial shocks to investment (Ottonello and Winberry, 2020; Drechsel, 2023; Jeenas et al., 2023; Drechsel et al., 2025). I show that capital pledgeability constitutes a key dimension of such heterogeneity, giving rise to a *sectoral* financial accelerator, with firms holding highly pledgeable assets responding more strongly to shifts in credit conditions. This mechanism notably helps rationalize evidence that credit to real estate investors is particularly procyclical (Duca and Ling, 2020; Berg et al., 2023; Ivashina et al., 2024; Müller and Verner, 2024) and highlights how heterogeneous pledgeability generates aggregate capital misallocation.

The paper also contributes to the literature on capital misallocation by highlighting heterogeneous capital pledgeability as a source of misallocation. Resource misallocation has been extensively studied—see Hopenhayn (2014) and Restuccia and Rogerson (2017)—and has become increasingly prominent in the business-cycle literature after two decades of low investment and growth despite historically low interest rates (OECD, 2025). A first set of studies highlights how credit expansion can create *intra-sectoral* misallocation by tilting production toward low-productivity firms (Aghion et al., 2019; Albuquerque, 2024; Asriyan et al., 2025; González et al., 2024a,b). My paper is closer to a second set that focuses on *cross-sectoral* misallocation. Bleck and Liu (2018) study a two-sector economy with heterogeneous financial frictions and show that excessive credit expansion can crowd out the most financially constrained sector. Within this strand, Hirano and Stiglitz (2025) show in a two-sector model how credit policy design affects long-term growth by feeding land speculation at the expense of productive investment. The contribution of this paper is to identify heterogeneous capital pledgeability as a distinct and empirically grounded source of sectoral misallocation, to study it at business-cycle frequency, and to characterize the optimal design of corrective policy.

This paper finally contributes to the literature on macroprudential policy (Mendoza, 2010; Bianchi, 2011). Following the Global Financial Crisis (GFC) in 2008, the literature has shown how macroprudential tools can stabilize household consumption in the face of household boom-bust credit cycles generating pecuniary externalities (Ferrero et al., 2024). The relevance of macroprudential policies for non-financial firms in closed economies has been less studied. Muñoz and Smets (2022) focus on the regulation of real estate investors as a potential leakage channel for residential macroprudential regulations. Drechsel and Kim (2024) argue that the shape of firms' borrowing constraints is essential for macroprudential policy design. This paper instead emphasizes firm-level sectoral heterogeneity in pledgeability creates misallocation, thereby constituting a motive for macroprudential intervention, on top of standard pecuniary externality motives.

The rest of the paper is structured as follows. Section 2 presents stylized facts on firms' balance sheet structure and credit sensitivity as a function of capital pledgeability. Section 3 introduces a general equilibrium model featuring heterogeneous capital pledgeability and derives analytical results on sectoral misallocation. Section 4 studies sectoral capital allocation in an estimated quantitative version of the model. Section 5 assesses the efficiency of redistributive sectoral taxes on credit. Section 6 concludes.

2 Stylized facts

This section presents some stylized facts on capital pledgeability by combining the financial accounts of French non-financial firms and the corporate credit registers of French banks. I show that firms with a higher mortgage ratio are more leveraged and display a stronger sensitivity of their investment to credit supply shocks than other non-financial firms.

2.1 Data and credit supply shocks

I build a yearly firm-level dataset ranging 2019 to 2024 by combining two data sources. The first source is Fiben (*Fichiers Bancaires des Entreprises*), a database gathering financial accounts and credit ratings of a large sample of French firms collected by the French central bank. The sample covers firms with more than 750,000 euros of sales and represent approximately 70% the value added of French firms. I retrieve from this data source some identification variables: the national identification number (SIREN), age, 5-digit NACE sector code, and whether the firm is part of a corporate group. I also retrieve a number variables linked to firms' balance sheets and income statement: sales, value added, Earning before Interests, Taxes, Depreciation and Amortization (EBITDA), net result, total assets, fixed assets[1], fixed physical assets, liquid assets, equity, total financial debt, financial debt with a residual maturity below one year. Finally, I also retrieve credit ratings produced by the French central bank. These credit ratings are based on accounting documents and more qualitative information, such as individual interviews conducted by analysts with firms' managers. These credit ratings feature 12 categories (21 since 2022) and are updated at least annually.

The second source is AnaCredit France (Analytical Credit Datasets), a credit register of French banks collected by the French central bank, and which is part of a broader Eurosystem database. This database records at a monthly frequency any credit instrument granted by a French bank to a moral person since 2019, for all credit relationships exceeding 25,000 euros. I only keep end-of-year observations to match the frequency of the Fiben data. I retrieve three variables from this dataset. The first two variables provides information on the relation between a loan and the underlying capital of the firm: the mortgage ratio (the firm-level share of credit explicitly guaranteed by physical capital) and the recourse ratio (the firm-level share of credit for which the bank can seize assets other than those used as guarantees). The third variable is an idiosyncratic bank credit supply shock, computed following the methodology of Amiti and Weinstein (2018). More specifically, I estimate a weighted least squares regression of credit growth at the bank-firm level, on bank-year and firm-year fixed effects. Credit growth is computed as the mid-point growth rate and observations are weighted by the average of present and lagged outstanding credit, following Beaumont et al. (2019), to account for new credit relationships. To ensure the identification of both sets of fixed effects, the sample is restricted to firms borrowing from at least two banks and banks lending

[1]Fixed assets include financial assets (*e.g.* participations), non-financial non-physical assets (*e.g.* patents) and non-financial physical assets (*e.g.* real estate).

to at least five firms. I retrieve bank-year fixed effects, which can be interpreted as idiosyncratic bank credit supply shocks.[2] I then compute the firm-level average of these shocks, weighting them by the average of present and lagged outstanding credit, and express them in standard deviations.[3]

I finally merge these two datasets at the firm-year level. I transform the resulting dataset in several ways. I exclude from the sample the following sectors: financial services, public administration, and residential real estate investors. I keep only firms with strictly positive sales, non-financial fixed assets, equity and debt. I winsorize all variables at the top and bottom 1% of the year-by-year distribution, except for age and size which I winsorize at the top 1%. The resulting variables are summarized in Table 5, while Figure 8 plots the distribution of credit supply shocks (see Appendix A).

2.2 Fact 1: There is a positive correlation between the mortgage ratio and leverage

I first investigate the link between capital pledgeability, as measured by the mortgage ratio, and the level of leverage a firm can take on.[4] To do, I estimate the following equation:

$$l_{it} = \alpha_t + \beta\theta_{it} + Z'_{it}\gamma + \eta_{it} \tag{2.1}$$

l_{it} denotes leverage of firm i at time t, θ_{it} is the mortgage ratio, while α_t denotes year fixed effects which excludes cyclical variations to focus on structural cross sectoral heterogeneity. To control for confounding factors, I include a number of additional variables included in Z'_{it}: age, log of total assets, operating return on assets (defined as earnings over lag total assets), net return on assets, liquidity (cash over sales), short-term debt (share of financial debt with a residual maturity below one year), credit rating and the recourse ratio. I also estimate a version of the equation adding sector as control, so as to investigate the role of pledge ability *within* a sector. η_{it} is the error term. Standard errors are clustered at the firm level.

Results are reported in Table 1. Columns (1)-(3) present the result with leverage defined as financial debt over total assets. Columns (4)-(6) present the result with leverage defined as financial debt over financial debt plus equity. Controlling for years only, a one percent higher mortgage ratio is associated with a 6 to 8 basis point higher leverage. Controlling for other confounding factors, notably credit rating and profitability, the relationship remain significative, with a point estimate of 3 to 5 basis points. Even within a given sector this relationship remains significative, with 2

[2] Altavilla et al. (2022) shows using a structural model that this methodology provides a plausible estimate of credit supply shocks, while it is less reliable for credit demand shocks.

[3] Note that the credit supply shocks I recover are thus *idiosyncratic*, while the credit supply shock I introduce in a general equilibrium in the next sessions is *macroeconomic*. This slight inconsistency comes from the fact that identifying a macroeconomic credit supply shock at the frequency of firms' *yearly* accounts is particularly difficult. I thus rather rely on a large-cross section of banking relations data to identify this class of shocks.

[4] Note that the mortgage ratio measures *pledged* capital rather that *ex ante* capital pledgeability *per se*. However, the alternative for a firm is to resort to a recourse loan that exposes the whole asset of the firm to lenders' seizure in case of default, or to a non-recourse loan with higher interest rate. Therefore, if they can, firms usually prefer to resort to a mortgage, such that the mortgage ratio can be regarded as a reliable albeit imperfect measure of pledgeability.

to 4 basis points estimate. Note that this relationship could be blurred by non-financial groups that divide their capital in multiple entities but whose situation is assessed at the results. These findings are nonetheless robust to the exclusion of firms that are part of a non-financial groups (cf. Table 6 in Appendix A).

Table 1: Mortgage ratio and leverage

	Dependent variable:					
	Debt / total assets			Debt / debt and equity		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	20.785***	11.434***	23.851***	33.508***	20.226***	28.236***
	(0.048)	(0.293)	(0.388)	(0.066)	(0.382)	(0.484)
Mortgage ratio	0.076***	0.054***	0.039***	0.056***	0.032***	0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Firm-level controls	No	Yes	Yes	No	Yes	Yes
Sectoral dummy	No	No	Yes	No	No	Yes
Observations	1,148,930	970,465	970,465	1,148,930	970,465	970,465
R^2	0.024	0.202	0.277	0.014	0.284	0.315

*Note: clustered standard errors at the firm level (in parenthesis); *p<0.1; **p<0.05; ***p<0.01*

Overall, these findings indicate that the composition and the level of credit are tied. In particular, all other things being equal, a firms displaying more pledgeable capital is able to sustain higher leverage. Although the set of controls used in these controls is rather large, this correlation cannot be interpreted as causation. In particular, it is possible that the relations is biased by omitted variables or reverse causation. In the next subsection, I use the dynamic response of firms to credit supply shocks to show that owning high-pledgeable capital enables to take on more debt.

2.3 Fact 2: Firms with a higher mortgage ratio are more responsive to credit supply shocks

I investigate the role of capital pledgeability in influencing the reaction of investment to credit supply shocks. To do so, I estimate the following equation:

$$\Delta K_{it} = \alpha_i + \alpha_{st} + \beta_0 \theta_{it-1} + \beta_1 \varepsilon_{it} + \beta_2 \left(\varepsilon_{it} \times \theta_{it-1} \right) + Z'_{it}\gamma + \eta_{it} \tag{2.2}$$

ΔK_{it} denotes capital growth, ε_{it} is the idiosyncratic bank credit supply shock estimated following Amiti and Weinstein (2018), θ_{it-1} is the lagged mortgage ratio, α_t denotes year fixed effects, while α_i denotes firm fixed effects. As in the previous subsection I include the operating return on assets, the net return on assets, the liquidity ratio, the short-term debt ratio, credit ratings and recourse ratio. η_{it} is the error term. Standard errors are clustered at the firm level.

Results are reported in Table 2. Columns (1)-(2) present the results with a broad definition of capital, computed as the the change in fixed assets over lagged total assets. Columns (3)-(4) presents the results with a with a narrower definition of capital, compute as the change in physical assets over lagged total assets. Across all specifications, a one standard deviation idiosyncratic credit supply shock yields no effect on investment for firms with a mortgage ratio of zero. Taking the extreme case of a firm with a mortgage ratio of one yields a very different picture: a one standard deviation credit supply shock yields a 0.3 to 0.5 percentage points increase in capital growth. This is statistically and economically significant, given that the median capital growth rate was of -0.2/-0.3% over the period (see Table 5 in Appendix A). Note that this relationship could be blurred by non-financial groups that divide their capital in multiple entities but whose situation is assessed at the results. These findings are nonetheless robust to the exclusion of firms that are part of a non-financial groups (cf. Table 7 in Appendix A).

Table 2: Mortgage ratio and investment

	Dependent variable:			
	Fixed assets		Physical assets	
	(1)	(2)	(3)	(4)
Credit supply	-0.006	0.012	0.006	0.013
	(0.014)	(0.014)	(0.010)	(0.010)
Credit supply × Mortgage ratio	0.468^{***}	0.431^{***}	0.332^{***}	0.310^{***}
	(0.045)	(0.047)	(0.036)	(0.037)
Firm controls	No	Yes	No	Yes
Observations	821,620	735,455	821,620	735,455
R^2	0.312	0.332	0.304	0.323

Note: clustered standard errors at the firm level (in parenthesis); *p<0.1; **p<0.05; ***p<0.01

Overall, these findings indicate that firms owning pledgeable capital display a greater sensitivity of their investment to credit supply shocks. Because they can put more capital as collateral, these firms capture the credit expansion, while those who cannot are limited by the leverage constraint imposed by firms. Capital pledgeability is thus a cental for the allocation of capital across firms. To study the macroeconomic implications of these stylized facts, I build in the next section a general equilibrium model with capital goods producers diplaying heterogeneous capital pledgeability.

3 Model

This section introduces a real business cycle (RBC) model with heterogeneous capital goods producers facing different level of credit constraints. These firms produce capital types which are imperfect substitutes combined by final goods producers. Households supply labor to final goods producers and funds to financial intermediaries. In turn, financial intermediaries supply credit to capital goods producers, subject to time-varying constraints, giving rise to credit supply shocks as in Justiniano et al. (2019) and Ferrero et al. (2024). I present the problem of each agent in turn before analyzing the effects of heterogeneous capital pledgeability on expected capital returns.

3.1 Capital goods producers

capital goods producers are operated by two types of entrepreneurs, denoted $e \in \{L, H\}$. They supply a type-specific good X_{et} through a linear production function:

$$X_{et} = K_{et-1} \tag{3.1}$$

Where K_{et} denotes capital. The law of motion of this capital is then:

$$K_{et} = (1-\delta)K_{et-1} + \left[1 - \frac{\varphi_e}{2}\left(\frac{I_{et}}{I_{et-1}} - 1\right)^2\right] I_{et} \tag{3.2}$$

Where I_{et} denotes investment, and δ is the depreciation rate of capital. I assume homogeneous depreciation rates across capital types. This assumption is made for simplicity and because heterogeneous depreciation rates are compensated by tax rebates (at least partially).[5] $\varphi_e \in \mathbb{R}^+$ controls for the strength of investment adjustment costs, as in Christiano et al. (2005). I allow this parameter to be type-specific, meaning that capital types can differ in productivity. The resulting market value of capital Q_{et} is then determined in equilibrium as the Lagrange multiplier associated to the law of motion of capital.

The entrepreneurs can fund themselves in two ways: they can use internal resources by reducing dividend payments d_{et},[6] and issue inter-period risk-free bonds B_{et} with gross interest rates $1 + r_t$. Following Hart and Moore (1994) and Kiyotaki and Moore (1997), I assume that entrepreneurs have inalienable human capital. If they leave the project, the value of capital is then liquidated at a discount. Financial intermediaries then limit the value of lending to this discounted value of capital. Entrepreneurs thus face the following borrowing constraint:

$$B_{et} \leq \theta_e Q_{et} K_{et} \tag{3.3}$$

Where $\theta_e \in (0, 1)$ can be interpreted as the liquidation discount or the share of capital that can be pledged in a credit contract, and therefore captures capital pledgeability. In line with the empirical evidence in section 2, I assume that the two types of capital produced have different levels of

[5]This boils down to assume that there is a fiscal authority which pays a subsidy on capital that depreciates more quickly, financed through non distortive lump-sum taxes on households, such that the effective depreciation rate is equal across sectors.

[6]Negative dividend then captures equity injection.

pledgeability, and that, without loss of generality, $\theta_H > \theta_L$.[7] This assumption echoes Bleck and Liu (2018), which introduces heterogeneously pledgeable cash flows in a simple three-period model.

The last constraint entrepreneurs face is a budget constraint:

$$d_{et} + (1 + r_{t-1})B_{et-1} + I_{et} \leq r_{et}X_{et} + B_{et} \tag{3.4}$$

Where r_{et} denotes the rental rate of capital, determined on a perfectly competitive market. Finally, the entrepreneur faces an exogenous survival probability γ, as in Gertler and Kiyotaki (2010). When she exits, she joins back the representative household she is replaced by another entrepreneur of the same type. I show below that this features creates a preference of firms for debt over equity, leading to a binding borrowing constraint at the steady state.[8] The entrepreneur maximizes the flow of discounted dividends on behalf of households:

$$\mathcal{V}_{et} = \mathbb{E}_t \sum_{j=0}^{\infty} \gamma^j \Lambda_{t,t+j} d_{et+j} \tag{3.5}$$

Where $\Lambda_{t,t+j}$ is households' stochastic discount factor of period $t+j$ at period t, which the capital good producer takes as given.[9]

3.2 Final goods producers

The representative final good producer rents labor and the capital goods described above to produce goods consumed by households. The production function takes the form of embedded Constant Elasticity of Substitution (CES) functions. At the first stage, the two types of capital goods are combined into a capital bundle X_t, with elasticity of substitution $1/(1-\omega)$ where $\omega \in (-\infty, 1)$:

$$X_t = \left(\nu X_{Ht}^{\omega} + (1-\nu) X_{Lt}^{\omega}\right)^{\frac{1}{\omega}} \tag{3.6}$$

And with $\nu \in (0,1)$ the relative weight of the high-pledgeable type in the aggregate capital bundle. This capital bundle is then combined with labor N_t following a standard Cobb-Douglas technology with elasticity of substitution $\alpha \in (0,1)$, such that output is:

$$Y_t = X_t^{\alpha} N_t^{1-\alpha} \tag{3.7}$$

[7] An alternative modeling would be the costly state verification framework of Bernanke et al. (1999), allowing for heterogeneity in the recovery value of capital. This would enable to distinguish pledgeability from leverage, which are the same objects in the Kiyotaki and Moore (1997) framework, but would unnecessarily complexify analytical derivations in the next subsections.

[8] Alternatively, the macro-finance literature assumes a tax rebate on interest payment to break the Modigliani-Miller theorem—see Jermann and Quadrini (2012) for instance. The tradition I follow implies that the failure of the theorem lays in a structural parameter, rather that in the design of the tax system. This is of particular interest for this paper, as it will investigate welfare-maximizing corporate taxes.

[9] The one-period ahead stochastic discount factor is $m_{t,t+1} = \Lambda_{t,t+1}/\Lambda_{t,t}$.

Labor is rented by final goods producers to households at wage w_t, and the two types of capital at rate r_{et}, $e \in \{L, H\}$. The profit function final goods producers maximize is thus:

$$\Pi_{ct} = Y_t - r_{ct}X_{ct} - r_{ht}X_{ht} - w_t N_t \tag{3.8}$$

3.3 Financial intermediaries

To discuss the effect of credit supply shock in the model, I introduce a simple pass-through financial intermediary that faces an exogenous and time-varying balance sheet constraint, following the recent macro-finance literature on residential real estate (Justiniano et al., 2019; Ferrero et al., 2024). The representative financial intermediary issues two instruments bought by households: deposits D_t (borrowed at rate r_{dt}) and securities S_t (borrowed at rate r_{st}). This financial intermediary grants credit B_t capital good producer, irrespective of their types. Her balance sheet is thus the following:

$$B_t = S_t + D_t \tag{3.9}$$

In addition, she faces an exogenous and time-varying balance sheet constraint κ_t:

$$S_t \geq \kappa_t B_t \tag{3.10}$$

With $\kappa_t = \kappa + \zeta_{\kappa t}$, where $\zeta_{\kappa t}$ is an AR(1) process:

$$\zeta_{\kappa t} = \rho_\kappa \zeta_{\kappa t-1} + \varepsilon_{\kappa t} \tag{3.11}$$

Where $\varepsilon_{\kappa t}$ is an exogenous shock and $\rho_\kappa \in (0, 1)$ controls for the persistence of the shock. Because of portfolio adjustment cost at the household level introduced below, $r_{st} \geq r_{dt}$. It is thus less costly for financial intermediaries to collect deposits than to issue securities. The balance sheet constraint thus binds in equilibrium and directly affects credit spreads charged by financial intermediaries.

Given these constraints, the financial intermediary maximizes the following profit function:

$$\Pi_{bt} = r_t B_t - r_{st} S_t - r_{dt} D_t \tag{3.12}$$

Rewriting this function using the balance sheet and leverage constraints yields the following optimality condition:

$$r_t = (1 - \kappa_t) r_{dt} + \kappa_t r_{st} \tag{3.13}$$

Changes in the balance sheet constraint then capture credit supply shocks that move the spreads charged by intermediaries independently of borrowers' credit risk. This simple modeling choice deliberately abstracts from several features central to financial intermediation, including maturity transformation and interest rate risk. As a result, κ_t should be interpreted broadly: it captures any shift in interest rates that goes beyond (expected) movements in the short-term risk-free rate. This includes long-term interest rate risk (*i.e.*, the term premium), changes in intermediaries' risk aversion, or credit policies that affect lending costs without directly altering discount rates. This paper does not aim to provide a full evaluation of each of these shocks, but instead focuses on the transmission mechanism through which this class of shocks affects the real economy.

3.4 Households

The representative household consumes C_t units of the final good and supplies labor N_t to final goods producers. In addition, she saves through two financial instruments: deposits D_t and securities S_t, both issued by financial intermediaries. Security holding is subject to portfolio adjustment costs, capturing their illiquid and risky nature. This adjustment cost is controlled by the parameter $\psi \in \mathbb{R}^+$. Moreover, the households collect the dividends of all firms Π_t. The household thus faces the following budget constraint:

$$C_t + D_t + S_t + \frac{\psi}{2}\left(\frac{S_t}{\bar{S}_t} - 1\right)^2 \bar{S}_t \leq w_t N_t + (1 + r_{dt-1})D_{t-1} + (1 + r_{st-1})S_{t-1} + \Pi_t \tag{3.14}$$

Where $\bar{S}_t$ is the target level of securities that the household takes as given. For simplicity, I set $\bar{S}_t = \kappa B_t$. As I will demonstrate below, this functional form implies that credit spreads moves if and only if there is a change in the balance sheet constraint of financial intermediaries, as in Ferrero et al. (2024).

The household derives utility from consumption, with risk-aversion $\sigma \in \mathbb{R}^+$. In addition, she derives disutility from labor, controlled by parameters $\chi \in \mathbb{R}^+$ and $\eta \in \mathbb{R}^+$:

$$U(C_t, N_t) = \frac{1}{1-\sigma} C_t^{1-\sigma} - \frac{\chi}{1+\varphi} N_t^{1+\varphi} \tag{3.15}$$

Each period, the household maximizes lifetime utility with discount rate $\beta \in (0, 1)$:

$$\mathcal{V}_t = \mathbb{E}_t \sum_{j=0} \beta^j U(C_{t+j}, N_{t+j}) \tag{3.16}$$

Hence the following stochastic discount factor for interest payments of period $t + j$ at period t:

$$\Lambda_{t,t+j} = \beta^j \mathbb{E}_t C_{t+j}^{-\sigma} \tag{3.17}$$

3.5 Shocks and equilibrium

The only shock hitting this economy is the credit supply shock $\zeta_{\kappa t}$ introduced above. A competitive equilibrium in this economy is defined as a sequence of prices and quantities such that for a given sequence of prices, the first-order conditions of all agents and sectors are satisfied, and for a given sequence of quantities, prices adjust so that all markets clear. In particular, the credit market clears:

$$B_t = B_{Ht} + B_{Lt} \tag{3.18}$$

The resource constraint writes as follows:

$$Y_t = C_t + I_{Ht} + I_{Lt} + \frac{\psi}{2}\left(\frac{S_t}{\bar{S}_t} - 1\right)^2 \bar{S}_t \tag{3.19}$$

3.6 Heterogeneous capital pledgeability and capital allocation

In this subsection, I show in the model how heterogeneity in capital pledgeability shapes capital allocation. To do so, I first look at capital supply. The first order condition of entrepreneurs with respect to capital yields the following equation for capital supply:

$$Q_{et} = \mathbb{E}_t \gamma m_{t,t+1}\Big((1-\delta)Q_{et+1} + r_{et+1}\Big) + \theta_e \mu_{et} Q_{et} \tag{3.20}$$

Where μ_{et} is the Lagrange multiplier associated to the borrowing constraint, and can be interpreted as the shadow cost of debt. Consider also credit demand:

$$\mu_{et} = 1 - \mathbb{E}_t \gamma m_{t,t+1}(1 + r_t) \tag{3.21}$$

Note that although capital supply is type-specific (explicitly because of θ_e and implicitly because of φ_e that feeds into Q_{et}), credit demand is not. This is at the root of credit misallocation, as fund demand is type-specific, while fund supply is not: there is only one interest rate but two fund demands curve. To see this, combine the two equations:

$$\underbrace{(1-\theta_e)Q_{et}}_{\text{Cost}} = \underbrace{\mathbb{E}_t \gamma m_{t,t+1}\Big((1-\delta)Q_{et+1} + r_{et+1} - \theta_e(1+r_t)Q_{et}\Big)}_{\text{Benefit}} \tag{3.22}$$

The cost of investment today is diminished by the amount of debt the investor can take on. The benefit next period is equal to underappreciated capital at market value, plus its marginal product, minus the share of the investment financed through debt that has to be repaid. The discount factor $m_{t,t+1}$ and the lending rate $1 + r_t$ are common across types, while rental rates and capital prices are not. I then derive expressions that tie type-specific expected capital returns $\mathbb{E}_t r_{et+1}$ to pledgeability θ_e.

Let's start with the steady state. Credit demand can be expressed as:

$$\mu_e = 1 - \gamma m(1+r) = 1 - \gamma\beta \times \frac{1}{\beta} = 1 - \gamma \tag{3.23}$$

Because $\gamma < 1$, the cost of credit is lower than the cost of equity, so $\mu_e > 0$ and the borrowing constraint binds. Capital supply can then be expressed as:

$$1 - \delta + r_e = \frac{1-(1-\gamma)\theta_e}{\gamma\beta} \Longrightarrow r_e = \frac{\gamma_e}{\beta} - 1 + \delta \tag{3.24}$$

Where $\gamma_e = \frac{1-(1-\gamma)\theta_e}{\gamma}$ is the type-specific discount rate and is decreasing with capital pledgeability θ_e. The higher is pledgeability, the lower is expected capital return, as the firm can fund its investment with debt, which is cheaper than the expected dividend return. Put differently, because higher pledgeability enables firms to benefit more from the relatively low credit costs, compared to equity costs, entrepreneurs to accumulate more capital. Because $\theta_H > \theta_L$, $\gamma_H < \gamma_L$, there is a capital return spread:

$$r_L - r_H = \frac{\gamma_L - \gamma_H}{\beta} > 0 \tag{3.25}$$

In the model I study, because H-entrepreneurs are less constrained, it is more efficient to focus capital accumulation on this sector, leading to lower marginal productivity for this type of capital, leading to heterogeneity in expected returns.

This statement is also valid out of steady state. To show this, I log-linearize the above equations around the deterministic steady state. Variables with a hat denote percent deviation from steady state, except for returns and Lagrange multipliers, which are in percentage point deviation from steady state. I first show that the credit spread is purely exogenous in the model. More formally, normalizing $\psi = \frac{1}{(1+r)\kappa}$, I show that $\hat{r}_t - \hat{r}_{dt} = \hat{\kappa}_t$ (see Appendix B). Using this result, I log-linearize equation (3.22):

$$\hat{Q}_{et} = \hat{m}_{t,t+1} + \frac{1}{1-\delta+r_e-\theta_e(1+r)}\left((1-\delta)\hat{Q}_{et+1} + \hat{r}_{et+1} - \theta_e\hat{r}_{dt} - \theta_e\hat{\kappa}_t - \theta_e(1+r)\hat{Q}_{et}\right) \tag{3.26}$$

As $\hat{r}_{dt} = -(1+r)\hat{m}_{t,t+1}$ and $1-\delta+r_e = \gamma_e/\beta$, re-arranging this expression yields:

$$\mathbb{E}_t\hat{r}_{et+1} = \underbrace{\theta_e}_{\text{Direct exposure}}\hat{\kappa}_t + \underbrace{\frac{1-(1-\gamma)\theta_e}{\gamma\beta}}_{\text{Discount rate}}\left(\hat{Q}_{et} - \mathbb{E}_t\hat{m}_{t,t+1}\right) - (1-\delta)\mathbb{E}_t\hat{Q}_{et+1} \tag{3.27}$$

This expression shows that capital pledgeability affects the dynamics of expected returns through two channels. The first channel is direct exposure to the credit supply shock κ_t: higher pledgeability means a funding mix titled towards debt, hence a greater sensitivity to credit supply shock. The second is the discount rate, which alters the transmission of capital price and discount rate to expected returns. Higher pledgeabiliy means a lower correlation between these variables and expected returns: by tilting funding towards debt, higher pledgeability insulates capital accumulation from shifts in the discount rate and capital prices. Put differently, high pledgeability allows a firm to more easily absorb the increase in discount rate and capital prices through debt. Note that this channel may further amplify the general equilibrium effect of a credit supply shock on capital accumulation. Suppose an expansion in credit supply ($\hat{\kappa}_t < 0$). A high pledgeability firms has then high exposure to the shock, but because of investment adjustment costs, the direct effect is limited by the rise in capital price. However, a high pledgeability firm is also more insulated from this change in capital price, thereby limiting the strength of this rigidity. The reaction of the stochastic discount factor, as for capital prices, can also be mitigated by pledgeability. However, whether it decreases or increases following a credit expansion is less straightforward and depends on the path of consumption, given that $\hat{m}_{t,t+1} = \sigma(\hat{c}_t - \hat{c}_{t+1})$.

By inspecting capital supply, I showed the channel through which required return depends on negatively on capital pledgeability. To go from required return to capital allocation, one has to turn to capital demand. Because entrepreneurs rent their capital on a perfectly competitive market, returns are equal in equilibrium to the marginal product of each capital type. In the case of high-pledgeability capital for instance, and because $X_{et} = K_{et-1}$, capital demand writes as:

$$r_{et} = \nu\Big(K_{et-1}/X_t\Big)^{\omega-1}\alpha\Big(X_t/N_t\Big)^{\alpha-1} \tag{3.28}$$

As long as the elasticity of substitution is finite (*i.e.* $\omega < 1$), the marginal product is a decreasing function of capital. Therefore, a lower expected return is associated to a higher capital stock. All in all, this means that heterogeneous capital pledgeability distort capital allocation and tilt it towards highly pledgeable goods. The next section discuss the magnitude of this distortion by calibrating and estimating the model, taking Commercial Real Estae (CRE) as a typical example of a pedgeable capital good.

4 Capital allocation and credit cycles: the case of commercial real estate

The previous section introduced a sytlized RBC model to discuss the role of heterogeneous pledgeability on capital accumulation and allocation. In this section, I estimate a richer quantitative New Keynesian model based on French data, and on a simple distinction between capital goods: commercial real estate and other types of capital goods. I do so for three reasons. First, as exemplified by Figure 1, commercial real estate firms display a particularly high mortgage ratio, suggesting that the type of capital they hold is an extreme case of pledgeability. Second, this type of capital represents a sizeable proportion of capital owned by firms: in the sample of firms I study in (2), land and constructions accounts for 25% of non-financial fixed assets. Third, this distinction can be found in national accounts, making quarterly estimation feasible. The full model, presented in Appendix C, features standard frictions (consumption habits, price rigidity, variable capital utilization) and shocks (time discounting, cost-push, investment adjustment, monetary policy, fiscal policy, total factor productivity, labor productivity) in the New Keynesian literature (Smets and Wouters, 2007).

4.1 Calibration and estimation

I calibrate a first set of parameters that affects steady state values. The period of the model is a quarter. The discount factor β targets a standard 2% risk-free rate. γ targets a survival rate of 20 years, in line with the median age of French non-financial firms (see Table 5). The intertemporal elasticity of substitution σ is set to 2, and the inverse elasticity of labor supply φ to 1. The capital share α and capital depreciation δ follow Smets and Wouters (2007). For convenience, I choose a Cobb-Douglas production for the capital bundle X_t, by setting the elasticity of substitution ω between CRE capital and standard capital to 0.[10]. The share of CRE in the capital bundle ν is to 0.25, in line with the ratio of land and buildings to non-financial fixed assets in the sample of firms I study in section (2). As discussed in subsection (3.6), a central set of parameters are capital pledgeabilities θ_H and θ_L. As these parameters directly determine the leverage ratio of capital goods producers, this metric consists a natural target. Therefore, I consider the leverage of CRE investors as a good approximation of credit conditions faced by firms when acquiring real estate. In the sample of firms I studied in section (2), this leverage amounts to 65%. I calibrate the leverage of other types of capital to 40%, based on the leverage of firms with no real estate in their assets. This assumption implies a sizable expected capital returns gap, and distorts capital allocation in favor of CRE at the steady state (see Equation 3.25). Finally, up to to the first order, the balance sheet constraint of financial intermediaries κ and households' portfolio adjustment cost ψ only influence the dynamics of spreads in the model, and are thus only scaling factors of credit supply shocks. Calibrated parameters are summarized in Table 3.

Table 3: Calibrated parameters

Description	Parameter	Value	Target/source
Deposit discount factor	β	0.995	2% yearly interest rate
Survival probability	γ	0.9875	Median age of firms (20 years)
Intertemporal substitution	σ	2	Standard
Inverse elasticity of labor supply	φ	1	Standard
Capital share of output	α	0.35	Smets and Wouters (2007)
Capital depreciation	δ	0.025	Smets and Wouters (2007)
CRE and other capital substitution	ω	0	Cobb-Douglas production
CRE share of capital	ν	0.35	$K_H/X = 35\%$
Leverage of CRE	θ_H	0.6	$B_H/K_H = 60\%$
Leverage of other capital	θ_L	0.35	$B_L/K_L = 35\%$
Labor disutility	χ	1	Scaling factor
Financial intermediaries' constraint	κ	0.15	Scaling factor
Portfolio adjustment cost	ψ	0.2	Scaling factor

I estimate the remaining parameters based on eight French data series from 1999:Q1 to 2025:Q4: real GDP per capita, real consumption per capita, nominal interest rates, inflation, hours worked per capita, non-financial firms' credit spread, and two series of real investment per capita by non-financial firms (real estate and others). Real values and inflation are computed based on the deflator of consumption. All quantities are in log differences. The short-term interest rate is the shadow estimate of Krippner (2013), to take into account the zero interest rate period. Credit spread are measured by taking AA corporate bond yields of European firms with a maturity between 5 and

[10]This assumption is made for simplicity and given the lack of micro estimates of this parameter. Sensitivity analysis with respect to this parameter is conduced in particular in Figure 11 in Appendix A

7 years, minus expected policy rates over 5 years as reported by Krippner (2013).[11] The resulting spread is plotted in Figure 9 in Appendix A, along with sectoral investment growth rates. On top of the credit spread shock $\varepsilon_{\kappa t}$ presented in details in the previous section, I estimate the diffusion of standard shocks: sectoral investment ε_{Ht} and ε_{Lt} following Justiniano et al. (2011), labor productivity ε_{nt}, total factor productivity ε_{at}, monetary policy ε_{it}, fiscal policy ε_{gt}, cost-push $\varepsilon_{\mu t}$ and discount ε_{ct}. All of these shocks are normally distributed and generate $AR(1)$ dynamics, except for the cost-push shock, which generates $ARMA(1,1)$ dynamics as in Smets and Wouters (2007). In particular, the non-financial credit supply shock captures slow-moving investment dynamics that are common to both non-financial sectors and correlated with credit growth. Investment shocks then capture more sectoral dynamics, as well as financial shocks unrelated to credit spreads.

The estimation follows a Bayesian approach applied to a first-order linearization of the model around its deterministic steady state, using the Kalman filter and a Monte Carlo Markov Chain with 1,000,000 draws. Computations are performed with the Dynare toolbox (Adjemian et al., 2024). Prior and posterior distributions are reported in Table 4. One striking features is that both investment adjustment costs turn to be relatively low. One reason maybe that my credit spread shock capture slow-moving investment dynamics and investment shocks capture more short-run dynamics, while these studies only use the latter in their estimations, which leads to high adjustment cost to rationalize data. Another striking result is that the CRE investment adjustment cost φ_H is significantly lower than the standard investment adjustment cost φ_L. This can seem surprising, as it is no uncommon in the macroeconomics literature to assume that real estate is in fixed supply (Iacoviello, 2015). This assumption does not well apply to commercial real estate, which proved to be less rigid than other capital types. Indeed, one one hand, CRE capital can be regarded as more costly to scale up, as buildings are less divisible than machines, and require land, which is in fixed supply. However, this applies less to CRE than to residential real estate, as CRE can more easily built in less dense zones. In addition, note that investment adjustment costs also capture the ability to integrate new investment to the existing capital stock. In this regard, it is more difficult for a firm to integrate machines or software to its production process and thus its effective capital stocks, while the addition of a new building in the portfolio of a CRE investor does not require such effort. In addition, CRE can be built in less dense zones, while there seem to be a more pronounced demand for central zones on the residential real estate market. Note that in contrast variable capital utilization costs are relatively close. Other parameters are fairly standard. Appendix A gathers additional results, namely variance decomposition (Table 9), comparison between model-implied moments and empirical moments (Table 8), as well as median impulse response functions along with credible sets of all shocks (Figure 10).

[11] This spread then captures the term premium and the excess bond premium (Gilchrist and Zakrajšek, 2012). Although the model is estimated at the first order, this measure enables to still capture (exogenous) term premium dynamics.

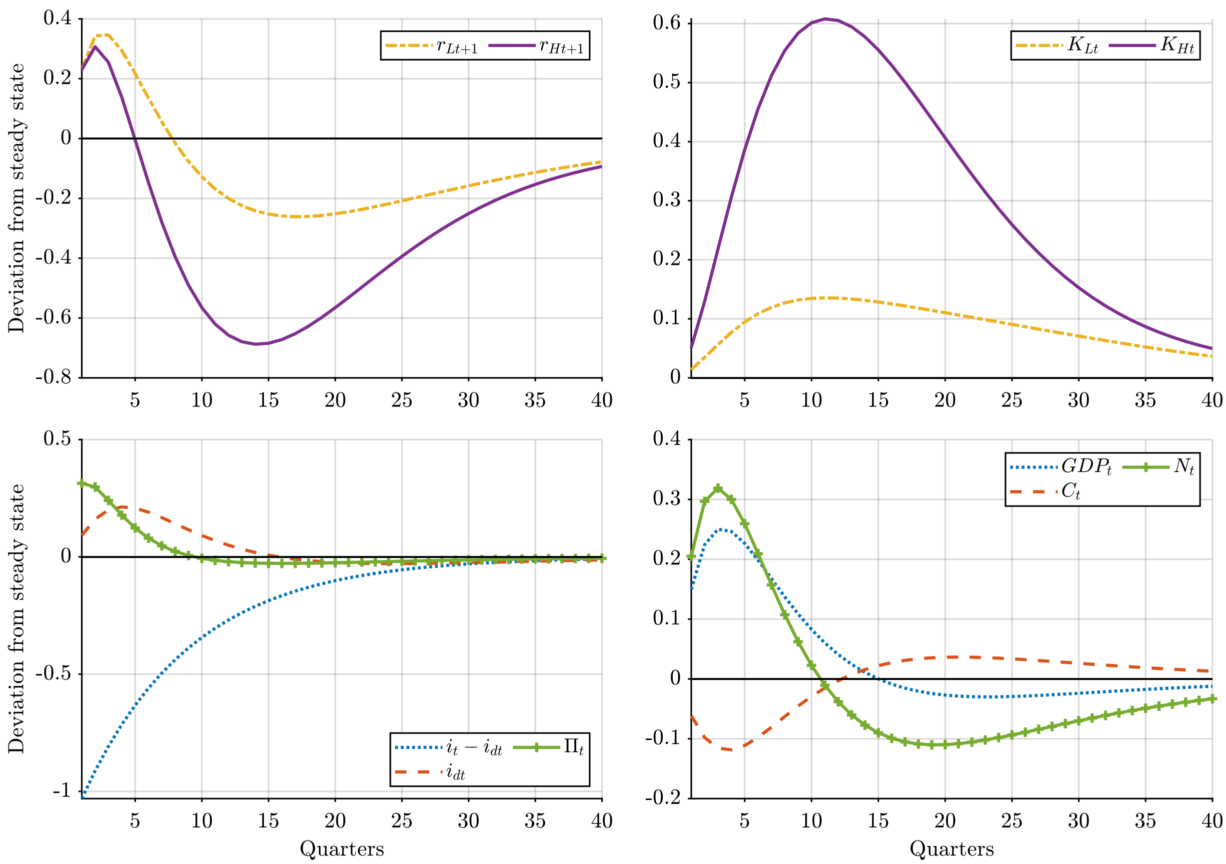
Table 4: Prior and posterior distributions of estimated parameters

	Prior	Prior mean	Prior std	Post. mean	Post. std	90% HPD	90% HPD
φ_H	Normal	4.00	1.00	0.72	0.15	0.48	0.95
φ_L	Normal	4.00	1.00	1.36	0.29	0.88	1.82
υ	Normal	4.00	1.00	9.18	0.68	8.25	10.36
φ_π	Normal	1.50	0.20	1.49	0.12	1.29	1.69
ρ	Beta	0.50	0.20	0.81	0.02	0.77	0.84
ζ_H	Beta	0.50	0.20	0.77	0.11	0.60	0.94
ζ_L	Beta	0.50	0.20	0.88	0.06	0.79	0.98
h	Beta	0.50	0.20	0.28	0.06	0.19	0.37
ρ_κ	Beta	0.50	0.20	0.89	0.02	0.85	0.92
ρ_H	Beta	0.50	0.20	0.77	0.07	0.65	0.88
ρ_L	Beta	0.50	0.20	0.87	0.06	0.78	0.97
ρ_a	Beta	0.50	0.20	0.99	0.00	0.99	1.00
ρ_μ	Beta	0.50	0.20	0.78	0.05	0.70	0.86
ρ_i	Beta	0.50	0.20	0.24	0.07	0.12	0.36
ρ_c	Beta	0.50	0.20	0.99	0.00	0.99	1.00
ρ_g	Beta	0.50	0.20	0.87	0.03	0.83	0.92
ρ_n	Beta	0.50	0.20	0.25	0.16	0.02	0.49
μ_p	Beta	0.50	0.20	0.17	0.09	0.03	0.30
σ_κ	Inv. Gamma	0.50	0.20	0.93	0.06	0.83	1.04
σ_H	Inv. Gamma	0.50	0.20	1.33	0.31	0.89	1.73
σ_L	Inv. Gamma	0.50	0.20	1.55	0.26	1.13	1.94
σ_a	Inv. Gamma	0.50	0.20	0.63	0.06	0.54	0.72
σ_μ	Inv. Gamma	0.50	0.20	1.95	0.10	1.79	2.12
σ_i	Inv. Gamma	0.50	0.20	0.15	0.01	0.13	0.17
σ_c	Inv. Gamma	0.50	0.20	9.96	1.14	8.08	11.75
σ_g	Inv. Gamma	0.50	0.20	0.51	0.21	0.24	0.77
σ_n	Inv. Gamma	0.50	0.20	0.46	0.10	0.29	0.61

4.2 Credit supply shock and sectoral capital allocation

In this subsection, I study the response of the model to a one percentage point decrease in annualized interest rate spread. Figure 2 reports the response of the main variables to this shock. All variables are expressed in percent deviation from steady state, except interest rates which are in annualized percentage point deviation from steady state.

Figure 2: Impulse responses to an increase in credit supply



Note: The figure plots the effects of a credit supply shock calibrated to yield a +1pp decrease in the credit spread. Variables are in percent/percentage point deviations from steady state, interest rates and inflation are annualized.

As expected, the decrease in spread (blue dotted line, bottom left panel) leads to a progressive rise in the capital stocks of both sectors (upper right panel). However, the peak response of capital accumulated by CRE producers is much larger than that of other capital goods producers, leading to a more pronounced fall in expected returns (upper left panel). Overall, this fits the analytical discussion in the previous section. However, this unbalanced capital accumulation takes time to unfold, after nearly a year: in the short run, both capital marginal productivity rise. This is because in the short run firms do not immediately scale up their capital stocks, and therefore increase their labor demand in the meantime.[12] Note that the real interest rate (nominal interest rate minus expected inflation) on deposits decreases: households' fund supply increase more than firms' demand, as investment adjustment costs hinder capital accumulation in the short run. After a few quarters however, the real interest rate starts to increase, as investment speeds up. This comes with a decrease in consumption, before increasing as capital accumulates: in the closed economy set-up I study, as there is no direct productivity gains from these shocks, the increase in investment can only be funded by a decrease in consumption. Consumption needs to fall to fund capital accumulation.[13] Finally, output follows a hump shape, driven by labor in the short run, and then by capital accumulation in the medium run (lower right panel, blue dotted line).

Investment adjustment costs reduce the gap in capital accumulation across sectors. Figure 3 plots the same shock, assuming $\varphi_L = \varphi_H = 0$. The heterogeneous capital accumulation rates becomes wider, and interestingly K_{Lt} *decreases* in the short run. This is because in the absence of investment adjustment costs, the interest rate on deposits rise sharply.[14] As discussed in the previous section, other capital goods producers are more sensitive than CRE producers to the real interest rate on deposits, which then offset the decrease in credit costs. This suggests that CRE investment crowds out investment by other capital goods producers: as CRE capital supply elasticity to credit spreads is higher, their increase in capital supply pushes up *all* interest rates, spilling over other capital goods producers which are particularly sensitive to deposit interest rates. Because there is only one interest rate but heterogeneous capital supply, this creates potential for misallocation across sectors, as one crowds out the other.

Note that the shock concerns only the ability of the banking sector to supply *intertemporal credit to non-financial firms*. As such, it is does not fully capture the effect of a realistic credit supply shock, that can also apply to *intra* temporal credit (typically, to finance working capital) or household credit. Compared to a credit crisis, it affects mostly the medium term behavior of the economy through investment dynamics. As my purpose is to rationalize an observed pattern of sectoral corporate heterogeneity, rather than provide an all-encompassing model fully replicating the effect of a credit shock, I do not judge this behavior problematic.

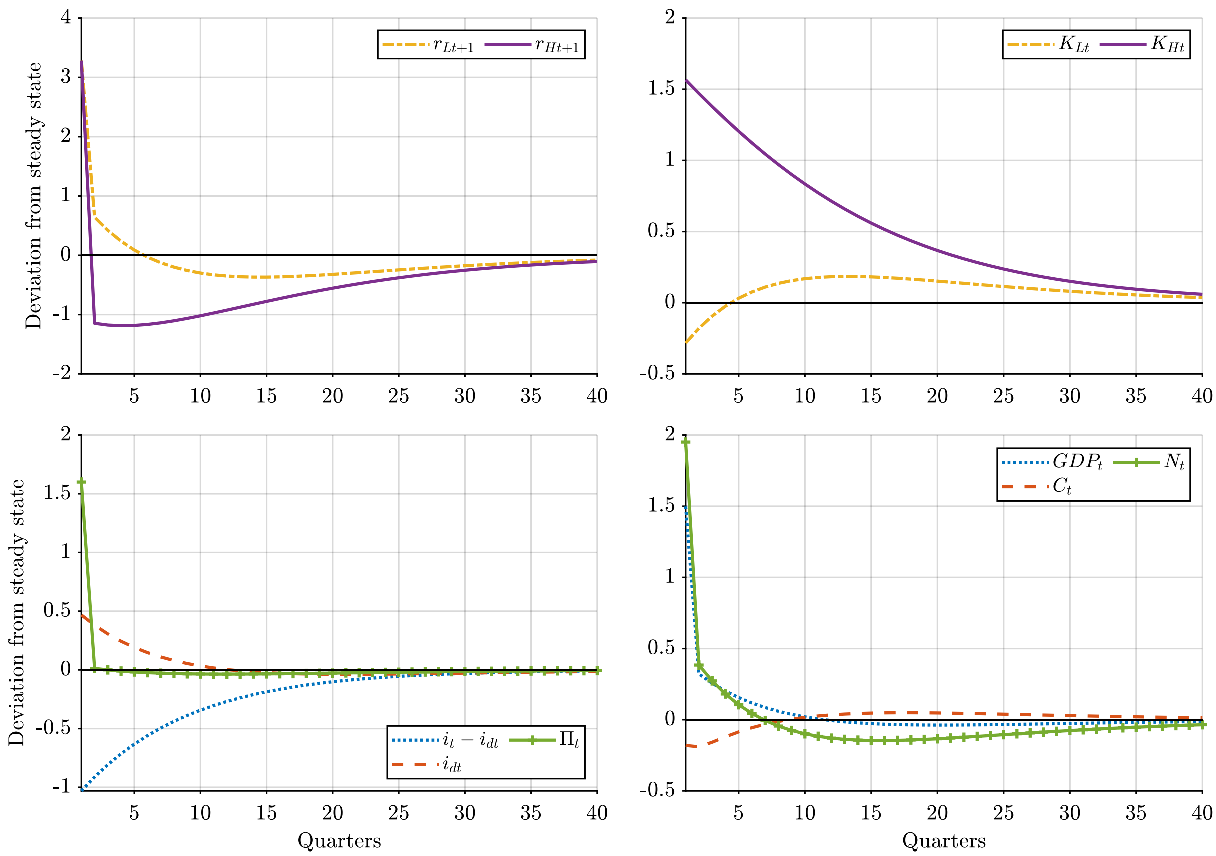
Overall, these findings confirm the intuition of the previous section and provide a more quantitative assessment: credit supply shock disproportionately affect CRE producers, leading to diverg-

[12]Because I assume separable utility, labor supply also increases, through a wealth effect linked to the low interest rate on deposits.

[13]This is by opposition to a more standard modeling of financial shocks as shocks to the marginal efficiency of investment (Justiniano et al., 2011), along with with no complementarity between hours worked and consumption households' welfare (Furlanetto and Seneca, 2014). However, the modeling of financial shocks as credit supply shocks, following Justiniano et al. (2019) and Ferrero et al. (2024), offers a more intuitive interpretation and is more suited to the study of a common financial shock hitting heterogeneous firms.

[14]The link between investment adjustment cost and the real interest rate is a standard result of the medium-scale DSGE literature (Christiano et al., 2005). These adjustment costs disconnect the real interest rate from the marginal product of capital: the presence of adjustment cost decreases capital supply, leading to a decrease of the real interest rate in the short run.

Figure 3: Impulse responses to an increase in credit supply - no investment adjustment costs



Note: The figure plots the effects of a credit supply shock calibrated to yield a +1pp decrease in the credit spread. Variables are in percent/percentage point deviations from steady state, interest rates and inflation are annualized.

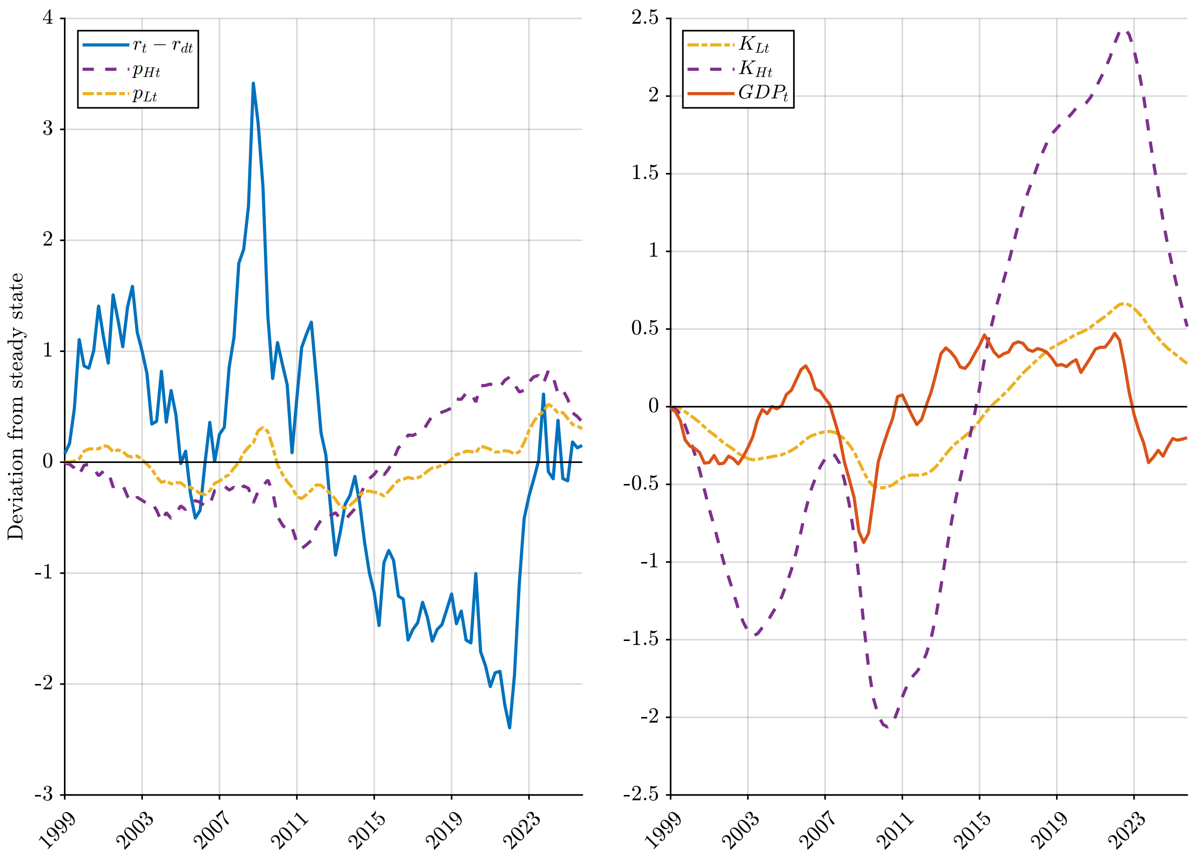
ing capital accumulation processes between CRE producers and other capital goods producers. Heterogeneous capital demand elasticities play a key role, notably by generating crowding out on financial markets.

4.3 Credit cycle and sectoral capital allocation

The previous subsection focused on the effect of a positive credit supply shock starting from the steady state. However, credit supply shocks do not usually occur in isolation: they are usually part of a credit cycle, defined as a sequence of small unanticipated positive credit supply shocks, followed by a large unanticipated negative credit supply shocks that more than reverses the previous dynamic (Krishnamurthy and Muir, 2025). I thus recover smoothed estimated credit supply shocks κ_t. As the model is linearized, this cycle is merely a linear combination of IRFs. Key insights from the previous subsection then remain, but this more realistic process enables to assess the ability of the model to fit some stylized facts on credit cycles and capital allocation. In addition, the next section will consider the implementations of some public policies along this cycle.

[Figure 4](#) reports the effects of this sequence of shocks, the left panel presenting the interest rate spread in blue, along with the stock valuation of each sector, defined as $p_{et} = \mathbb{E}_t m_{t,t+1}(p_{et+1} + d_{et+1})$, $\forall e \in \{L, H\}$. Credit expansion in the run-up to the GFC is abrupt but too short to fully reverse the effect of the rise in spreads on CRE at the beginning of the 2000s. When the GFC and the sovereign debt crisis hit, both valuations immediately adjust downward but more so for CRE producers. Once the crisis has settled, the credit spread drops and credit supply increases. This enables a swift recovery of CRE accumulation, before its rate outpaces that of other capital goods in the second half of the 2010s. The return of the credit spread to its long-term average puts an end to this increasing supply of CRE capital. Overall, these results are line with contributions dissecting the behavior of the CRE sector in the past decades: while CRE was particularly hit by the GFC (Duca and Ling, 2020), its late 2010s expansion is an unintended consequences of unconventional monetary policies (Berg et al., 2023).

Figure 4: Effects of estimated credit supply shocks



Note: The figure plots the effects of the sequences of credit supply shocks estimated over the period. Variables are in percent/percentage point deviations from steady state an interest rates are annualized.

5 Policy for credit misallocation

Taking the example of CRE, the previous section highlighted that heterogeneous capital pledgeability affects capital allocation at the steady state and in face of credit supply shocks. Capital accumulation is then concentrated in firms which are the least exposed to financial frictions. However, this excess accumulation of pledgeable capital stumbles over imperfect substituability between capital types: unbalanced capital accumulation reduces production efficiency. This potentially leaves some room for a policy intervention reallocating resources across sectors, so as to increase production efficiency, and ultimately households' welfare.

5.1 Policy instruments and welfare gains

I investigate the welfare effects of sectoral taxes on debt. More specifically, I assume that policymakers have access to proportional taxes and subsidies on firms' debt, denoted τ_{et}, $e \in \{L, H\}$. The introduction of these taxes in the model introduced above changes only firms' credit demand, which can be re-written as:

$$1 + \tau_{et} = \mu_{et} + \mathbb{E}_t \gamma m_{t,t+1}(1 + r_t) \tag{5.1}$$

Note that for a tax level to be feasible, it must be that:

$$\tau_{et} \geq \mathbb{E}_t \gamma m_{t,t+1}(1 + r_t) - 1 \tag{5.2}$$

These inequality constraints stem form the fact that the policymaker moves the Lagrange multipliers on debt through the taxes she sets. Therefore, a feasible policy needs to respect $\mu_{et} \geq 0$, $e \in \{L, H\}$, yielding the above conditions. Moreover, I assume that the resulting policy is purely redistributive, *i.e.*, it must respect balanced budget:

$$\tau_{Ht} B_{Ht} + \tau_{Lt} B_{Lt} = 0 \tag{5.3}$$

This means that by setting τ_{Ht}, τ_{Lt} endogenously adjusts, so as to ensure balanced budget. Although this policy might appear as unorthodox from the perspective of a *fiscal* authority, it fits the toolkit of *macroprudential* authorities. In the European Union, these authorities have the ability to indirectly change the interest charged by banks to different types of borrowers through sectoral prudential requirements.[15]

I compute welfare gains in consumption-equivalent terms, taking into account transition dynamics. This can be interpreted as the level of consumption the household in the no-policy economy would need to receive to be indifferent between the no-policy economy and the alternative policy considered. A positive value indicates that the policy is desirable. As there is only one

[15] See ESRB website for sector specific risk weights or sectoral capital requirements. Note that because in the model financial intermediaries are simply pass-though vehicles, it is equivalent to directly tax firms or to impose sectoral capital requirements on banks. Relaxing this assumption and studying its implication for the practical design of the policy intervention I propose is left to further research.

representative agent, computations are naturally based on households' lifetime utility. Formally, expected welfare gains of a given policy ι_τ are defined as follows:

$$\sum_{t=0}^{\infty} \beta^t U\Bigg((1+\iota_\tau)(C_t - hC_{t-1}), N_t\Bigg) = \sum_{t=0}^{\infty} \beta^t U(C_{\tau t} - hC_{\tau t-1}, N_{\tau t}) \tag{5.4}$$

Where $C_{\tau t}$ and $N_{\tau t}$ denote consumption and labor under a specific tax scenario. Using the definition of the utility function, this can be re-written as:

$$\iota_\tau = \left(\frac{\sum_{t=0}^{\infty} \beta^t (\frac{1}{1-\sigma}(C_{\tau t} - hC_{\tau t-1})^{1-\sigma} - \frac{\chi}{1+\varphi} N_{\tau t}^{1+\varphi} + \frac{\chi}{1+\varphi} N_t^{1+\varphi})}{\sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma}(C_t - hC_{t-1})^{1-\sigma}}\right)^{\frac{1}{1-\sigma}} - 1 \tag{5.5}$$

Although one policy can be optimal from an ex-ante perspective at $t = 0$, its political implementation may also depend on the *timing* of welfare gains. To asset those, I also compute period-by-period welfare gains $\iota_{\tau t}$ as follows:

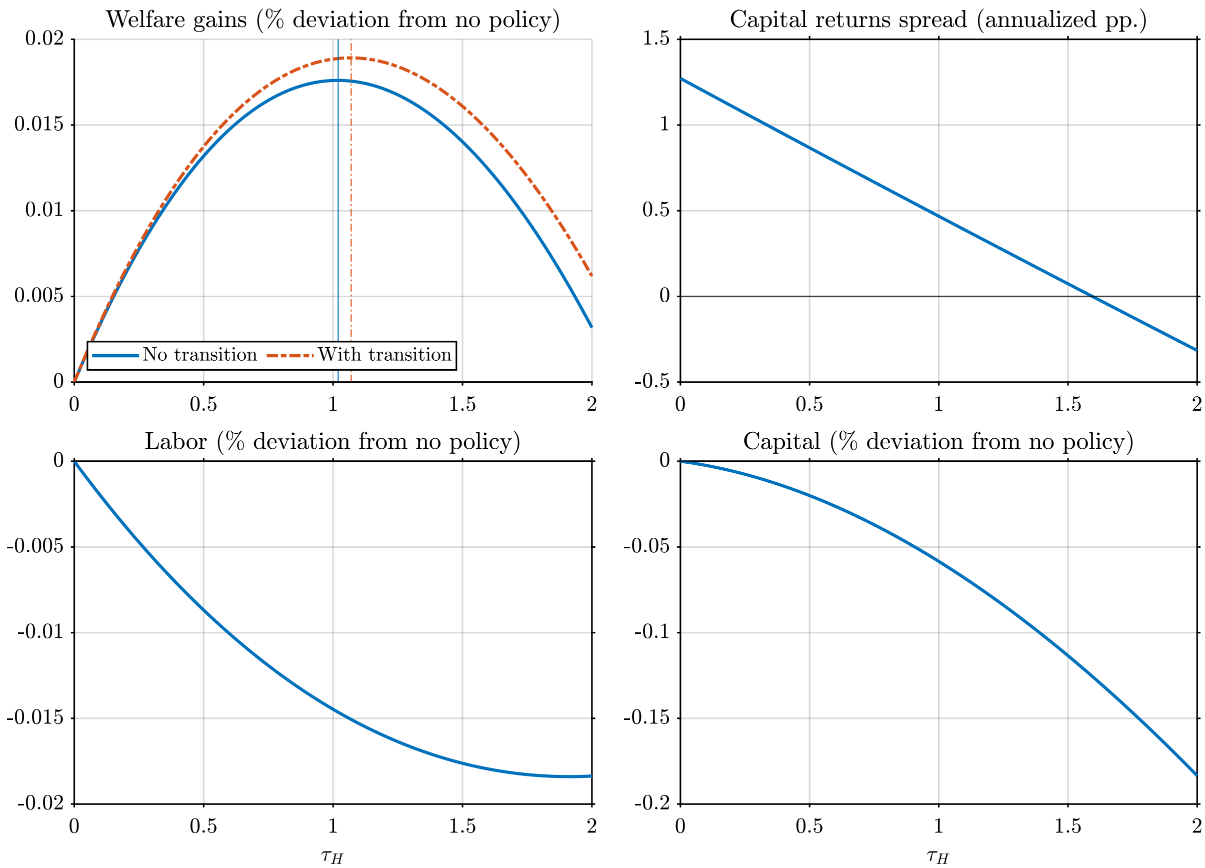
$$\iota_{\tau t} = \left(\frac{\frac{1}{1-\sigma}(C_{\tau t} - hC_{\tau t-1})^{1-\sigma} - \frac{\chi}{1+\varphi} N_{\tau t}^{1+\varphi} + \frac{\chi}{1+\varphi} N_t^{1+\varphi}}{\frac{1}{1-\sigma}(C_t - hC_{t-1})^{1-\sigma}}\right)^{\frac{1}{1-\sigma}} - 1 \tag{5.6}$$

5.2 Constant tax rates

In this subsection, I investigate the welfare gains of a constant tax on CRE debt τ_H, funding a subsidy to other firms τ_L. I consider two cases: *(i)* welfare gains ignoring transition dynamics, and *(ii)* welfare gains taking into account transition dynamics. I compute welfare gains over an horizon of 1,000 quarters. I check that the system has converged to the new steady state at this horizon, and that the Lagrange multiplier on debt remains strictly positive along the simulation. Figure 5 plots the results of these experiments.

The tax is presented in annualized percentage points, so as its size can be compared to interest rates. Increasing the tax on CRE debt (and increasing the subsidy on other capital goods producers' debt) decreases linearly the capital returns spread (upper right panel). This reduces the productivity-adjusted capital stock X_t (bottom right panel). The shape of this function is concave, meaning that capital losses are minimal for small values of the tax: the productivity gains partially offset the distortion linked to higher taxes. Increasing CRE taxes also reduces labor (bottom left panel). However, the shape of the function is convex, meaning that the reduction in labor is larger for small values increase in the tax rate. This means that the consumption labor increases for small values of τ_H before decreasing afterwards, hence the inverted u-shape curves for welfare gains (upper left panel). Note that taking into account transition dynamics increases welfare gains. This is because when implementing the policy, households still benefits from the relatively high productivity-adjusted capital stock inherited from the initial steady state, while already benefiting from lower hours worked. In both case, the welfare-maximizing tax rate of CRE is around one percentage point. Given that at the steady state deposit interest rate is set at 2%, this represents a

Figure 5: Welfare gains of constant policy



Note: The figure plots the effects of a given tax rate τ_H expressed in annualized percents, in deviation from the no policy economy.

significant increase in CRE investors' borrowing costs, along with a sizable decrease in other capital goods producers' borrowing costs (more than 50 basis points). Note that the optimal policy does not fully close the capital returns spreads, which remains at 50 basis points in annualized rates.[16]

Although the resulting tax system is optimal from the perspective of $t = 0$, documenting the precise timing of welfare gains is important for political implementation. In addition, some macroeconomic context may be better suited to implement the transition. Although this would also be captured by the approach introduced above, such welfare gains are dwarfed by the computations over a long horizon. I thus compute period-by-period welfare gains of implementing the welfare-maximizing tax under two different scenarios: *(i)* there are no other shocks except the transition to new tax rates, *(ii)* the transition occur along the sequence of credit supply shocks estimated from

[16]Because the elasticity of substitution across capital types is particularly complex to calibrate, but central to assess welfare effects of sectoral credit policies, I investigate the robustness of this result for different values of ω (see Figure 11 in Appendix A). Changing this parameter slightly changes the value of the optimal tax rate (the optimal tax is an increasing function of the elasticity of substitution), but not the overall shape of the welfare function.

2013 to 2025. More precisely, I assume that there is no redistributive tax implemented in period 0. In period 1, the new tax system is announced and implemented in both scenario. Therefore, agents realize that they are far away from the new steady state. They thus converge to this new steady state. In the second scenario, on top of this convergence, they adjust to the sequence of unexpected credit supply shocks. The welfare gains of the first scenario are hit by no other shocks, while that of the second scenario are computed against the no-policy economy hit by the same sequence of credit supply shocks.

Figure 6 plots period-by-period welfare gains. As exposed previously, the transition is a source of welfare gains, with period-by-period welfare gains being greater than steady-state welfare gains in the two scenarios: households still benefits from the high productivity-adjusted capital stock while already benefiting from lower hours worked. However, welfare gains are larger if the policy is implemented during a credit expansion, such as the one estimated from 2013 to 2025. This is because capital returns spreads are even wider than at the steady state and misallocation is particularly salient. When the cycle turns, welfare gains remain comparable to those of an implementation out of a credit cycle. Therefore, implementation in phases of credit expansion remains a reasonable implementation strategy. It makes clear that in the setup with exogenous credit supply shocks I study, the role of the policy introduced in this section is to maximize the efficiency of a credit expansion, not to avoid a credit bust.

5.3 Time-varying tax rates

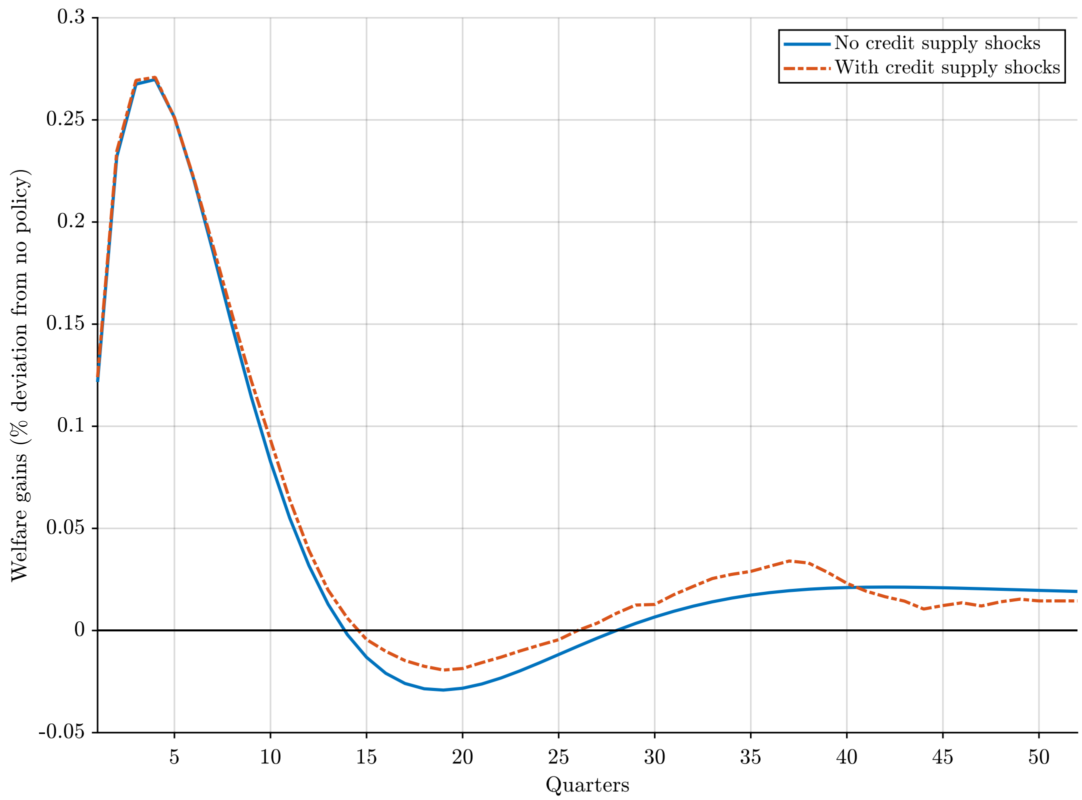
Once the economy has converged to optimal tax rates, policymakers may want to consider adjusting these taxes following the nature of the business cycle. Indeed, although misallocation is less salient in this new steady state, it remains time varying. In particular, it is increasing in times of credit expansion. If it is large enough, it may warrant policy action. Note that the fact the economy would particularly benefit from an increase in the tax on CRE debt τ_H during phases of credit expansion already hints in this direction. I thus compute period-by-period welfare gains of implementing a time-varying tax rate in the context of the sequence of credit supply shocks estimated from 2013 to 2025. Specifically, I assume that the economy has reached the steady state with optimal tax rate and that its time varying component follows a public rule:

$$\tau_{Ht} = \tau_H + \phi_\tau \Bigg((r_{Ht+1} - r_H) - (r_{Lt+1} - r_L) \Bigg) \tag{5.7}$$

Where ϕ_τ controls for the responsiveness of the authority to deviations of the expected returns spread form its steady state value. In the following simulations, I let τ_{Lt} adjust endogenously to maintain a balanced budget.

Figure 7 presents these instantaneous welfare gains for different values of ϕ_τ. In the absence of any policy, capital returns spread increases. Activating a time-varying rule enables to nearly mute

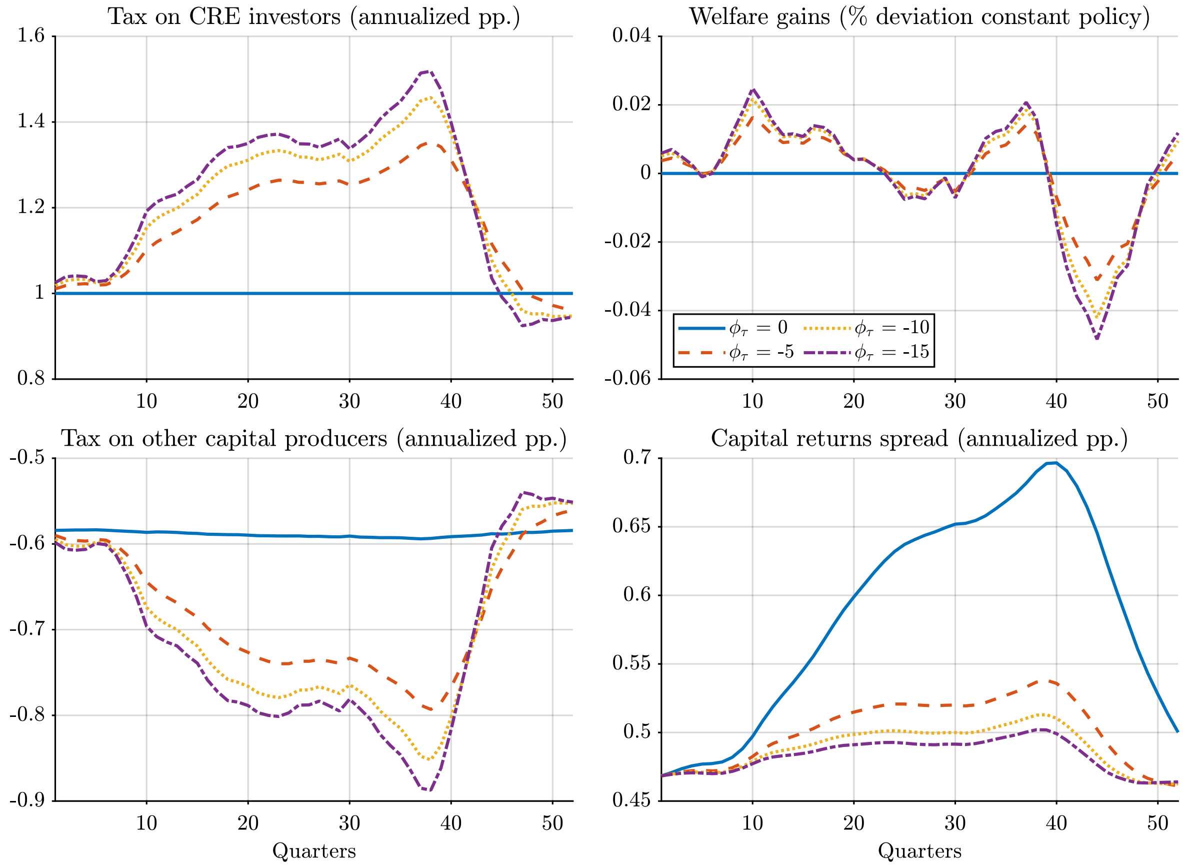
Figure 6: Period-by-period welfare gains of the transition to optimal constant tax rates



Note: The figure plots the period-by-period welfare gain for a transition to optimal policy with and without credit supply shocks. The sequences of credit supply shocks considered here are those estimated from 2013 to 2025.

fluctuations in capital returns' spread (bottom right panel), improving welfare (upper left panel). Although welfare gains are positive in the expansion phase, the contraction phase yields significant welfare loss, as the policy limit capital accumulation which is particularly valuable at times of high credit cost. Adjusting these tax rates to economic fluctuations thus appear as a second-order problem compared to hitting optimal constant tax rates. Also note that the adjustment parameter does not need to bee large to be effective: rising progressively the credit tax on CRE investors by around 25 basis point is sufficient to nearly close fluctuations in misallocation, welfare gains being marginal beyond this point.

Figure 7: Impulse responses to a credit supply shock with time-varying policy



Note: The figure plots the effects of the sequences of credit supply shocks estimated from 2013 to 2025 for different reaction function of sectoral debt tax rates to the expected capital return spread.

6 Conclusion

This paper shows that heterogeneity in capital pledgeability is an important source of sectoral capital misallocation. Using French firm-level data, I document that firms holding more pledgeable assets are systematically more leveraged and respond more strongly to changes in credit supply. I then develop and calibrate a general equilibrium model in which differences in pledgeability generate structural heterogeneity in expected returns across capital types. Because the two forms of capital are imperfect substitutes in production, these return differentials reflect inefficient resource allocation. Quantitatively and based on a simple distinction between CRE and other types of capital good, the resulting misallocation is substantial and becomes particularly pronounced during credit expansions.

The analysis further demonstrates that redistributive credit policies can improve welfare by counteracting these distortions. In particular, taxing borrowing by firms with highly pledgeable capital while subsidizing borrowing by more financially constrained firms reallocates resources toward sectors with higher marginal returns and increases aggregate welfare. The gains from such policies are largest when implemented during credit booms, when financial frictions generate the strongest departures from efficient allocation. Beyond the quantitative estimates of these tax and subsidy rates, the findings offer broader lessons for economic policy design. Prudential frameworks that preferentially relax financing conditions for highly pledgeable assets may inadvertently amplify misallocation (Duca and Ling, 2020), while unconventional monetary interventions should account for heterogeneous sectoral responses to credit expansions (Berg et al., 2023). Similarly, fiscal provisions that subsidize debt financing may be made more efficient by incorporating differences in asset pledgeability. More generally, the paper highlights the importance of heterogenity in capital pledgeability and the distribution of credit across sectors when evaluating the macroeconomic consequences of financial policies.

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A Figures and tables

Table 5: Descriptive statistics

Variable	Min	P25	Median	Mean	P75	Max
Age (in years)	0.0	10.0	19.0	22.6	31.0	91.0
Size (log total assets)	3.7	6.9	7.5	7.8	8.4	12.2
Debt / Total assets	0.0	9.6	20.4	24.2	34.8	80.4
Debt / Debt and equity	0.1	16.8	34.3	37.6	55.4	96.1
EBITDA / Lag total assets	-24.9	4.0	10.0	12.1	18.0	71.9
Net results / Lag total assets	-23.6	1.7	5.8	7.5	11.5	54.9
Cash / Sales	0.0	3.4	9.2	15.7	19.4	190.5
Share of debt maturing within one year	0.0	29.2	50.9	55.5	86.9	100.0
Change in fixed assets / Lag total assets	-17.4	-1.9	-0.2	1.6	2.1	60.1
Change in physical assets / Lag total assets	-12.8	-1.7	-0.3	0.9	1.3	41.9
Mortgage ratio	0.0	0.0	0.0	16.9	22.0	100.0
Recourse ratio	0.0	50.6	100.0	73.5	100.0	100.0
Credit supply shock (in standard deviations)	-4.4	-0.4	0.0	0.0	0.5	3.7

Figure 8: Distribution of credit supply shocks

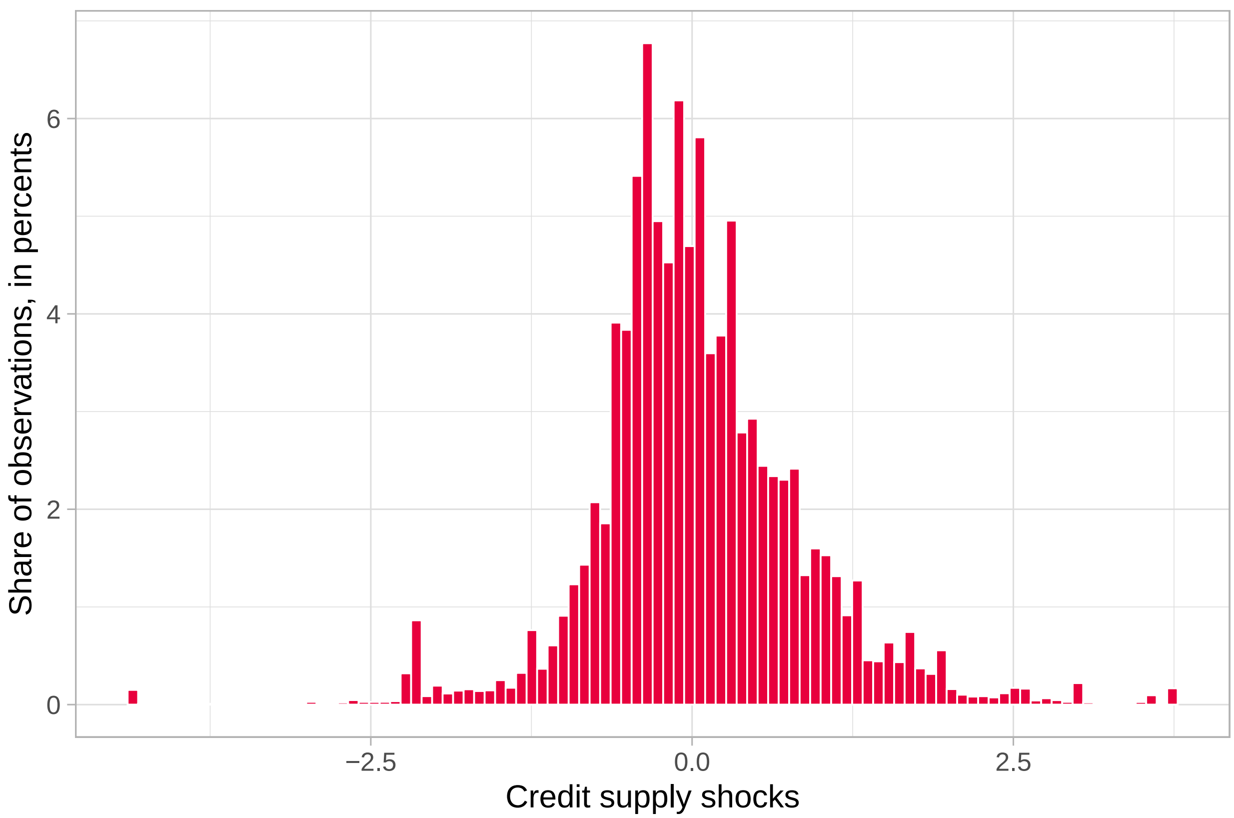


Table 6: Mortgage ratio and leverage - Independent firms

	Dependent variable:					
	Debt / total assets			Debt / debt and equity		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	21.922***	3.672***	18.237***	33.816***	13.725***	25.549***
	(0.071)	(0.475)	(0.567)	(0.095)	(0.577)	(0.692)
Mortgage ratio	0.067***	0.044***	0.034***	0.044***	0.025***	0.018***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Firm-level controls	No	Yes	Yes	No	Yes	Yes
Sectoral dummy	No	No	Yes	No	No	Yes
Observations	508,237	392,961	392,961	508,237	392,961	392,961
R^2	0.020	0.233	0.309	0.012	0.329	0.358

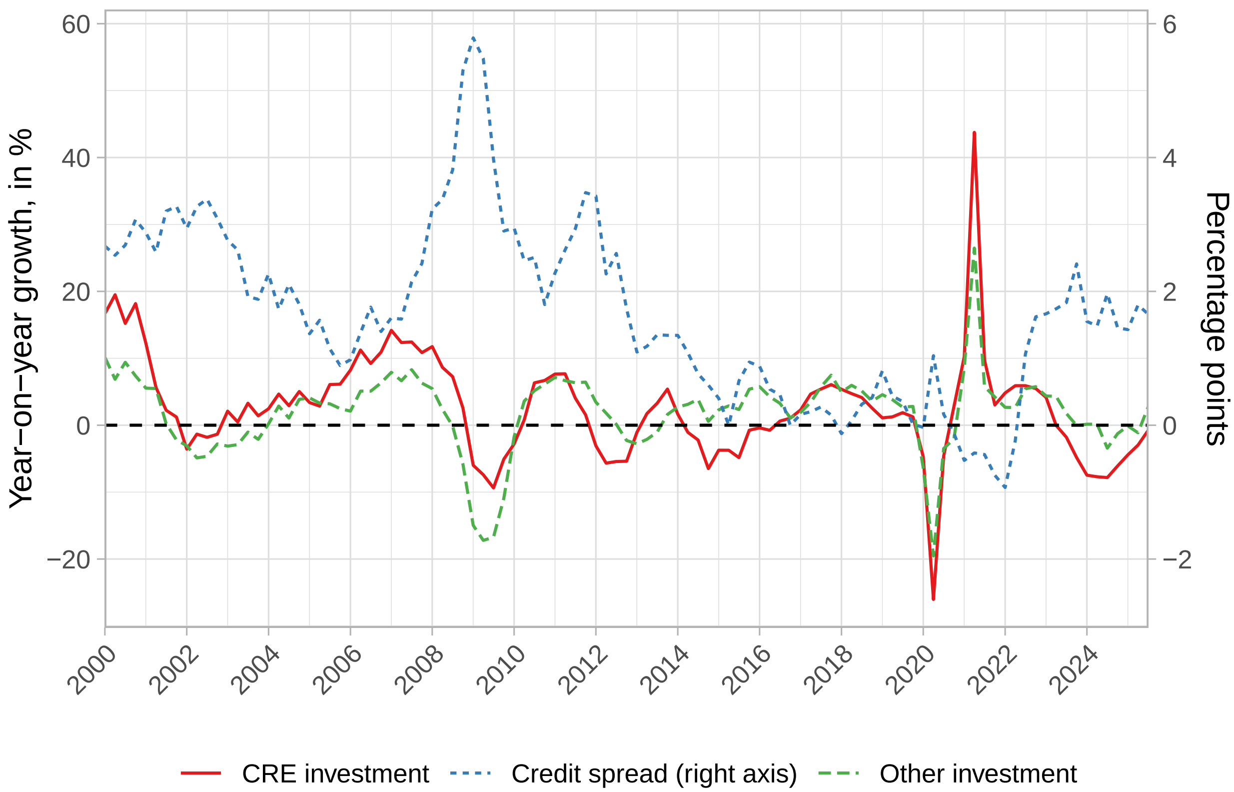
*Note: clustered standard errors at the firm level (in parenthesis); *p<0.1; **p<0.05; ***p<0.01*

Table 7: Mortgage ratio and investment - Independent firms

	Dependent variable:			
	Fixed assets		Physical assets	
	(1)	(2)	(3)	(4)
Credit supply	0.011	0.023	0.013	0.020
	(0.024)	(0.026)	(0.019)	(0.020)
Credit supply × Mortgage ratio	0.326***	0.323***	0.215***	0.224***
	(0.071)	(0.076)	(0.058)	(0.062)
Firm controls	No	Yes	No	Yes
Observations	313,302	263,147	313,302	263,147
R^2	0.345	0.378	0.336	0.369

*Note: clustered standard errors at the firm level (in parenthesis); *p<0.1; **p<0.05; ***p<0.01*

Figure 9: Credit spreads and sectoral investment



Source: INSEE, Refinitiv Workspace and Krippner (2013).

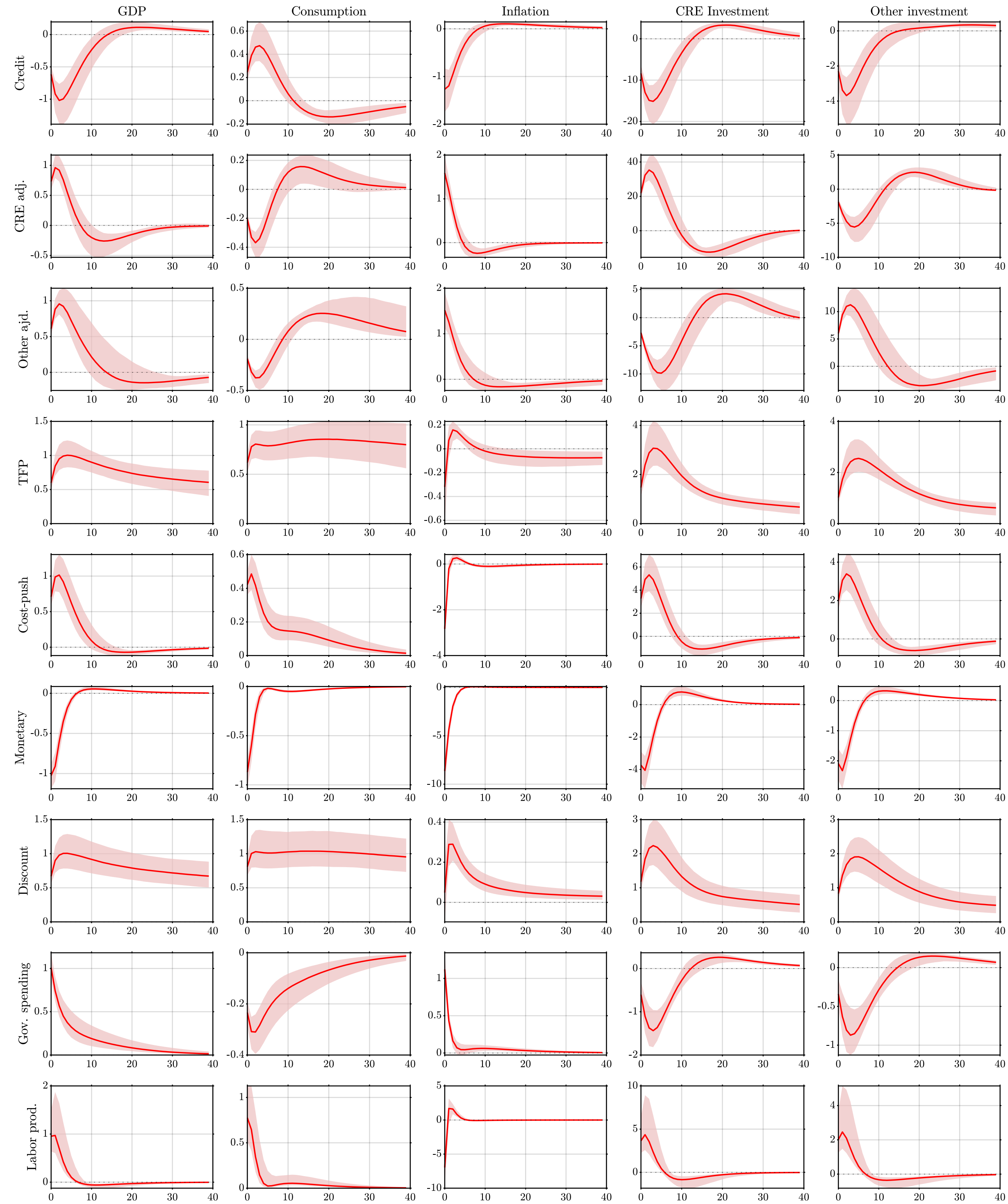
Table 8: Model-implied vs. empirical moments of observed variables

	Var. (model)	Var. (data)	Cor. w/ GDP (model)	Cor. w/ GDP (data)	AR(1) (model)	AR(1) (data)
Other investment	21.95	6.74	0.80	0.83	0.63	0.10
CRE investment	49.67	14.06	0.72	0.85	0.59	-0.06
Spread	0.65	1.46	-0.01	-0.09	0.89	0.95
GDP	5.52	2.73	1.00	1.00	0.35	-0.14
Consumption	6.76	4.55	0.95	0.92	0.24	-0.34
Interest rate	10.89	5.78	-0.08	0.12	0.96	0.98
Inflation	0.95	0.25	-0.03	0.27	0.48	0.69
Labor	10.40	7.92	0.94	0.92	0.30	-0.41

Table 9: Unconditional variance decomposition of observed variables (posterior mean, %)

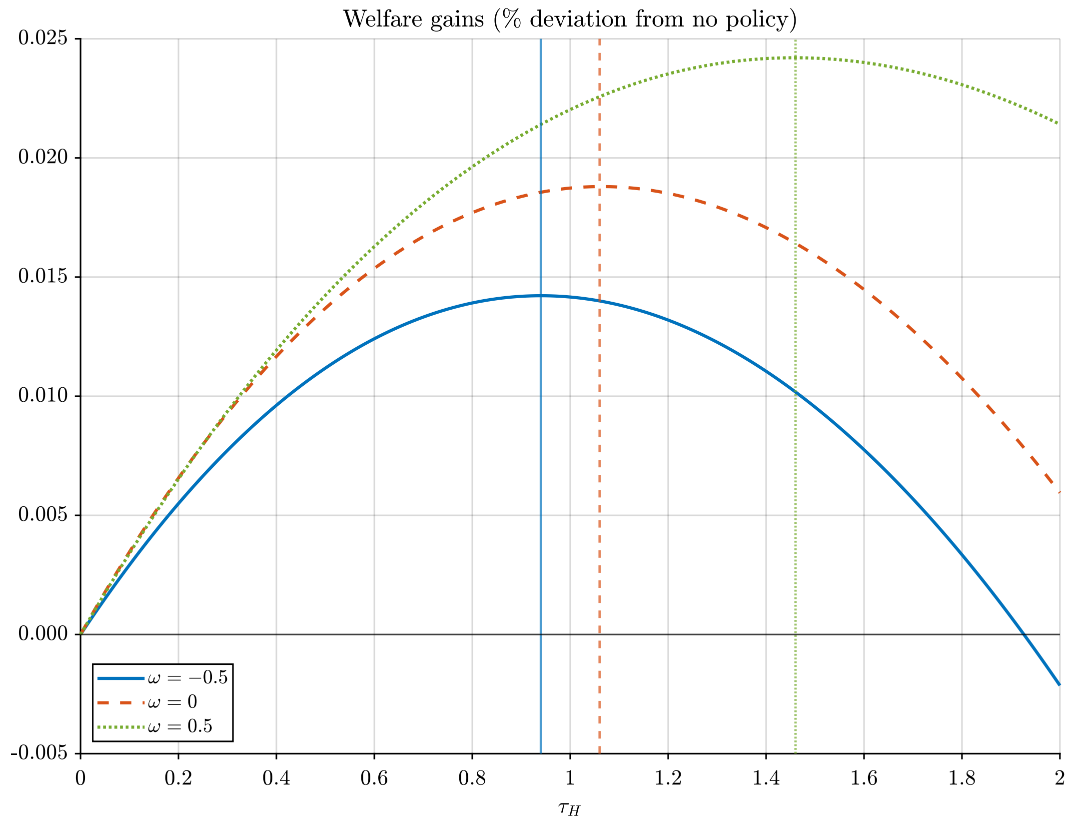
	Credit	CRE adj.	Other ajd.	TFP	Cost-push	Monetary	Discount	Gov. spending	Labor prod.
Other investment	0.3	1.0	25.4	4.3	20.3	0.6	47.9	0.2	0.2
CRE investment	1.9	24.4	6.8	3.5	24.9	0.9	37.1	0.2	0.3
Spread	100.0	0.0	0.0	0.0	-0.0	-0.0	0.0	-0.0	0.0
GDP	0.1	0.2	0.8	3.7	8.5	0.6	83.9	2.1	0.2
Consumption	0.0	0.0	0.1	2.9	2.1	0.4	94.3	0.1	0.1
Interest rate	0.4	0.4	4.1	6.3	12.8	0.5	74.2	0.8	0.4
Inflation	0.3	0.5	3.4	2.6	39.9	17.1	32.3	1.1	2.8
Labor	0.1	0.2	0.8	2.0	6.4	0.3	86.6	1.9	1.7

Figure 10: Impulse response function of estimated shocks



Note: all shocks are scaled so as to generate a 1% reaction in GDP. The solid black line reports the median response, while the shaded are represents the 90% credible set, based on 1,000 draws from the posterior distribution.

Figure 11: Welfare gains of constant policy - different elasticities of substitution



Note: The figure plots the welfare gains of a given tax rate τ_H, expressed in annualized percents, for different values of elasticities of substitution between capital types.

B Proof of exogenous credit spreads

Combining the Euler equations of households for deposits and securities:

$$1 + r_{st} = (1 + r_{dt}) \left[1 + \psi \left(\frac{S_t}{\bar{S}_t} - 1 \right) \right] \tag{B.1}$$

As the leverage requirement is binding:

$$1 + r_{st} = (1 + r_{dt}) \left[1 + \psi \left(\frac{\kappa_t}{\kappa} - 1 \right) \right] \tag{B.2}$$

Log-linearization around the deterministic steady state yields:

$$\hat{r}_{st} = \hat{r}_{dt} + \psi(1 + r)\hat{\kappa}_t \tag{B.3}$$

In addition, note that financial intermediaries' optimality condition can be expressed as follows:

$$\hat{r}_t = (1 - \kappa)\hat{r}_{dt} + \kappa\hat{r}_{st} \tag{B.4}$$

Combining these two equations and normalizing $\psi = \frac{1}{(1+r)\kappa}$:

$$\hat{r}_t - \hat{r}_{dt} = \hat{\kappa}_t \tag{B.5}$$

C Quantitative New Keynesian model

C.1 Final good producers

Objective function:

$$\Pi_t = p_t \left(\int_0^1 Y_{it}^{\mu_t} \mathrm{d}i \right)^{\frac{1}{\mu_t}} - \int_0^1 p_{it} Y_{it} \mathrm{d}i \tag{C.1}$$

Implies the following demand constraint for intermediary good producers:

$$Y_{it} = \left(\frac{p_{it}}{p_t} \right)^{\frac{1}{\mu_t - 1}} Y_t \tag{C.2}$$

And the following definition for real revenues for intermediary good producers:

$$\frac{p_{it}}{p_t} Y_{it} = \left(\frac{p_{it}}{p_t} \right)^{\frac{\mu_t}{\mu_t - 1}} Y_t \tag{C.3}$$

With:

$$\mu_t = \exp(\zeta_{\mu_t}) \mu \tag{C.4}$$

C.2 Intermediary good producers

Production:

$$Y_{it} = \exp(\zeta_{at}) X_{it}^{\alpha} \Big(\exp(\zeta_{nt}) N_{it} \Big)^{1-\alpha} \tag{C.5}$$

$$X_{it} = \Bigg(\nu (u_{iHt} X_{iHt})^{\omega} + (1-\nu)(u_{iLt} X_{iKt})^{\omega} \Bigg)^{\frac{1}{\omega}} \tag{C.6}$$

Budget constraint:

$$d_{it} + w_t N_{it} + \sum_{e \in \{L,H\}} \left(r_{et} + \bar{\zeta}_e \frac{u_{et}^{1+\zeta_e} - 1}{1 + \zeta_e} \right) X_{et} + \frac{\upsilon}{2} \left(\frac{p_{it}}{p_{it-1}} - 1 \right)^2 Y_t = \frac{p_{it}}{p_t} Y_{it} \tag{C.7}$$

Objective:

$$\mathcal{V}_{it} = \mathbb{E}_0 \sum_{j=0}^{\infty} \Lambda_{t,t+j} d_{it+j} \tag{C.8}$$

Lagrangian (using demand constraint and definition of real revenues stated above):

$$\mathcal{L}_{it} = \mathbb{E}_t \sum_{j=0} \Lambda_{t,t+j} \Bigg[d_{it+j} + \lambda_{it+j} \Bigg(\Big(\frac{p_{it+j}}{p_{t+j}} \Big)^{\frac{\mu_t}{\mu_t - 1}} Y_{t+j} - d_{it+j} - w_{t+j} N_{it+j} - \frac{v}{2} \Bigg(\frac{p_{it+j}}{p_{it+j-1}} - 1 \Bigg)^2 Y_{t+j} \Bigg)$$
$$- \Bigg(r_{Lt+j} + \bar{\zeta}_L \frac{u_{Lt+j}^{1+\zeta_L} - 1}{1 + \zeta_L} \Bigg) X_{iLt+j} - \Bigg(r_{Ht+j} + \bar{\zeta}_H \frac{u_{Ht+j}^{1+\zeta_H} - 1}{1 + \zeta_H} \Bigg) X_{iHt+j}$$
$$+ \eta_{it+j} \Bigg(\exp(\zeta_{at+j}) \Big(\nu (u_{iHt+j} X_{iHt+j})^{\omega} + (1 - \nu)(u_{iLt+j} X_{iLt+j})^{\omega} \Big)^{\frac{\alpha}{\omega}} \Big(\exp(\zeta_{nt+j}) N_{it+j} \Big)^{1-\alpha}$$
$$- \Big(\frac{p_{it+j}}{p_{t+j}} \Big)^{\frac{1}{\mu_t - 1}} Y_{t+j} \Bigg) \Bigg] \tag{C.9}$$

(Symmetric) Equilibrium conditions (and denoting $\Pi_t = \frac{p_t}{p_{t-1}}$):

$$\lambda_t = 1 \tag{C.10}$$

$$w_t = \exp(\zeta_{at}) \eta_t (1 - \alpha) \exp(\zeta_{nt}) \Big(\frac{X_t}{\exp(\zeta_{nt}) N_t} \Big)^{\alpha} \tag{C.11}$$

$$r_{Ht} + \bar{\zeta}_H \frac{u_{Ht}^{1+\zeta_H} - 1}{1 + \zeta_H} = \exp(\zeta_{at}) \eta_t u_{Ht} \nu (u_{Ht} X_{Ht} / X_t)^{\omega - 1} \alpha \Big(\frac{X_t}{\exp(\zeta_{nt}) N_t} \Big)^{\alpha - 1} \tag{C.12}$$

$$r_{Lt} + \bar{\zeta}_L \frac{u_{Lt}^{1+\zeta_L} - 1}{1 + \zeta_L} = \exp(\zeta_{at}) \eta_t u_{Lt} (1 - \nu) (u_{Lt} X_{Lt} / X_t)^{\omega - 1} \alpha \Big(\frac{X_t}{\exp(\zeta_{nt}) N_t} \Big)^{\alpha - 1} \tag{C.13}$$

$$\bar{\zeta}_H u_{Ht}^{\zeta_H} = \exp(\zeta_{at}) \eta_t \nu (u_{Ht} X_{Ht} / X_t)^{\omega - 1} \alpha \Big(\frac{X_t}{\exp(\zeta_{nt}) N_t} \Big)^{\alpha - 1} \tag{C.14}$$

$$\bar{\zeta}_L u_{Lt}^{\zeta_L} = \exp(\zeta_{at}) \eta_t \nu (u_{Lt} X_{Lt} / X_t)^{\omega - 1} \alpha \Big(\frac{X_t}{\exp(\zeta_{nt}) N_t} \Big)^{\alpha - 1} \tag{C.15}$$

$$\eta_t = \mu_t + (1 - \mu_t) v \Bigg[\Pi_t (\Pi_t - 1) - \mathbb{E}_t m_{t,t+1} \Pi_{t+1} (\Pi_{t+1} - 1) \frac{Y_{t+1}}{Y_t} \Bigg] \tag{C.16}$$

$$d_t + w_t N_t + \frac{v}{2} \Bigg(\Pi_t - 1 \Bigg)^2 Y_t + \sum_{e \in \{L,H\}} \Bigg(r_{et} + \bar{\zeta}_e \frac{u_{et}^{1+\zeta_e} - 1}{1 + \zeta_e} \Bigg) X_{et} = Y_t \tag{C.17}$$

C.3 Capital good producers

Two types of capital good producers $e \in \{L, H\}$. Production:

$$X_{et} = K_{et-1} \tag{C.18}$$

Capital accumulation:

$$K_{et} = (1 - \delta) K_{et-1} + \exp(\zeta_{et}) \Bigg[1 - \frac{\varphi_e}{2} \Bigg(\frac{I_{et}}{I_{et-1}} - 1 \Bigg)^2 \Bigg] I_{et} \tag{C.19}$$

Borrowing constraint:

$$B_{et} \leq \theta_e Q_{et} K_{et} \tag{C.20}$$

Budget constraint:

$$d_{et} + \frac{1 + i_{t-1} + \tau_{et-1}}{\Pi_t} B_{et-1} + I_{et} \leq r_{et} X_{et} + B_{et} \tag{C.21}$$

Objective:

$$\mathcal{V}_{et} = \mathbb{E}_0 \sum_{j=0}^{\infty} \gamma^j \Lambda_{t,t+j} d_{et+j} \tag{C.22}$$

Lagrangian:

$$\begin{aligned}
\mathcal{L}_{et} = \mathbb{E}_t \sum_{j=0} \gamma^j \Lambda_{t,t+j} \Bigg[& d_{et+j} \\
& + \lambda_{ct+j} \left(r_{et+j} K_{et+j-1} + B_{et+j} - d_{et+j} - \frac{1 + i_{t+j-1} + \tau_{et+j-1}}{\Pi_{t+j}} B_{et+j-1} - I_{et+j} \right) \\
& + Q_{et+j} \left((1-\delta) K_{et+j-1} + \exp(\zeta_{et+j}) \left[1 - \frac{\varphi_e}{2} \left(\frac{I_{et+j}}{I_{et+j-1}} - 1 \right)^2 \right] I_{et+j} - K_{et+j} \right) \\
& + \mu_{et+j} \left(\theta_e Q_{et+j} K_{et+j} - B_{et+j} \right) \Bigg]
\end{aligned} \tag{C.23}$$

Equilibrium conditions:

$$1 = \lambda_{et} \tag{C.24}$$

$$\lambda_{et} = \mu_{et} + \mathbb{E}_t \gamma m_{t,t+1} \lambda_{et+1} \frac{1 + i_t + \tau_{et}}{\Pi_{t+1}} \tag{C.25}$$

$$Q_{et} = \mathbb{E}_t \gamma m_{t,t+1} \left[(1-\delta) Q_{et+1} + \lambda_{et+1} r_{et+1} \right] + \mu_{et} \theta_e Q_{et} \tag{C.26}$$

$$\begin{aligned}
\exp(\zeta_{et}) Q_{et} = {} & \lambda_{et} + \exp(\zeta_{et}) Q_{et} \frac{\varphi_e}{2} \left(\frac{I_{et}}{I_{et-1}} - 1 \right) \left(3 \frac{I_{et}}{I_{et-1}} - 1 \right) \\
& - \mathbb{E}_t \gamma m_{t,t+1} \exp(\zeta_{et+1}) Q_{et+1} \varphi_e \left(\frac{I_{et+1}}{I_{et}} - 1 \right) \left(\frac{I_{et+1}}{I_{et}} \right)^2
\end{aligned} \tag{C.27}$$

$$K_{et} = (1-\delta) K_{et-1} + \exp(\zeta_{et}) \left[1 - \frac{\varphi_e}{2} \left(\frac{I_{et}}{I_{et-1}} - 1 \right)^2 \right] I_{et} \tag{C.28}$$

$$\mu_{et} \left(\theta_e Q_{et} K_{et} - B_{et} \right) = 0 \tag{C.29}$$

$$d_{et} + \frac{1 + i_{t-1} + \tau_{et-1}}{\Pi_t} B_{et-1} + I_{et} = r_{et} K_{et-1} + B_{et} \tag{C.30}$$

C.4 Financial intermediaries

Balance sheet:

$$B_t = S_t + D_t \tag{C.31}$$

Leverage constraint:

$$S_t \geq \kappa_t B_t \tag{C.32}$$

Objective:

$$\Pi_{bt} = i_t B_t - i_{st} S_t - i_{dt} D_t \tag{C.33}$$

Equilibrium conditions:

$$B_t = S_t + D_t \tag{C.34}$$

$$S_t = \kappa_t B_t \tag{C.35}$$

$$i_t = (1-\kappa_t) i_{dt} + \kappa_t i_{st} \tag{C.36}$$

$$\kappa_t = \kappa + \zeta_{\kappa t} \tag{C.37}$$

C.5 Households

Budget constraint:

$$C_t + T_t + D_t + S_t + \frac{\psi}{2}\left(\frac{S_t}{\bar{S}_t} - 1\right)^2 \bar{S}_t \leq w_t N_t + \frac{1+i_{dt-1}}{\Pi_t} D_{t-1} + \frac{1+i_{st-1}}{\Pi_t} S_{t-1} + d_{Ht} + d_{Lt} + d_t \tag{C.38}$$

Objective:

$$\mathcal{V}_t = \mathbb{E}_t \sum_{j=0}^{\infty} \beta^j \exp(\zeta_{c_{t+j}}) \Big(\frac{\left(C_{t+j} - h\bar{C}_{t+j-1}\right)^{1-\sigma}}{1-\sigma} - \chi \frac{N_{t+j}^{1+\varphi}}{1+\varphi} \Big) \tag{C.39}$$

Equilibrium conditions:

$$w_t = \frac{\chi N_t^{\varphi}}{U_{ct}} \tag{C.40}$$

$$1 = \mathbb{E}_t \left[m_{t,t+1} \frac{1+i_{dt}}{\Pi_{t+1}} \right] \tag{C.41}$$

$$1 + \psi \left(\frac{S_t}{\bar{S}_t} - 1 \right) = \mathbb{E}_t \left[m_{t,t+1} \frac{1+i_{st}}{\Pi_{t+1}} \right] \tag{C.42}$$

$$C_t + T_t + D_t + S_t + \frac{\psi}{2}\left(\frac{S_t}{\bar{S}_t} - 1\right)^2 \bar{S}_t = w_t N_t + \frac{1+i_{dt-1}}{\Pi_t} D_{t-1} + \frac{1+i_{st-1}}{\Pi_t} S_{t-1} + d_{Lt} + d_{Ht} + d_t \tag{C.43}$$

$$\bar{S}_t = \kappa B_t \tag{C.44}$$

$$m_{t,t+1} = \beta \frac{U_{ct+1}}{U_{ct}} \tag{C.45}$$

$$U_{ct} = \exp(\zeta_{c_t}) \left(C_t - hC_{t-1}\right)^{-\sigma} \tag{C.46}$$

C.6 Public authorities

Monetary policy:

$$1 + i_t = (1+i) \Pi_t^{\varphi} \exp(\zeta_{it}) \tag{C.47}$$

Fiscal policy:

$$T_t = G_t = \exp(\zeta_{gt}) \tag{C.48}$$

Credit policy:

$$\tau_{Ht} = \tau_H + \phi_\tau \Bigg((r_{Ht+1} - r_H) - (r_{Lt+1} - r_L) \Bigg) \tag{C.49}$$

$$\tau_{Ht} B_{Ht} + \tau_{LT} B_{Lt} = 0 \tag{C.50}$$

C.7 Exogenous processes

$$\zeta_{\kappa t} = \rho_\kappa \zeta_{\kappa t-1} + \varepsilon_{\kappa t} \tag{C.51}$$

$$\zeta_{Ht} = \rho_H \zeta_{Ht-1} + \varepsilon_{Ht} \tag{C.52}$$

$$\zeta_{Lt} = \rho_L \zeta_{Lt-1} + \varepsilon_{Lt} \tag{C.53}$$

$$\zeta_{at} = \rho_a \zeta_{at-1} + \varepsilon_{at} \tag{C.54}$$

$$\zeta_{nt} = \rho_n \zeta_{nt-1} + \varepsilon_{nt} \tag{C.55}$$

$$\zeta_{it} = \rho_i \zeta_{it-1} + \varepsilon_{it} \tag{C.56}$$

$$\zeta_{\mu t} = \rho_\mu \zeta_{\mu t-1} + \varepsilon_{\mu t} + \mu_p \varepsilon_{\mu t-1} \tag{C.57}$$

$$\zeta_{ct} = \rho_c \zeta_{ct-1} + \varepsilon_{ct} \tag{C.58}$$

C.8 Market clearing

$$B_t = B_{Ht} + B_{Lt} \tag{C.59}$$

$$Y_t = C_t + G_t + I_{Ht} + I_{Lt} + \frac{\psi}{2}\left(\frac{S_t}{\bar{S}_t} - 1\right)^2 \bar{S}_t + \frac{\upsilon}{2}\Big(\Pi_t - 1\Big)^2 Y_t + \sum_{e \in \{L,H\}} \bar{\zeta}_e \frac{u_{et}^{1+\zeta_e} - 1}{1 + \zeta_e} X_{et} \tag{C.60}$$