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Financial Frictions in Endogenous Firm Entry Framework

Tesi di Dottorato di: Sevag Agop
Matricola: 4713617

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Coordinatore: Prof. Rosario Crinò

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To my wife and family

I send my gratitude to all my professors and tutors whom I met during my academic life.

Special thanks to my supervisor Prof. Domenico Delli Gatti, without whom this thesis wouldn't have been accomplished.

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Preface

Business formation is a major source of aggregate fluctuations and job creation, hence it is not surprising that its contraction (in US and Euro Area) in the wake of 2008 financial crisis played an important role in amplifying and propagating the negative consequences on the economy. The period between 2007 and 2010 has witnessed an unprecedented decline of 25 percent in the number of entrants in the United States. This was an outcome driven partly by the tightened credit standards and the fall in lending volumes. Given the significance of firm creation in the economy there has been a growing literature to document firm entry dynamics and to study the role it plays in transmitting various types of shocks. The topic has gained even wider attention after the seminal paper by Bilbiie et al. (2012) in which the authors presented evidence that variation in the number of producers is generally associated to the length of a business cycle. Therefore, they constructed a DSGE model characterized by monopolistic competition and endogenous number of producers, where the latter feature generates an important propagation mechanism of productivity improvements. The setup was able to explain the pro-cyclical behavior of entry and profits. In that paper, broad view of producer entry is taken into account that also incorporates product creation. Later works such as La Croce and Rossi (2018), Bergin et al. (2018) and Siemer (2016) have introduced financial frictions to understand how deterioration in credit conditions would affect the economy through firm entry channel. Having said that, my dissertation also aims to contribute in this regard. Motivated by empirical observations the approach in my thesis is theoretical, which provides a framework to capture some of the transmission channels that were missing in previous works.

Data from the Euro Area in the post-2008 period reveal some interesting patterns on bank loan rates to small and large corporations: The spread between interest rates on large and small loans increased, meanwhile it became greater when the loan volumes got smaller. Studying heterogeneity in the borrowing costs that face enterprises with different sizes dates back to Gertler and Gilchrist (1994) and Bernanke et al. (1994). Considered to be riskier, smaller firms are subject to higher monitoring costs by the lenders and they are more likely to suffer during crisis. But start-ups also rely on bank loans to cover their initial set-up costs and are even more opaque than smaller-younger firms. Robb and Robinson (2014) used confidential data from Kauffman Firm Survey (a survey on around 5,000 new businesses in US) to show that newly founded firms depend heavily on outside debt financing (bank loans and business credit lines). They found that the average quantity of bank funding is seven times greater than the average quantity of inside-financed debt, and that the number of firms relying on external debt is three times larger than the number of firms relying on inside debt. Also, a study on financing start-ups in Italy by Bonaccorsi di Patti and Nigro (2018) conducted on large database between 2003 and 2010 documented that 55% of the start-ups depend on financial intermediaries, mainly banks. In addition, they showed that post-crisis share of start-ups using bank credit declined by five percentage points relative to the pre-crisis share of 50%. Thus, new entrants experience reduced access to external funds and have lower bargaining power during a period of bank funding difficulty. Such frictions play a role in preventing or discouraging start-ups from being launched. In addition, entrants are more vulnerable to changes in bank competition levels. In fact, bank market power presents itself as a barrier to entry as shown by Cetorelli and Strahan (2006). This concludes that financing start-ups plays an important role in transmitting feedback coming from the credit suppliers. In order to capture this link, the first chapter entitled **Sunk Costs and Endogenous Firm Entry: Borrowing From Imperfect Banks** develops a DSGE model characterized by endogenous firm entry and imperfect banking, where both incumbents and entrants borrow from banks in different interest rates. For incumbents, the loans are to cover the production costs, while entrants demand them to finance the initial set-up fees. The introduction of such a friction in the firm entry level allows the endogenous cost of entry to fluctuate in the borrowing costs. I find that the impact of the real and financial shocks is amplified because of the sunk cost upon entry, and that the model exhibits higher volatility as the spread in interest rates on loans gets wider.

This configuration has another advantage when it comes to expansionary monetary shocks. In line with evidence, the model with price rigidity predicts pro-cyclical dynamics for entry in response to exogenous drop in policy rate, which reverses the counter-cyclical behavior of entrants in the original sticky price version of Bilbiie et al. (2007) that contradicted empirical observations. As a result, the model constitutes a step towards richer framework that embeds important features with the aim to investigate further questions in policy intervention analysis.

Going back to the origin of the financial crisis, the burst of house bubbles triggered unparalleled amounts of loan defaults, which gives rise to a legitimate question: How the process of firm creation was impacted by such events? Taking a look at US quarterly data on establishment birth rates and bank charge off rates gives us some insight on the magnitudes of those rates' deviations from their averages[1]. For the sample period 1992:Q3-2019:Q4 the mean birth annual rate is 13.43%, while the charge-off rate's is 0.86%. However, the birth rates declined significantly during the Great Recession hitting its lowest level of 11.46% in 2009 which constituted 8.68% decrease from the previous year's rate and 14.63% from the mean. Meanwhile, there was a sharp rise in charge off rates in the same period with the rate reaching its highest level of 2.65% in 2009, being 1.43% in 2008.

Analyzing the cyclical behavior of establishment birth levels, bank charge-off volumes, house prices, and their correlation patterns observed in US data especially in the build up to and in the period of Great Recession, suggests that business formation reacted to asset price variations and default surprises, hinting to a crucial role in transmitting house demand shocks and in magnifying the adversity of debt defaults. The second chapter entitled **Loan Defaults in Endogenous Firm Entry Framework** discusses these observations with the aim to study the interaction between house prices, firm entry, and loan defaults. I present evidence through Structural Vector Autoregressive Model (SVAR) that reveals positive pro-cyclical response of birth to house price shock, and negative reaction to loan default shock. Then I develop a DSGE model characterized by endogenous firm entry that is able to predict and explain these responses. The endogeneity of collateral constraint and firm creation is in the core of the model's mechanism which works in the following way: Loan defaults, originated in the household sector and driven by collapse in house prices, distort the flow of credit. The losses incurred by the lenders reduce their ability to extend loans, thus financially constrained entrepreneurs -who rely on external finance to invest in firm entry- are affected as well. These investors experience decline in their collateral value -in this case houses- and face higher borrowing costs. Eventually, number of entrants drops and the contraction in total output is amplified.

The model developed in this chapter is populated by three types of households: lender, "unproductive" borrower, and investor borrower, incorporated with a banking sector in the

[1]Birth rate is the percentage of new created private establishments in the total number of existing ones, while charge-off rate is defined to be the net charge-offs of a bank divided by its outstanding loan amount and expressed as an annual percentage rate. The loan charge off data discussed here are for all bank loans and for all households.

extended version. The default shock is defined as a reallocation of resources from lenders to borrowers as in Iacoviello (2015). In addition, the model distinguishes between two types of default surprises that come from the two distinct types of borrowers, and comparing their implications allows us to highlight the role of the shock's origin in the amplification story. House preference shock is also studied which can be perceived as house demand shift that is directly responsible in relaxing or tightening the collateral constraint of the borrowers. Also, the agents are heterogeneous across their masses, a feature that plays a role in the size of the shock's impact. Last but not least, some second moments generated by the model with its extended version are reasonably close to their data counterparts, particularly the standard deviations of the relevant variables as fractions to the output's.

Given the importance of firm creation in business cycle, the two chapters investigate some important channels that affect firm entry, particularly the ones that have impact on the access to external finance. In times of funding difficulties it is highly likely that we fail to observe businesses that would have been created otherwise, an outcome that obviously has an influence on economy's growth. The frameworks developed in this thesis have the potential to be incorporated with additional elements that can study policy measures that target the requirements of funding entrants and their participation in the credit market.

Contents

Chapter 1

Sunk Costs and Endogenous Firm Entry: Borrowing From Imperfect Banks

1.1 Introduction

It is well documented that firm creation is a crucial aspect of business cycles. In the US, adverse financial shocks in 2007-9 years were associated with a fall in the creation of new firms. Many European countries have witnessed similar firm dynamics in the post-2008 period. The declining pattern of number of enterprises and birth rates[1] in that period is evident in Figures 1.1 and 1.2 which display the dynamics in US and several European countries[2]. For all the countries shown, the figures illustrate how the total number of enterprises started to fall in the wake of the financial crisis triggered by the sharp drop in firm entry during year 2008 relative to the previous year. The dynamics in US and UK are quite similar (Figure 1.1), where the recovery started after the recession period and earlier than the European countries -Italy, Spain and Portugal- who were subject to another recession period (2011-2013) and were hit hard during European debt crisis. In the latter countries, it can be noticed that the lower birth levels were prolonged during the second recession and the recovery of enterprise levels was delayed (Figure 1.2).

Evidence also suggests that weaker bank competition serves as a barrier to entry, thus if the initial set-up costs that are necessary to launch start-ups are financed through bank loans, then some aspects of the banking system -like bank market power or unexpected crunch in credit supply- and the presence of dispersion between interest rates of large and small loans should have consequences on firm entry levels. Hence, the aim of this paper is to address the following question: To what extent is the reliance of entrants on bank loans (in their pre-operational phase) important for business fluctuations? In other words, how productivity improvement, credit contraction, bank competition, and monetary shock impact the economy in an environment where entrants demand loans in order to cover their initial set-up costs? To address these issues, I develop a DSGE model characterized by endogenous firm entry and imperfect banking where both incumbents and entrants borrow in different costs. The heterogeneity in borrowing fees affects the fluctuations of the entry cost, whose endogeneity plays an important role in the transmission mechanism. In addition, I extend the model to incorporate nominal rigidity and suggest a new way to reverse the counter-cyclical behavior of

[1] The birth rate is defined as the number of enterprise births divided by the number of active enterprises in the current period.

[2] US data are obtained from Bureau of Labor Statistics, while for the European countries the data are available on Eurostat (Business Demography Statistics).

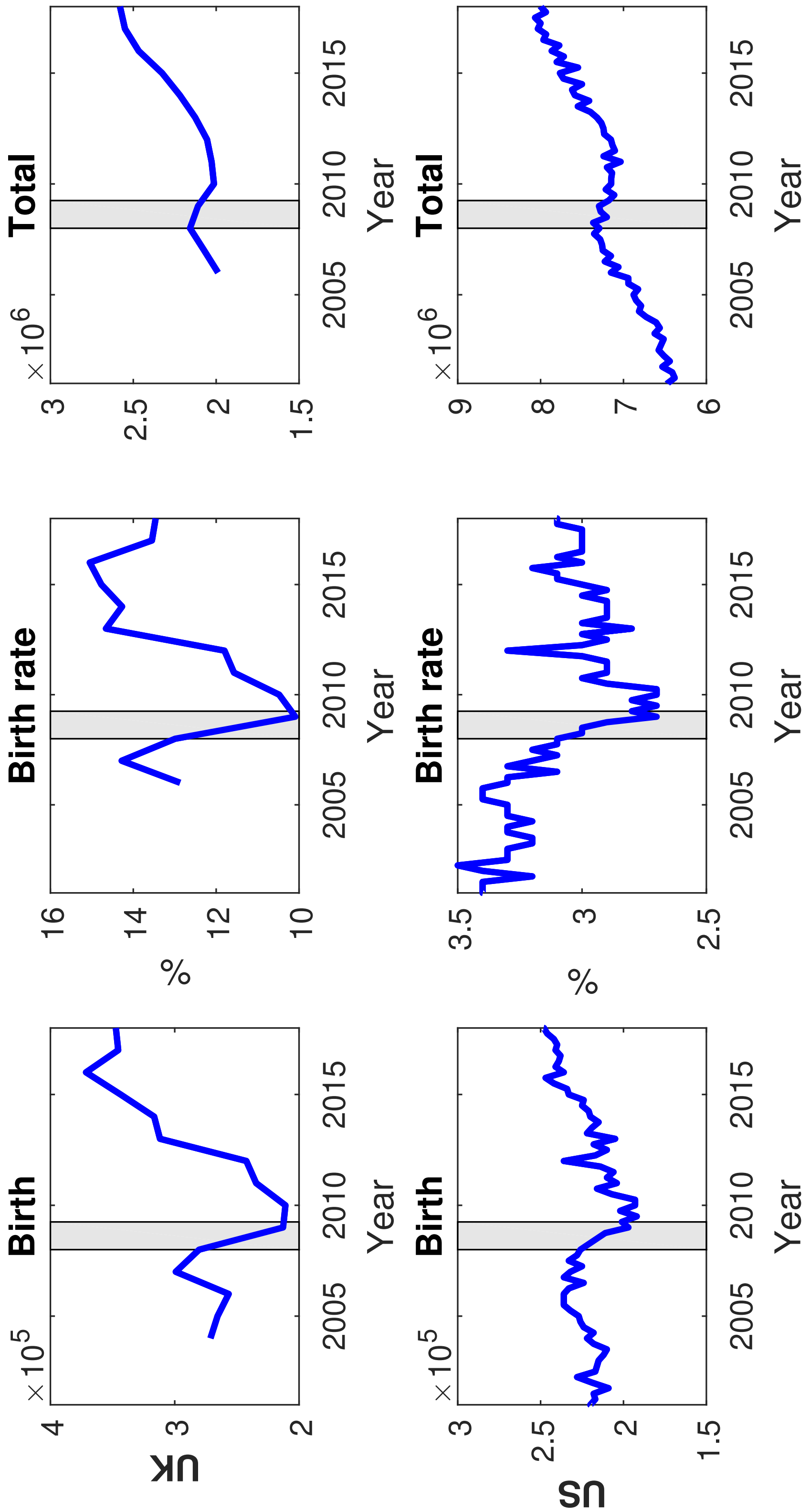

Figure 1.1: Dynamics of birth and total number of enterprises in UK and US (annual data for UK, quarterly data for US).

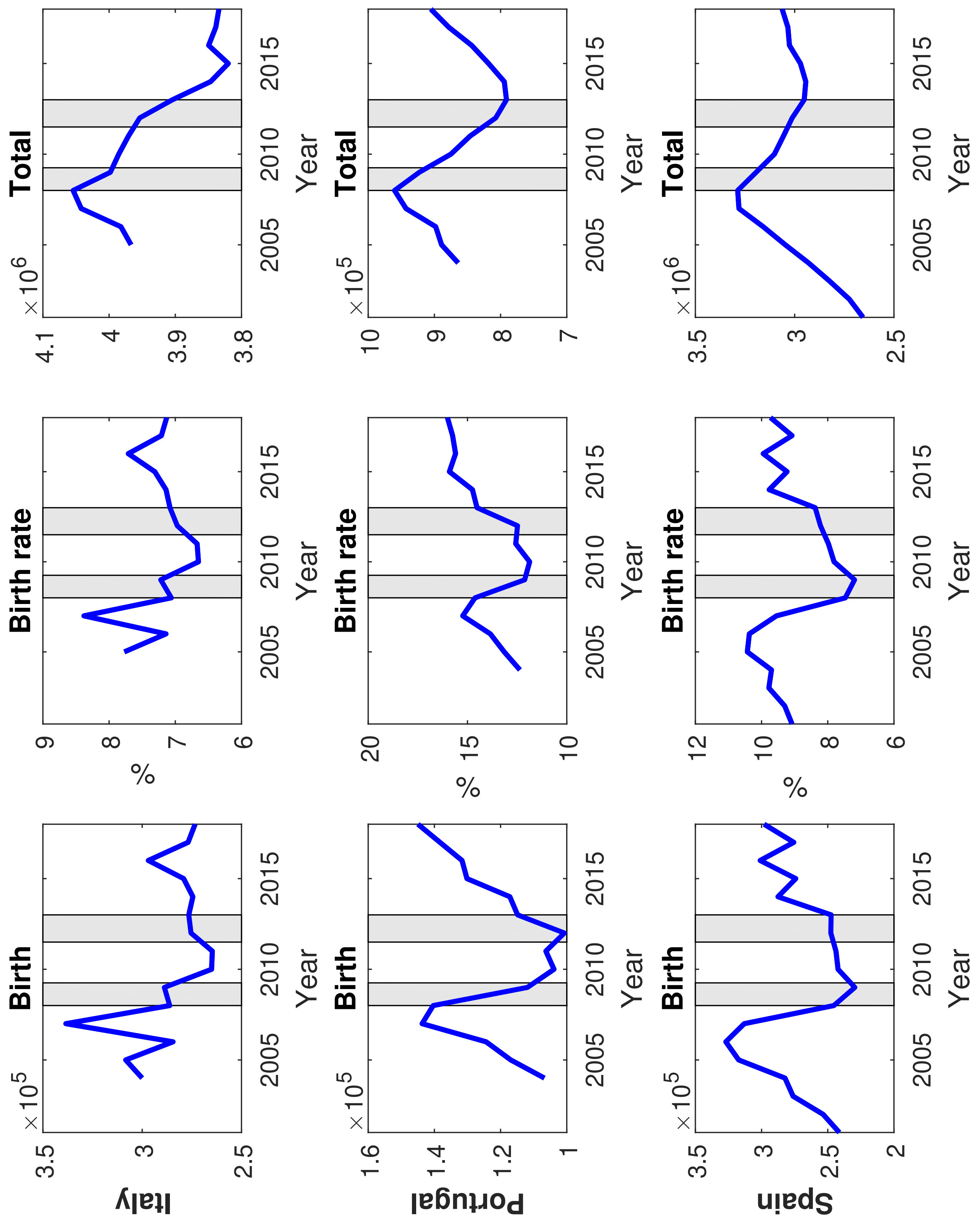

Figure 1.2: Dynamics of birth and total number of enterprises in Italy, Portugal and Spain (annual data).

firm entry in the face of monetary shock which was implied by the original sticky price version of Bilbiie et al. (2007), a response that contradicted the empirical observations.

Many studies were devoted to explain the empirical patterns of procyclicality of firm entry and profits, predicting the transmission of shocks through the extensive margin of investment. Lewis (2006) tested those predictions and found significant response of firm entry to expansionary shocks to productivity, aggregate spending, monetary policy, and entry costs. Also, Broda and Weinstein (2010) provided evidence that net product creation is strongly pro-cyclical in the U.S economy. Bilbiie et al. (2012) set up a DSGE model (henceforth BGM) that successfully explains these empirical patterns, in which the creation of new firms was also interpreted as producing new varieties. They emphasize the importance of endogenous firm entry as a major source of business cycle fluctuations. The model is characterized by endogenous product creation (firm entry) and monopolistic competition with imperfect price adjustments, departing from the assumption of fixed number of firms. They showed how economic expansion implies higher entry rates, and the sunk entry fee introduced in the model generates a new and potentially important endogenous propagation mechanism.

On the other hand, financial frictions are mainly attributed to information asymmetry, which gives rise to heterogeneity in the borrowing costs that face the firms. Large and already established firms have easier access to outside financing compared to the smaller-younger firms, because more information on their creditworthiness is available and they are less likely to default on their debts. The heterogeneity in creditworthiness among large and small firms has been studied before. Gertler and Gilchrist (1994) have studied credit market imperfection's impact, and found that the negative effects on investment tend to be more severe for smaller firms. Also, Bernanke et al. (1994) argued that small firms are likely to bear the burden of an economic downturn due to the higher agency costs they face when borrowing in credit markets. In fact, the reliance of small firms on banks -with fewer external financing choices relative to mature firms- tends to create sharp dispersion in the spread during crisis. Holton and McCann (2017) analyzed the determinants of this spread based on bank data from twelve euro area countries from 2007 to 2015, and found that bank market power can lead to disproportionate rise in lending cost for smaller firms, which in turn worsens the impact of a weak macroeconomy. Figure 1.3 shows the monthly evolution of the spread between annualized interest rates charged on small and large bank loans that are extended to corporations in the euro area. These loans serve as a proxy for loans to small and large enterprises[3]. The blue plot represents the ratio between the borrowing costs of loans that are up to €1 million and that are over €1 million, while the red one plots the ratio between the interest rates of small loans that are below €0.25 million and large loans that are over €1 million[4]. Besides capturing the dispersion in the borrowing fees, these ratios are proxies for the markup applied by the banks on small loans (demanded by small firms and entrants) over the fee on large loans (demanded by incumbents and large corporations). Two pivotal observations appear in this graph. Firstly, it is noticeable that the markup -which captures the spread or the financial fragmentation- increased significantly in the post-2008 period. Secondly, the fragmentation is larger when the loan volumes are smaller (the red plot is always above the blue one), suggesting that smaller enterprises are charged higher interest rates on loans because of the lower bargaining power they have.

However, start-ups are even more opaque than smaller-younger firms and are considered to be riskier therefore they are subject to higher monitoring costs by the lenders, hence the negative shocks would affect them in a stronger manner even in the pre-production stage of the firm's life cycle. Empirical observations suggest that bank concentration implies less entry,

[3]Data on bank interest rates for different loan categories to corporations are provided online by European Central Bank (MIR - MFI Interest Rate Statistics).

[4]Data for loans below €0.25 million before year 2010 are not available.

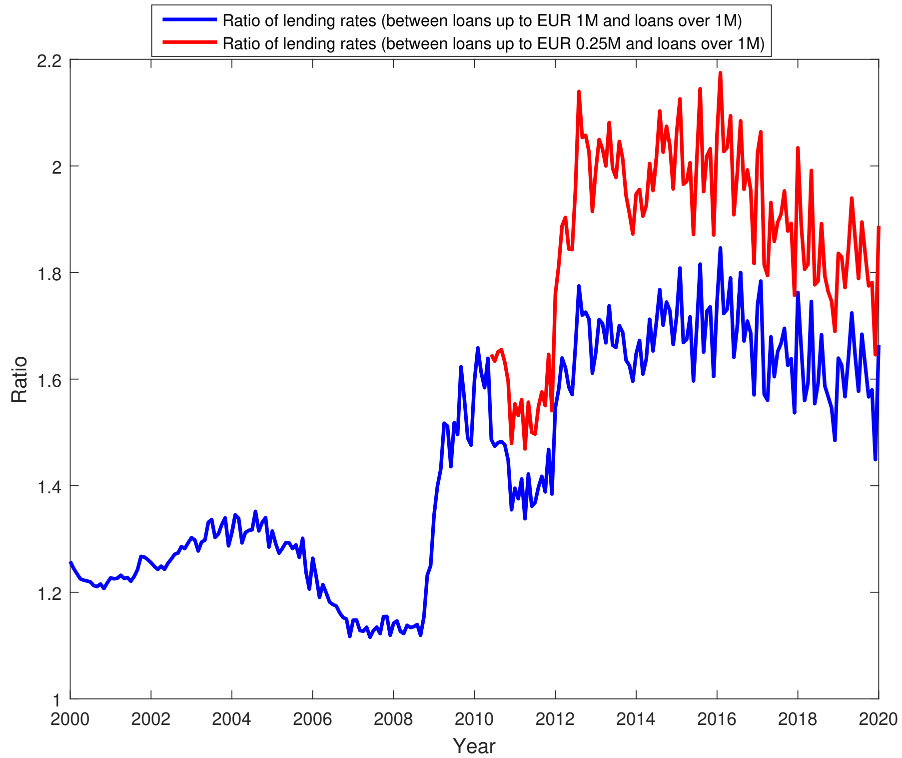

Figure 1.3: Spread in the annualized interest rates between large and small loans (Euro area).

given that a potential entrant finds it more difficult to gain credit access. Cetorelli and Strahan (2006) have investigated the direct impact of bank market power on the industry structure in a study conducted on US local markets for banking and non-financial sectors. They found that higher bank competition is associated with greater entry and increasing number of total establishments and with smaller average firm size, whereas no effect is detected on large firms mainly because of their access to various financial resources. It is not surprising that young businesses were hit relatively hard in the Great Recession, thus the channel through which the shock is transmitted is not only through existing producers. Although incumbent firms are indeed affected by disturbances generated in the financial sector, the entrants are also subject to these impacts significantly. In addition to the use of inside resources (family, friends), start-ups in their initial stages of life also rely on bank debt to cover their initial sunk costs. Robb and Robinson (2014) discussed evidence from the US supporting this claim. They used restricted-access version of data from Kauffman Firm Survey[5] and found that newly launched firms are financially dependent on external channels and bank debt to a surprising high degree. They documented that the average amount of bank funding is seven times greater than the average amount of inside-financed debt, while firms that rely on outside debt are three times as many as the ones that rely on inside debt. Furthermore, Bonaccorsi di Patti and Nigro (2018) studied a large database of Italian start-ups between 2003 and 2010, finding that 55% of the start-ups depend on external finance, mostly from banks[6]. Furthermore, they showed that post-crisis share of start-ups borrowing from banks declined by five percentage points relative to the pre-crisis share of 50%, pointing out that tighter credit supply conditions would discourage or prevent new businesses to start, acting as a selection mechanism at birth. In a study by Siemer (2016) on the financial crisis in US, the author attributed the slow recovery after the crisis to the reduction of the number of firms, driven by the inability of new businesses to get sufficient

[5]The Kauffman Firm Survey is an annual survey of 4,928 newly formed businesses in US (birth year of those strat-ups is 2004).

[6]Another study conducted on Belgian start-ups concludes that bank debt is the most important source of their funding (see Deloof and Vanacker (2018)).

funds, documenting that small business loans fell sharply by 4% in 2009, and 6% in 2010. These facts suggest that firm creation and its expansion play a crucial role in transmitting financial shocks, and that the extensive margin of activity has non-negligible impact on the economy[7].

Based on this, I focus in this study on business formation's channel through a DSGE set-up characterized by endogenous firm entry and monopolistic banking. The latter is a feature presented by Gerali et al. (2010) in a DSGE model where they introduced imperfectly competitive banking sector in order to understand the role of banking in the transmission of monetary impulses and credit supply shocks to the real economy. In order to link firm entry with imperfect banks, La Croce and Rossi (2018) built a DSGE model to study firms dynamics in the presence of inefficient banks that cannot ensure against the risk of firms default. They found that endogenous entry serves as propagation mechanism for both real and financial shocks, and that the response of the economic activity is more persistent. They described financial frictions by assuming that only the operating firms borrow from banks in order to cover their production costs. However in this work I add another friction, in addition to the incumbent the novelty is to assume that entrants rely on bank funds to cover their initial sunk costs. This is the crucial modeling device that captures how financial shocks affect the economy by influencing the financial needs of the entrants. I also model heterogeneity in the borrowing fees that face the firms, which creates dispersion that reflects the diversity in the creditworthiness between incumbents and entrants, an important element to explain the immediate impact of shocks on entry cost. The endogenous dynamics of entrants' borrowing cost -connected to the monopolistic nature of banks- lie at the core of our model, and its higher volatility than incumbents' borrowing cost causes fluctuations in entry cost. On the other hand, Bergin et al. (2018) have studied the need of firm's external borrowing for its startup costs through the endogenous choice between alternative means of financing, and found that financial shocks are propagated through firm entry. However, their model is absent of imperfect banking system, hence fluctuations in loan rates spread are not taken into account, nor the impact of competition among monopolistic banks upon entry.

Number of key results emerge from the model. Firstly, the impact of the shocks is amplified compared to a model without borrowing in the entrant's level and to a model without a spread in borrowing costs. Moreover, larger spreads in interest rates on loans imply higher volatility of firm entry and output. Secondly, in response to an increase in bank concentration (decrease in bank competition) the number of entrants declines hence the total number of firms as well. Thirdly, in the face of tighter credit supply number of entrants drops and the recovery of the economy is delayed, a result that is in line with the findings of Siemer (2016), who argues that a portion of bank dependent stat-ups failed to enter the market during the financial crisis, and the recession was prolonged because of missing generation of firms. The model also predicts that the ratio of entrant loans to total loans decreases after credit crunch which coincides with the finding by Bernanke et al. (1994) which states that borrowers who face higher agency costs should end up receiving relatively lower share of extended credit. Fourthly, unlike the benchmark sticky price model of Bilbiie et al. (2007), our model with nominal rigidity predicts a rise in both firm entry and consumption in the wake of an exogenous contraction in policy rate thanks to entry cost's dependence on borrowing fee, a result that agrees with empirical evidence provided by Bergin and Corsetti (2005), Lewis (2009), and Poutineau and Vermandel (2015). The latter evaluated the effect of financial frictions on the extensive margin of activity by estimating a model on US data over a sample period from 1993 to 2012, and their main result was that restrictive monetary policy is followed by a drop in the number of firms, and that the bank lending conditions is a transmission channel for monetary policy shocks, also stating that

[7] Many findings also highlighted the role of new young businesses in job creation as well, and captured the importance of financial constraints that face small-young firms in explaining the unemployment dynamics around the Great Recession (see Haltiwanger et al. (2013) and Duygan-Bump et al. (2015)).

financial shocks had depressing impact on firm entry since 2009. Apart from entry, the role of firm's exit was explored by Rossi et al. (2015) and Rossi (2019) in a NK-DSGE framework and monopolistic banking where the firms' exit is endogenous as well as the entry, and the authors underlined the exit margin as another important transmission channel of shocks. The model anticipated endogenous counter-cyclical number of firms destruction, and generated a stronger propagation mechanism compared to efficient banks model. In line with the empirical patterns and the theoretical DSGE models developed so far, we notice that firms' entry link between the economy and the credit suppliers represents an important transmission channel, since financial ability is a critical factor in determining the creation of a firm. Moreover, our qualitative conclusions remain unchanged by considering other types of entry costs.

In what follows, section 1.2 presents the baseline model with flexible prices, section 1.3 demonstrates the results, section 1.4 extends the model by incorporating sticky prices, section 1.5 considers other entry cost definition, and section 1.6 concludes.

1.2 The Baseline Model

The economy in the baseline model is populated by households, firms and banks. Banks operate under monopolistic competition, who as financial intermediaries get deposits from the households at the policy rate and supply loans to the two types of firms: incumbents and entrants. To introduce heterogeneity between the borrowing costs of the two types, suppose that incumbents borrow at a rate i_t^I whereas the entrants borrow at higher rate i_t^E assuming that monopolistic banks are able to exercise their market power only on entrants. This assumption reflects the fact that bank competition has no significant effect on large establishments, an observation that is documented by Cetorelli and Strahan (2006). The dispersion in the lending fees is crucial for the analysis of this study, as I want to isolate the impact of the shocks on the entrants in order to understand how credit weakening and bank competition affect the economy through entry costs and firm creation process. Both incumbents and entrants borrow at the start of the period to cover their production and entry fees respectively, and repay them back with their respective interests at the end of the period. This feature introduces a cost channel where the marginal cost depends directly on the borrowing fee (see Ravenna and Walsh (2006)).

In the following subsections I present and solve each agent's problem and provide the associated conditions.

1.2.1 Household

A representative household has a unit mass. She consumes, works, lends deposits to the banks at the policy rate, and buys equity shares from the incumbent firms as well as the entrants. On her income side, she receives wages, interests on the deposits, and dividends from producing firms. The household maximizes the following expected utility:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \Big[\log C_t - \frac{{L_t}^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}} \Big] \tag{1.1}$$

where C_t is the basket of consumption goods produced by the incumbent firms and aggregated through CES preferences:

$$C_t = \Big[\int_{N_t} C_{i,t}^{\frac{\theta-1}{\theta}} \, di \Big]^{\frac{\theta}{\theta-1}} \tag{1.2}$$

$\theta > 1$ is the elasticity of substitution across the goods. Accordingly the "appropriate" CPI is:

$$P_t = \Big[\int_{N_t} P_{i,t}^{1-\theta} di\Big]^{\frac{1}{1-\theta}} \tag{1.3}$$

The demand for each consumption good can be obtained by minimizing total expenditure $\int_{N_t} P_{i,t}C_{i,t}di$, hence it is:

$$C_{i,t} = \Big(\frac{P_{i,t}}{P_t}\Big)^{-\theta} C_t \tag{1.4}$$

The household is subject to the following budget constraint (in real terms):

$$C_t + D_t + v_t(N_t + N_t^E)x_{t+1} \leq w_t L_t + \frac{(1+i_{t-1})}{1+\pi_t} D_{t-1} + (d_t + v_t)N_t x_t \tag{1.5}$$

D_t represents desired loans supplied by the household to the banks (deposits) at the nominal interest rate i_t (the policy rate), while $\pi_t \equiv \frac{P_t - P_{t-1}}{P_{t-1}}$ is the inflation rate. L_t is labor supplied by the household to both incumbents and entrants, while w_t is the real wage.

As in BGM the household buys equity shares from both existing firms (incumbents) and start-up firms (entrants). x_t represents the share invested in each firm, v_t is firm's real value of share, N_t is the number of operating firms, N_t^E is the number of new entries (or the number of new varieties) and d_t is the real dividends received from each incumbent.

The Lagrangian of the household's maximization problem is the following:

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta^t \Big[\log C_t - \frac{L_t^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}} + \lambda_t\big(w_t L_t + \frac{1+i_{t-1}}{1+\pi_t} D_{t-1} + (d_t+v_t)N_t x_t - C_t - D_t - v_t(N_t+N_t^E)x_{t+1}\big)\Big]$$

In each period t the household chooses C_t, D_t, L_t, x_{t+1}, and the first order conditions are:

$$[C_t] : \lambda_t = \frac{1}{C_t} \tag{1.6}$$

$$[D_t] : \frac{1}{1+i_t} = E_t\Big[\beta \frac{C_t}{C_{t+1}} \frac{1}{1+\pi_{t+1}}\Big] \tag{1.7}$$

$$[L_t] : \frac{w_t}{C_t} = L_t^{\frac{1}{\varphi}} \tag{1.8}$$

$$[x_{t+1}] : v_t = (1-\delta)E_t\Big[\beta \frac{C_t}{C_{t+1}}(d_{t+1} + v_{t+1})\Big] \tag{1.9}$$

where λ_t is the Lagrange multiplier in period t attached to the budget constraint and $E\big[.\big]$ is the expectation operator. Equation (1.7) represents the consumption Euler equation, while (1.8) is the labor supply and (1.9) is the Euler equation for share holding. To get (1.9) we used the law of motion of the number of firms: $N_{t+1} = (1-\delta)(N_t + N_t^E)$, where δ is the fraction of existing firms that exits the market ($(1-\delta)$ is the survival rate). From (1.9) we can solve for the value of the firm by forward looking, without speculative bubbles:

$$v_t = E_t \sum_{s=1}^{\infty} Q_{t,t+s} d_{t+s} \tag{1.10}$$

where $Q_{t,t+s} \equiv \big[\beta^s (1-\delta)^s \frac{C_t}{C_{t+s}}\big]$ is household's stochastic discount factor. This expression means that firm's current value (both for entrants and incumbents) is equal to the expected future stream of profits, as both types face the same survival rate and production in the subsequent periods.

1.2.2 Firms

Incumbents (Operating Firms)

There is a continuum of incumbents located on a segment with mass N_t. They produce differentiated consumption goods under monopolistic competition in a flexible price setting using only labor, with substitutability between goods $\theta > 1$. Firm i maximizes each period's real profits by choosing labor $L_{C,i,t}$ and the price of the good $P_{i,t}$ using the technology $Y_{C,i,t} = A_t L_{C,i,t}$. The firm faces the following demand curve:

$$Y_{C,i,t} = \left(\frac{P_{i,t}}{P_t}\right)^{-\theta} Y_{C,t} \tag{1.11}$$

where $Y_{C,t}$ is the total consumption output and P_t is the price index.

They also borrow the amount $b^I_{i,t}$ from banks at the beginning of the period to pay wages with borrowing cost i^I_t, hence: $b^I_{i,t} = w_t L_{C,i,t}$ to be paid back with interests at the end of the period.

Let $\mu_{i,t}$ be the real marginal cost that faces the incumbent, hence the Lagrangian associated to the maximization problem is:

$$\mathcal{H} = \left(\frac{P_{i,t}}{P_t}\right)^{1-\theta} Y_{C,t} - (1 + i^I_t) w_t L_{C,i,t} + \mu_{i,t}\Big[- \left(\frac{P_{i,t}}{P_t}\right)^{-\theta} Y_{C,t} + A_t L_{C,i,t}\Big]$$

Hence, the first order conditions are:

$$[L_{C,i,t}] : \mu_{i,t} = (1 + i^I_t)\frac{w_t}{A_t} \tag{1.12}$$

$$[P_{i,t}] : \frac{P_{i,t}}{P_t} = \frac{\theta}{\theta - 1}\mu_{i,t} \tag{1.13}$$

where equation (1.13) represents the relative price that firm i chooses at period t.

Finally, the firms' outputs will be aggregated to produce the final good according to the CES technology:

$$Y_{C,t} = \Big[\int_{N_t} Y_{C,i,t}^{\frac{\theta-1}{\theta}} di\Big]^{\frac{\theta}{\theta-1}} \tag{1.14}$$

We impose symmetry among the operating firms, hence from the aggregate output (1.14) we find:

$$Y_{C,t} = N_t^{\frac{\theta}{\theta-1}} Y_{C,i,t} \tag{1.15}$$

This can be combined with the demand schedule (1.11) to find the variety effect on pricing:

$$\rho_t = N_t^{\frac{1}{\theta-1}} \tag{1.16}$$

where we denoted $\rho_t \equiv \frac{P_{i,t}}{P_t}$ as the relative price. Note that N_t enters the equations describing the final output and the relative price, where the latter reflects consumer's love for variety. Symmetry among the operating firms also yields the following total loan demand and total labor demand for production purposes:

$$b^I_t = N_t b^I_{i,t} \tag{1.17}$$

$$L_{C,t} = N_t L_{C,i,t} \tag{1.18}$$

This allows us to rewrite the consumption output (1.15) in terms of N_t in the following form:

$$Y_{C,t} = N_t^{\frac{1}{\theta-1}} A_t L_{C,t} \tag{1.19}$$

The incumbent's profits d_t can be derived starting from the following expression:

$$d_t = \rho_t Y_{C,i,t} - (1 + i_t^I) w_t L_{C,i,t}$$

This can be elaborated using the first order conditions (1.12) and (1.13) and the demand curve equation (1.11), hence it becomes:

$$d_t = \frac{1}{\theta} \rho_t^{1-\theta} Y_{C,t}$$

Finally, by plugging in the variety effect equation (1.16) we obtain the expression that describes firm profits:

$$d_t = \frac{1}{\theta} \frac{Y_{C,t}}{N_t} \tag{1.20}$$

Entrants (The Creation of New Varieties)

At the start of each period a prospective entrant j faces an initial fixed sunk entry fee of f_E units of effective labor, which is equal to $w_t \frac{f_E}{A_t}$ units of consumption goods, which represents the real wages paid to the labor units devoted to firm creation purpose. We assume that the entrant borrows $b_{j,t}^E$ from the bank, an amount that is equal to the entry fee, hence: $b_{j,t}^E = w_t \frac{f_E}{A_t}$. The borrowing cost is i_t^E and the loan is to be paid back at the end of the period with interests after selling the shares of the new created firm to the household. The value of the share (the value of the new firm or new variety) is anticipated correctly by the entrant which is computed according to (1.10), and entry occurs until firm value matches the total debt (total cost of entry), hence until the following condition is satisfied:

$$v_t = f_E (1 + i_t^E) \frac{w_t}{A_t} \tag{1.21}$$

We denote the total number of new entrants by N_t^E and the quantity of labor needed to create those firms (new varieties) by L_t^E, therefore the relationship between the two quantities can be described by the following equation:

$$N_t^E = \frac{A_t L_{E,t}}{f_E} \tag{1.22}$$

Finally, the total amount of borrowing by all entrants is $N_t^E b_{j,t} = N_t^E w_t \frac{f_E}{A_t}$ or simply: $b_t^E = w_t L_t^E$.

The addition of borrowing cost to the entrant's problem will have amplifying impact on the economy directly through entry channel by affecting the cost of new firm creation. Any change in the cost of external financing will have an impact on the entry cost for the bank dependent entrants, hence on the mass of new firms.

New entrants start to produce next period allowing a one period time to build lag in the model. We assume $\delta \in (0, 1)$ to be a death shock that hits all firms of both types at the end of each period, which causes a constant fraction δ of the existing firms to exit the market, implying the following law of motion for the operating number of firms in the economy:

$$N_t = (1 - \delta)(N_{t-1} + N_{t-1}^E) \tag{1.23}$$

Finally, given that the value of the share is based on future expected profits, then the values of new and existing firms are the same. This is because both types of firms expect the same future profits and face the same death shock at the end of the period.

1.2.3 The Bank Sector

We model the bank sector as a variant of Gerali et al. (2010). There are two branches in the banking sector: the wholesale branch and the retail branch. The latter has a unit mass and operates in an imperfect competition regime. Before modeling each sector, we present the demand side of the loans.

The Loans Demand

Recall that banks can exercise their market power only on the entrants hence applying a mark-up over the marginal cost only in the entrants' case. Therefore, we introduce the demand schedule of entrants' loans. We assume that loan demand b_t^E is an aggregate CES basket of differentiated loans $b_{j,t}^E$, each supplied by a bank j, while the elasticity of substitution between the loans is $\theta_t^b > 1$:

$$b_t^E = \left[\int_0^1 {b_{j,t}^E}^{\frac{\theta_t^b - 1}{\theta_t^b}} dj \right]^{\frac{\theta_t^b}{\theta_t^b - 1}} \tag{1.24}$$

Given the Dixit-Stiglitz framework the entrant decides the amount of loans needed by minimizing the total repayments $\int_0^1 i_{j,t}^E b_{j,t}^E dj$ given the interest rate $i_{j,t}^E$ charged by bank j. Hence the demand function of loans by the entrant from bank j can be derived:

$$b_{j,t}^E = \left(\frac{i_{j,t}^E}{i_t^E} \right)^{-\theta_t^b} b_t^E \tag{1.25}$$

where i_t^E is the aggregate interest rate charged on loans to entrants by the banks, which is defined by the following expression:

$$i_t^E = \left[\int_0^1 {i_{j,t}^E}^{1-\theta_t^b} dj \right]^{\frac{1}{1-\theta_t^b}} \tag{1.26}$$

The Wholesale Branch

We assume that the wholesale branch collects the deposits from the households at the policy rate i_t, and issues intra-bank loans B_t to the retail sector at the rate i_t^W by combining the deposits D_t and bank capital K_t. In doing so, they are subject to quadratic adjustment costs whenever the capital-to-assets ratio $\frac{K_t}{B_t}$ deviates from a certain value ν^b:

$$adj_t^b = \frac{\kappa}{2} \left(\frac{K_t}{B_t} - \nu^b \right)^2 K_t \tag{1.27}$$

As to be seen next, this cost which is related to the capital position of the bank allows us to study the impact of credit contraction originated from the bank sector. Bank capital is accumulated through the following law of motion in nominal terms: $K_t^N = \big((1-\eta)K_{t-1}^N + J_{t-1}^{N,b}\big)\epsilon_t^K$, therefore it can be expressed in real terms:

$$K_t = \frac{1}{1+\pi_t} \Big((1-\eta)K_{t-1} + J_{t-1}^b \Big) \epsilon_t^K \tag{1.28}$$

where J_t^b is the real profits made by the retail sector, and η measures resources used in managing bank capital. ϵ_t^K is an AR(1) process that highlights a shock to the bank capital.

The wholesale branch maximizes its profits by choosing the amount of deposits D_t and the amount of loans B_t to the retail branch, subject to the balance sheet constraint:

$$\max_{\{D_t, B_t\}} (1 + i_t^W) B_t - (1 + i_t) D_t - K_t - \frac{\kappa}{2} \left(\frac{K_t}{B_t} - \nu^b \right)^2 K_t$$

$$\text{s.t:} \qquad B_t = D_t + K_t \tag{1.29}$$

The FOCs of the problem implies a spread between the intra-loan rate i_t^W and the policy rate i_t, which can be described by the following equation:

$$i_t^W = i_t - \kappa\Big(\frac{K_t}{B_t} - \nu^b\Big)\Big(\frac{K_t}{B_t}\Big)^2 \tag{1.30}$$

This condition highlights the optimal behavior of the bank regarding its choice of extending intra-bank loans given the capital level K_t. As long as there is a spread between the intra-bank loan rate and the policy rate the bank will supply loans to increase its profits. However, this means that capital-to-asset ratio moves further away from the constant value ν^b which implies costs, hence reducing the profits. These two driving forces are opposed to each other, thus dragging the bank to choose the optimal level of loans that equates the marginal cost of reducing the capital-asset-ratio to the policy-loan spread.

Retail Sector for Loans (The Loan Branch)

The retail banks have unit mass and compete under monopolistic competition with flexible rates in the loan market for entrants. Bank j obtains loans $b_{j,t}^E$ from the wholesale branch at the rate i_t^W, and resells them to the entrants after differentiating them. As in La Croce and Rossi (2018), banks are aware of the survival rate of the borrower, hence taking the probability of firm exit δ into account. Then, bank j maximizes its profits by choosing the interest rate $i_{j,t}^E$ while facing a downward sloping demand schedule (1.25):

$$\max_{\{i_{j,t}^E\}} (1 + i_{j,t}^E)(1-\delta)b_{j,t}^E - (1 + i_t^W)b_{j,t}^E$$

In equilibrium, we impose symmetry among the banks, thus: $i_{j,t}^E = i_t^E$ and $b_{j,t}^E = b_t^E$ and the FOC yields to the following equation:

$$i_t^E = \frac{\theta_t^b}{\theta_t^b - 1}\frac{i_t^W + \delta}{1-\delta} \tag{1.31}$$

On the other hand we assume that the loan market for incumbents is perfectly competitive, hence they have access to bank loans at a borrowing fee i_t^I that does not require a bank markup, a rate at which bank profits are zero: $(1 + i_{j,t}^I)(1-\delta)b_{j,t}^I - (1 + i_t^W)b_{j,t}^I = 0$, therefore:

$$i_t^I = \frac{i_t^W + \delta}{1-\delta} \tag{1.32}$$

Note that δ enters into the expressions in such a way that larger exit rate yields higher loan rates. Also, notice that banks can charge higher margins on the entrants because of their monopolistic nature, while the incumbents are unaffected by the type of competition among banks. In addition, θ_t^b is stochastic hence allowing us to examine the influence of bank competition variability on the economy through the entry channel. A positive shock to θ_t^b reduces the mark-up which implies fiercer competition between banks, while a negative shock increases the mark-up and raises the bank concentration.

Finally, bank profits can be characterized by the following expression:

$$J_t^b = i_t^E(1-\delta)b_t^E + i_t^I(1-\delta)b_t^I - \delta B_t - i_t D_t - adj_t^b \tag{1.33}$$

1.2.4 Markets Clearing

The labor market clears when the supply of labor by the household equals the demand by both the incumbents and entrants, hence:

$$L_t = L_{C,t} + L_{E,t} \tag{1.34}$$

While the credit market clears when the following holds:

$$b_t^I + b_t^E = B_t \tag{1.35}$$

Finally the goods market clearing condition is:

$$C_t = Y_{C,t} \tag{1.36}$$

We also denote the total output (GDP) by Y_t, which can be defined as the sum of the total consumption and total investment:

$$Y_t = Y_{C,t} + v_t N_t^E \tag{1.37}$$

1.2.5 Monetary Policy Rule

We complete the model by introducing a proper Taylor rule as monetary policy to pin down the policy rate:

$$\log\left(\frac{1+i_t}{1+i}\right) = \phi_r \log\left(\frac{1+i_{t-1}}{1+i}\right) + (1-\phi_r)\Big[\phi_\pi \log\left(\frac{1+\pi_t}{1+\pi}\right) + \phi_y \log\left(\frac{Y_t}{Y}\right)\Big] \tag{1.38}$$

1.2.6 The Shocks

We analyze the consequences of three types of shocks: TFP shock, bank capital shock, and bank mark-up shock.

The TFP shock can be studied by describing the productivity A_t as an AR(1) process:

$$\log\left(\frac{A_t}{A}\right) = \rho_A \log\left(\frac{A_{t-1}}{A}\right) + u_{A,t} \tag{1.39}$$

In the law of motion of bank capital, we consider ϵ_t^K to be a bank capital shock, hence:

$$\log\left(\frac{\epsilon_t^K}{\epsilon^K}\right) = \rho_K \log\left(\frac{\epsilon_{t-1}^K}{\epsilon_t^K}\right) + u_{K,t} \tag{1.40}$$

Finally, the bank mark-up shock θ_t^b is also described as a stochastic AR(1) process:

$$\log\left(\frac{\theta_t^b}{\theta^b}\right) = \rho_b \log\left(\frac{\theta_{t-1}^b}{\theta^b}\right) + u_{b,t} \tag{1.41}$$

where $u_{A,t}$, $u_{K,t}$ and $u_{b,t}$ are all i.i.d. The summary of the model is inserted in Table 2.3.

1.2.7 The Steady States

We assume that productivity is constant at the steady state: $A_t = A$. We denote the long run levels of the endogenous variables by dropping the time index t from their notations. We define the long run real interest rate to be function of household's discount factor β: $1+r \equiv \frac{1+i}{1+\pi} = \frac{1}{\beta}$. We also consider the steady state inflation rate to be $\pi = 0$, hence $i = r$.

We first compute the steady state levels of the nominal interest rates on the loans. Since ν_b represents the long run level of capital-to-loan ratio, i.e: $K/B = \nu_b$, this implies that $i^W = r$ from (1.30). From (1.32) and (1.31) we get the steady state levels of the interest rates on firm loans:

$$i^I = \frac{r+\delta}{1-\delta} \tag{1.42}$$

$$i^E = \frac{\theta_b}{\theta_b - 1}\frac{r+\delta}{1-\delta} \tag{1.43}$$

From the Euler equation for share holding (1.9) the gross return on investment in new varieties becomes:

$$r^E \equiv 1 + \frac{d}{v} = \frac{1+r}{1-\delta} \tag{1.44}$$

This captures the premium for expected firm destruction. Now we write the long run values in terms of the steady state value of number of goods N. From the FOCs of the incumbent's problem (1.12) and (1.13), and from the variety effect equation (1.16) we compute the long run relative price and wage:

$$\rho = N^{\frac{1}{\theta-1}} \tag{1.45}$$

$$w = A\frac{1}{1+i^I}\frac{\theta-1}{\theta}N^{\frac{1}{\theta-1}} \tag{1.46}$$

From the entry condition (1.21), the firm value is pinned down:

$$v = f_E\frac{1+i^E}{1+i^I}\frac{\theta-1}{\theta}N^{\frac{1}{\theta-1}} \tag{1.47}$$

While from (1.44) we find the profits:

$$d = f_E\frac{r+\delta}{1-\delta}\frac{1+i^E}{1+i^I}\frac{\theta-1}{\theta}N^{\frac{1}{\theta-1}} \tag{1.48}$$

In addition, the long run consumption level can be computed using (1.20) and (1.36):

$$C = f_E\frac{r+\delta}{1-\delta}\frac{1+i^E}{1+i^I}(\theta-1)N^{\frac{\theta}{\theta-1}} \tag{1.49}$$

On the other hand, from the law of motion of the number of firms (1.23) we find that new entrants compensate for the exogenous exit of the operating firms:

$$N^E = \frac{\delta}{1-\delta}N \tag{1.50}$$

which also helps us to express the long run GDP level:

$$Y = f_E\frac{1+i^E}{1+i^I}\frac{1}{1-\delta}\frac{\theta-1}{\theta}\Big[\theta(r+\delta)+\delta\Big]N^{\frac{\theta}{\theta-1}} \tag{1.51}$$

Notice that the heterogeneity in the borrowing costs among the incumbents and the entrants is reflected in the ratio $\frac{1+i^E}{1+i^I}$ which is included in the long run values of the variables.

From both technologies of creating consumption goods (1.19) and creating new firms (1.22), we compute the steady state levels of both types of labor:

$$L_E = \frac{f_E}{A}\frac{\delta}{1-\delta}N \tag{1.52}$$

$$L_C = \frac{f_E}{A}\frac{r+\delta}{1-\delta}\frac{1+i^E}{1+i^I}(\theta-1)N \tag{1.53}$$

While the labor market clearing (1.34) dictates the long run total amount of hours worked:

$$L = \frac{f_E}{A}\Big[\frac{r+\delta}{1-\delta}\frac{1+i^E}{1+i^I}(\theta-1)+\frac{\delta}{1-\delta}\Big]N \tag{1.54}$$

At this stage we can compute the important long run ratios which are presented in Table 1.3. Compared to the benchmark model of BGM, all the expressions that characterize the long run ratios are unchanged, except the share of labor income in GDP. The interest rates on firm loans enter into the latter expression reducing the share of labor income in GDP compared to the BGM counterpart. On the other hand, higher wedge between i^E and i^I -which is captured by the ratio $\frac{1+i^E}{1+i^I}$- implies larger share of incumbent loans in total loans and lower share for entrants.

As stated earlier, the steady state expressions were in terms of N. However, substituting the wage expression in the labor supply schedule (1.8), and by using (1.54) we solve for the total labor steady state level, hence getting the following expression in terms of model's parameters:

$$L = \Big[\frac{\theta-1}{\theta}\frac{1}{1+i^I}+\frac{\delta}{\theta(r+\delta)}\frac{1}{1+i^E}\Big]^{\frac{\varphi}{1+\varphi}} \tag{1.55}$$

Again, note that the presence of the borrowing costs i^I and i^E reduces the long run level of total hours worked relative to its BGM counterpart.

After pinning down the value of L we can easily compute the steady state number of goods N, and eventually for all the other variables.

1.3 Impulse Responses

1.3.1 Calibration

In the model, the periods are considered as quarters hence we set $\beta = 0.99$ which implies 4 percent annualized average interest rate. For the group of parameters θ, φ, δ and f_E I follow the standard calibration used by BGM. For the elasticity of substitution between the intermediate goods I set $\theta = 3.8$, and for the elasticity of labor supply I set $\varphi = 4$. For firm's constant death shock I set $\delta = 0.025$ which implies 10 percent annual production destruction rate, something that is in line with US empirical evidence and also with some European countries[8]. As for the entry fee parameter f_E I set it equal to one without loss of generality, as it does not affect the impulse responses.

We assume that the regulatory required capital-asset ratio is 9%, thus we set $\frac{K}{B} = \nu_b = 0.09$ at steady state which implies a value $\eta = 0.077$ satisfying the requirement (the fixed share of resources used to manage bank capital), while we choose $\kappa = 10.82$ which appears in the adjustment cost of the wholesale branch as in Gerali et al. (2010). For the purpose of choosing the steady state value of the elasticity of substitution between the bank loans that matches its counterpart in Figure 1.3, I first calculate the sample mean of the ratio between the borrowing costs of small and large loans, which serves as a proxy for the markup $\frac{\theta^b}{\theta^b-1}$ applied by the banks on entrant loans (markup over the fee on the incumbent loans). The value of this sample mean is 1.87 which corresponds to a value of $\theta^b = 2.15$.

The steady state productivity level is set at $A = 1$. The persistence of the stochastic AR(1) processes are $\rho_A = 0.975$, $\rho_K = 0.9$ and $\rho_b = 0.9$, while the standard deviations of the

[8]For example, the average annual destruction rate from 2008 to 2018 is 11.77% in the US, 8.95% in Spain, and 11.07% in the UK.

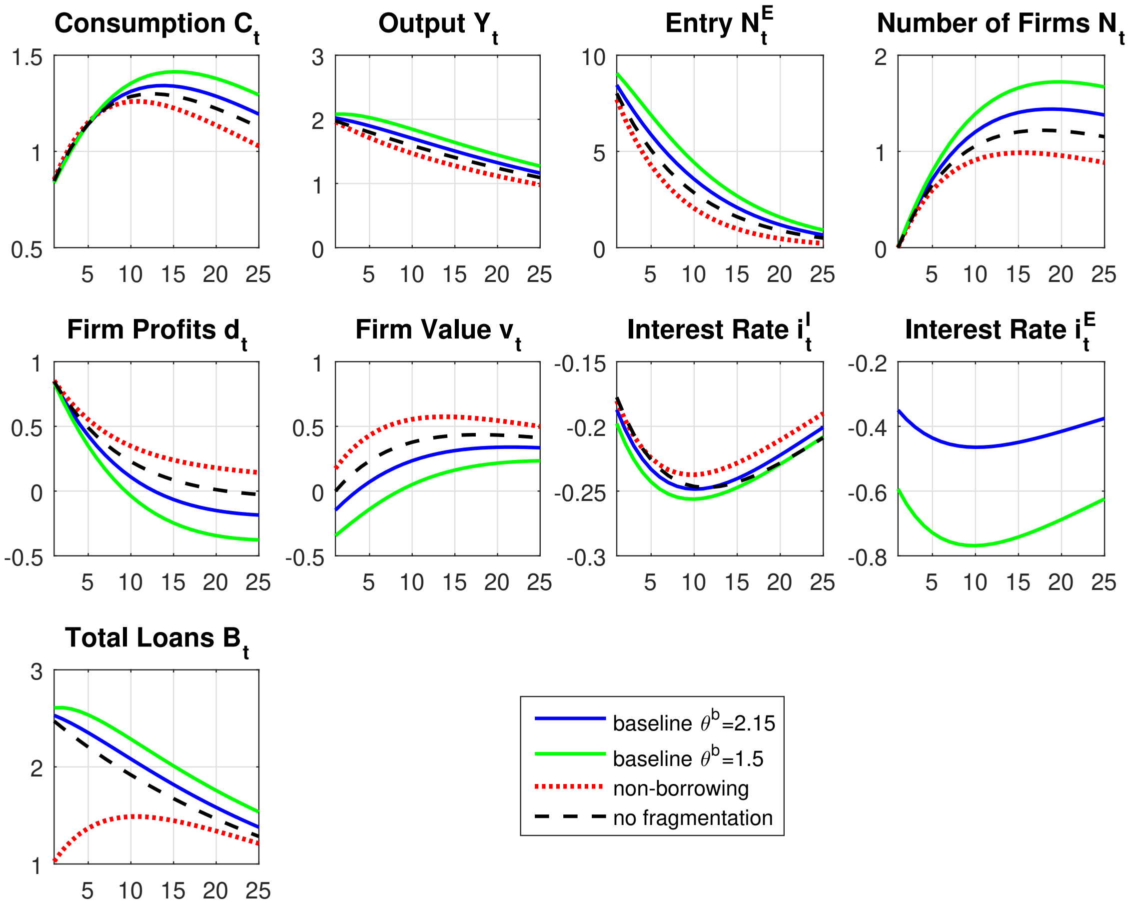

Figure 1.4: IRFs for 1% positive productivity shock.

shocks are set equal to 0.01. Finally, the Taylor rule parameters are: $\phi_r = 0.8$, $\phi_\pi = 1.75$ and $\phi_y = 0.125$, values that are common in the literature.

1.3.2 Productivity Shock

To explore the consequences of entrant's reliance on bank credit and the importance of the diversity in borrowing costs, we compare the impulse responses of the baseline framework for different levels of interest rate spreads to the model without bank finance and to the version without spread. Figure 1.4 displays the impulse responses of the endogenous log-variables to 1% productivity increase[9]. The solid lines represent the IRFs for the baseline model for different spread levels, while the dotted line is for the model where entrants do not borrow (non-borrowing case), and the dashed one is for the case where entrants borrow at the same cost i_t^I as the incumbents (no-fragmentation case).

Productivity improvement generates higher profits expectations because of higher demand for consumption goods. In addition, the decline in policy rate i_t yields to lower interest rate on loans to incumbents i_t^I, hence a fall in production costs and a further increase in profits and loans amount b_t^I. These positive impacts on profits attract firm creation till the entry condition is met. However, since entrants rely on bank financing then entry cost depends on the borrowing fee i_t^E which in turn declines in the policy rate. As a result entry cost drops on impact, and to understand why, it is useful to write it in the following form:

$$c_t^E \equiv f_E(1 + i_t^E)\frac{w_t}{A_t} = f_E\frac{(1 + i_t^E)}{(1 + i_t^I)}\mu_t \equiv f_E S_t \mu_t$$

[9]Simulations are constructed using Dynare.

where we denoted the entry cost by c_t^E and used (1.12) to obtain the expression. Note that the ratio $S_t \equiv \frac{(1+i_t^E)}{(1+i_t^I)}$ captures the heterogeneity between the borrowing costs of incumbents and entrants, hence is equal to 1 in the no-fragmentation case. Since N_t is a state variable then marginal cost μ_t is unchanged on impact (through (1.13) and (1.16)), and the presence of spread between the interest rates drives the ratio S_t down (i_t^E decreases more than i_t^I), which implies a fall in c_t^E in response to positive TFP shock. The drop in entry cost gives an additional boost to the number of entrants which is absent in the non-borrowing and no-fragmentation cases. Eventually, higher investment in new varieties is followed by higher levels of output on impact. Meanwhile, the model demonstrates larger amplification for wider spreads (as shown in the case where $\theta^b = 1.5$).

Note that the number of firms N_t is pre-determined, therefore it starts to increase gradually. In addition to the initial impact, the model exhibits more persistence compared to its other counterparts. The higher persistence in number of entrants implies stronger rise in number of firms but dampened dynamics of firm profits because of the fiercer firm competition, although total profits remain above the steady state during the transition periods. Finally, the consumption is hump-shaped because the household saves by reallocating its labor supply from production of existing goods to variety creation as it becomes more attractive.

1.3.3 Bank Capital Shock

Figure 1.5 demonstrates the impulse responses of a negative bank capital shock. This can represent negative financial shock that comes from the supply side of credit. Credit contraction forces the banks to increase the loan interest rates, which in turn implies lower demand for loans by both entrants and incumbents due to higher borrowing fees. Again, reduced profit expectation -because of higher production costs- is not the only channel through which entry shrinks but also through the higher entry costs as a consequence to the rise in S_t (since i_t^E is more volatile than i_t^I). The baseline model shows stronger negative response by entrants, number of firms, GDP, and loan amounts relative to the non-borrowing and no-fragmentation versions. As noticed, the recovery of the economy is delayed as a result of obstructing new firm creation. Moreover, the model predicts a rise in the incumbent loan share in total loans, combined with a fall in the entrant's share.

1.3.4 Mark-up Shock

Figure 1.6 presents the IRFs for a positive shock on the bank mark-up (negative shock to the substitutability between bank loans), where higher mark-up is interpreted as an increase in bank concentration. In response, competition among monopolistic banks becomes weaker and access to bank finance becomes more limited. Thus entrants are charged at higher rates for their borrowing (a direct effect through equation (1.31)), which results in a decline in firm entry rate and loan volumes due to the higher entry cost c_t^E, hence both investment in new varieties and GDP fall despite of the initial rise in consumption, which is followed by a gradual decline in the number of firms. The movements of i_t^I are purely related to policy rate's dynamics since bank competition does not directly affect the incumbents' borrowing cost. The fall in i_t drags down the loan rate i_t^I, therefore demands for loans and labor by incumbents increase although total labor falls on impact.

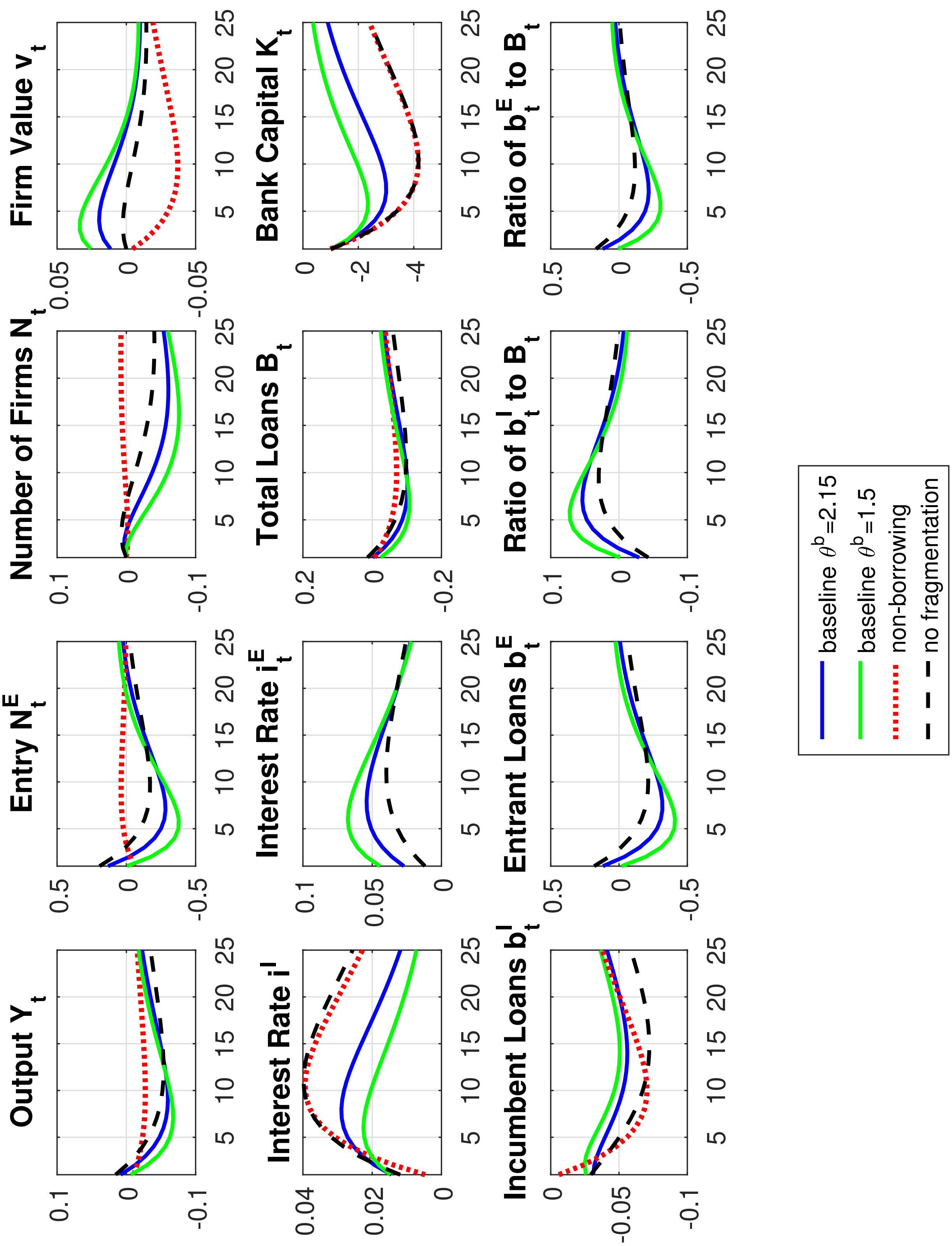

Figure 1.5: IRFs for 1% negative bank capital shock.

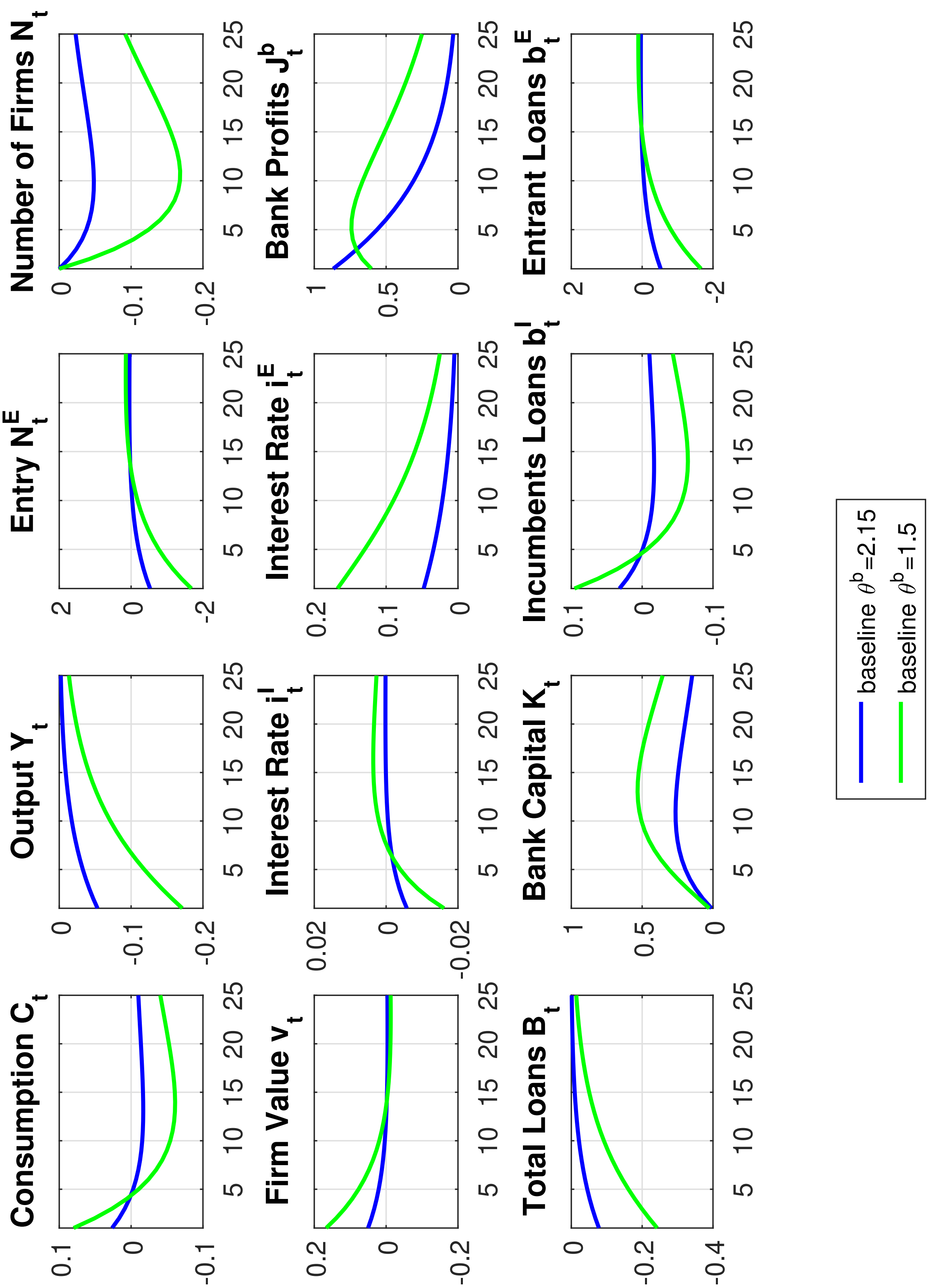

Figure 1.6: IRFs for 1% positive bank mark-up shock

1.4 The Model with Sticky Prices

In this section we extend the model to incorporate nominal rigidity, where incumbents face price adjustment costs expressed in quadratic form (Rotemberg (1982)). The aim is to discuss the cyclical behavior of firm entry as a consequence to expansionary monetary policy.

1.4.1 The Modified Equations

As in the baseline framework, firms are identical in equilibrium. We start by defining the quadratic price adjustment cost's expression:

$$PAC_t \equiv \frac{\gamma}{2}\pi_t^2 Y_{C,t} \tag{1.56}$$

Incorporating this cost, goods market clearing becomes: $Y_{C,t} = C_t + PAC_t$, and is simplified to the following equation:

$$C_t = (1 - \frac{\gamma}{2}\pi_t^2)Y_{C,t} \tag{1.57}$$

By solving firm's problem, the equation for pricing can be written:

$$\rho_t \equiv \frac{P_{i,t}}{P_t} = M_t \mu_t$$

where μ_t is the real marginal cost, and M_t denotes for the markup that can be expressed in the following form[10]:

$$M_t = \frac{\theta}{(\theta-1)(1-\frac{\gamma}{2}\pi_t^2) + \gamma\Big\{(1+\pi_t)\pi_t - \beta(1-\delta)E_t\Big[\frac{1-(\gamma/2)\pi_t^2}{1-(\gamma/2)\pi_{t+1}^2}\frac{N_t}{N_{t+1}}(1+\pi_{t+1})\pi_{t+1}\Big]\Big\}} \tag{1.58}$$

1.4.2 Expansionary Monetary Shock

The benchmark models in both Bilbiie et al. (2007) and Lewis (2009) imply counter-cyclical response of firm entry in the face of expansionary monetary shock, which contracts evidence provided by Bergin and Corsetti (2005) and Lewis (2006). To understand why, consider an exogenous drop in policy rate that generates a boost in consumption and GDP, thus inflation rises. Because of imperfect price adjustment price markup contracts, which in turn drives down profits. These dynamics are accompanied by an increase in real wage (since nominal wages are flexible but prices are sticky) which leads to a rise in the entry cost. On net, firm entry drops. To overcome this contradiction against empirical observations, Bilbiie et al. (2007) has proposed another definition for the sunk entry fee that does not depend on real wages, while Lewis (2009) assumed wage rigidity to dampen the response of real wages and the rise of entry cost. As a result, both mechanisms become predicting pro-cyclical dynamics of firm entry in the face of expansionary monetary policy. However, our model provides another way to overcome the counter-cyclical behavior of firm entry. As discussed earlier, the assumption that entrants borrow to cover their initial set-up fees implies that entry cost depends on the borrowing cost i_t^E which in turn is related to the policy rate because of the imperfect banking system. The exogenous reduction in interest rate i_t yields to a decline in i_t^E as well (sharper decline than i_t^I), acting as an opposite force to the increase in real wage (entry fees) hence firm entry rises on balance. Figure 1.7 illustrates the model dynamics in response to 1% negative transitory shock to policy rate. Note that our model predicts positive co-movement between consumption, output and firm entry, unlike the non-borrowing and no-fragmentation cases where entry contracts on impact while consumption rises. In addition, higher spread in the loan interest rates amplifies the response of the main variables.

[10] For simplicity we do not distinguish between consumption based inflation and producer price inflation. The results would not change with that consideration too.

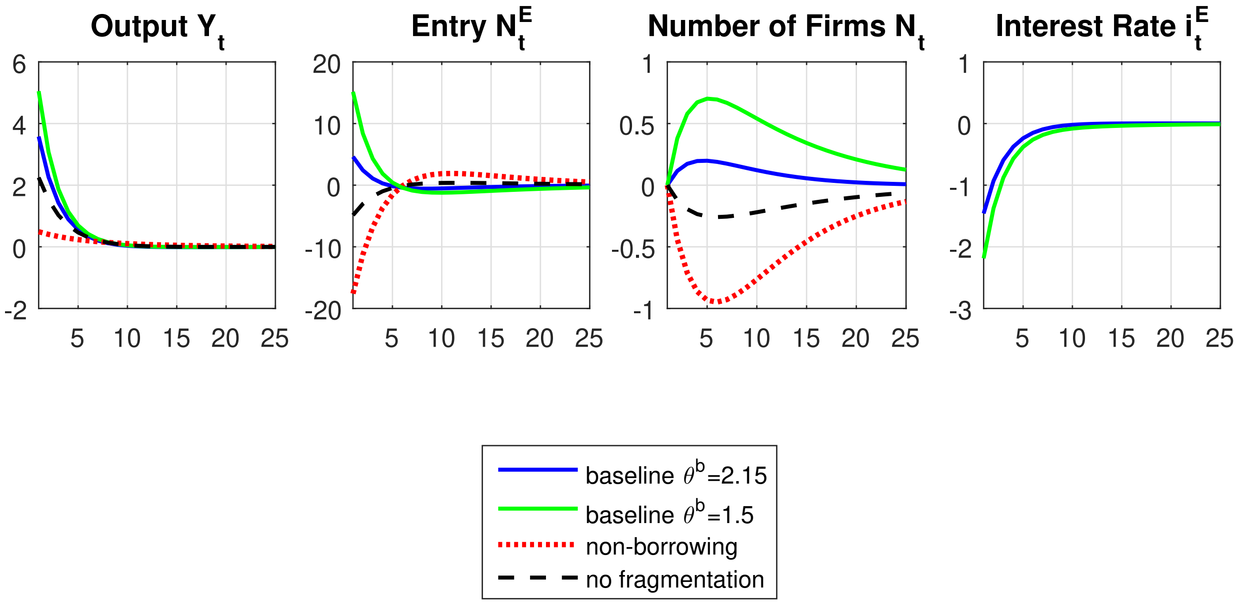

Figure 1.7: IRFs for 1% transitory expansionary monetary shock

1.5 Other Entry Costs

Here we consider other entry fee expression which has also been utilized in the literature. This robustness check will be applied in order to examine if the results achieved earlier are going to change by altering the formula of the entry fee. In the baseline model we followed the definition of entry condition as in BGM where the sunk cost equals the wages of constant f_E units of effective labor. However in the following set up we consider the fee needed to create a new firm equals the value of constant f_E units of consumption goods.

To cover the sunk cost, the entrant borrows from the bank an amount $b_{j,t}^E = f_E$ described in real terms, with interests to be paid and the end of the period (after selling the shares to the household). Entry occurs until firm value equals the total debt, which is highlighted by the following entry condition:

$$v_t = f_E(1 + i_t^E) \tag{1.59}$$

Assuming $Y_{E,t}$ to be the total amount of consumption goods needed to create all the new firms in equilibrium, therefore the production function of creating new firms is altered in the following way:

$$N_t^E = \frac{Y_{E,t}}{f_E} \tag{1.60}$$

While the total amount of loans b_t^E demanded by all the entrants is given by:

$$b_t^E = Y_{E,t} \tag{1.61}$$

Moreover, goods and labor markets clearing conditions become:

$$Y_{C,t} = C_t + Y_{E,t} \tag{1.62}$$

$$L_t = L_{C,t} \tag{1.63}$$

While the total output produced by the incumbents is given by the expression:

$$Y_{C,t} = \rho_t A_t L_{C,t} \tag{1.64}$$

and the GDP coincides with total firm output:

$$Y_t = Y_{C,t} \tag{1.65}$$

Finally, the firm profits will be described by the formula:

$$d_t = \frac{1}{\theta}\frac{Y_{C,t}}{N_t} \tag{1.66}$$

The rest of the model remains the same.

Figures 1.8, 1.9 and 1.10 at the end of the chapter illustrate the comparison of the IRFs for TFP, bank capital, and bank mark-up shocks respectively between the baseline model and the model with constant entry fee in terms of consumption goods. We can summarize that the dynamics are similar in both cases against all shocks, however the responses of the main variables are stronger in the second case. This is because the cost of entry depends purely on the borrowing fee i_t^E, while in the baseline version it depends on the real wage too, where its procyclical fluctuations play a dampening role on the sunk cost. Entry, output, labor and loans exhibit higher volatility and persistence when entry fee is defined in constant units of consumption goods. Thus, we can conclude that the qualitative results are robust to the change in entry fee definition.

1.6 Conclusion

Empirical observations suggest that firm entry is a vital transmission channel of shocks and that start-ups indeed suffered the most during the latest financial crisis. Lenders are more inclined to finance large and already established enterprises, hence potential entrants experience tougher access to external funds because of the high uncertainty surrounding their creditworthiness, which in turn leads to sharp dispersion in lending fees relative to other borrowers. This paper has presented a DSGE model characterized by endogenous firm entry where both incumbents and entrants depend on bank loans to cover their production and entry costs at different rates. The model captures firm dynamics by emphasizing the importance of start-ups' access to outside debt in transmitting real, financial, and monetary shocks. Banks were modeled in an imperfect fashion charging higher rates on start-up loans. The model implies stronger amplification and persistence in response to all shocks, and higher volatility in entry and output dynamics when the spread between interest rates gets wider. In line with evidence, the model predicts slower recovery of the economy after credit contraction due to lower firm entry rates, combined with a fall in the start-up loans' share in total loans. Moreover, the number of entrants decreases as a result of lower bank competition, which yields a decline in the total number of firms. Finally, following an expansionary monetary shock the model successfully implies positive co-movement between entry and consumption, a result that agrees with empirical evidence. The findings were robust to change in entry fee definition.

The study is a step forward towards understanding the mechanisms by which the shocks affect the economy through firm entry channel. As a next step, considering that start-ups constitute an important sector in the economy, the model can be modified by embedding house investment as well. The collapse of house prices combined with a fall in firm entry rates is an observation that cannot be ignored during the last recession. Along these lines, house prices emerge as an important factor when we think of the household as an investor in creating new firms, as large portion of household's borrowing is done through collateral against houses.

Interpretation	**Equations**
Labor supply	$w_t = C_t L_t^{\frac{1}{\varphi}}$
Consumption Euler equation	$\frac{1}{1+i_t} = E_t\left[\beta \frac{C_t}{C_{t+1}} \frac{1}{1+\pi_{t+1}}\right]$
Euler equation for share holding	$v_t = (1-\delta)E_t\left[\beta \frac{C_t}{C_{t+1}}(d_{t+1} + v_{t+1})\right]$
Real marginal costs	$\mu_t = (1 + i_t^I)\frac{w_t}{A_t}$
Pricing	$\rho_t = \frac{\theta}{\theta-1}\mu_t$
Variety effect	$\rho_t = N_t^{\frac{1}{\theta-1}}$
Entry condition	$v_t = f_E(1 + i_t^E)\frac{w_t}{A_t}$
Entry	$N_t^E = \frac{A_t L_{E,t}}{f_E}$
Total labor	$L_t = L_{C,t} + L_{E,t}$
Labor for production	$Y_{C,t} = \rho_t A_t L_{C,t}$
Firm profits	$N_t d_t = \frac{1}{\theta} Y_{C,t}$
Law of motion for the number of firms	$N_t = (1-\delta)(N_{t-1} + N_{t-1}^E)$
Gross Return to investment in new varieties	$r_{t+1}^E = E_t\left[\frac{v_{t+1}+d_{t+1}}{v_t}\right]$
Goods market clearing	$Y_{C,t} = C_t$
GDP	$Y_t = Y_{C,t} + v_t N_t^E$
Loans to incumbents	$b_t^I = w_t L_{C,t}$
Loans to entrants	$b_t^E = w_t L_{E,t}$
Total amount of loans	$B_t = b_t^I + b_t^E$
Law of motion for bank capital	$K_t = \frac{1}{1+\pi_t}\left((1-\eta)K_{t-1} + J_{t-1}^b\right)\epsilon_t^K$
Balance sheet constraint	$B_t = D_t + K_t$
Bank profits	$J_t^b = i_t^E(1-\delta)b_t^E + i_t^I(1-\delta)b_t^I - \delta B_t - i_t D_t - adj_t^b$
Bank adjustment costs	$adj_t^b = \frac{\kappa}{2}\left(\frac{K_t}{B_t} - \nu^b\right)^2 K_t$
Intra-bank interest rate	$i_t^W = i_t - \kappa\left(\frac{K_t}{B_t} - \nu^b\right)\left(\frac{K_t}{B_t}\right)^2$
Interest rate on incumbents' loans	$i_t^I = \frac{i_t^W+\delta}{1-\delta}$
Interest rate on entrants' loans	$i_t^E = \frac{\theta_t^b}{\theta_t^b-1}\frac{i_t^W+\delta}{1-\delta}$
Taylor rule (monetary policy)	$\log\left(\frac{1+i_t}{1+i}\right) = \phi_r \log\left(\frac{1+i_{t-1}}{1+i}\right) + (1-\phi_r)\left[\phi_\pi \log\left(\frac{1+\pi_t}{1+\pi}\right) + \phi_y \log\left(\frac{Y_t}{Y}\right)\right]$
Productivity	$\log\left(\frac{A_t}{A}\right) = \rho_A \log\left(\frac{A_{t-1}}{A}\right) + u_{A,t}$
Bank capital shock	$\log\left(\frac{\epsilon_t^K}{\epsilon^K}\right) = \rho_K \log\left(\frac{\epsilon_{t-1}^K}{\epsilon_t^K}\right) + u_{K,t}$
Bank mark-up shock	$\log\left(\frac{\theta_t^b}{\theta^b}\right) = \rho_b \log\left(\frac{\theta_{t-1}^b}{\theta^b}\right) + u_{b,t}$

Table 1.1: **Model Summary**

Parameter	Interpretation	Value
β	Household's discount factor	0.99
θ	Elasticity of substitution between goods	3.8
φ	Elasticity of labor supply	4
δ	Firm's exit probability	0.025
f_E	Entrant's sunk cost parameter	1
ν_b	Long-run capital-loan ratio	0.09
κ	Coefficient of adjustment cost of capital	10.82
θ^b	Elasticity of substitution between bank loans	2.15
γ	Coefficient of price adjustment cost	77
ϕ_r	Taylor rule parameter	0.8
ϕ_π	Taylor rule parameter	1.75
ϕ_y	Taylor rule parameter	0.125

Table 1.2: **Calibration**

Interpretation	**Expression**
Share of profit income in consumption output	$\frac{dN}{C} = \frac{1}{\theta}$
Share of investment in consumption output	$\frac{vN^E}{C} = \frac{\delta}{\theta(r+\delta)}$
Share of investment in GDP	$\frac{vN^E}{Y} = \frac{\delta}{\theta(r+\delta)+\delta}$
Share of profit income in GDP	$\frac{dN}{Y} = \frac{r+\delta}{\theta(r+\delta)+\delta}$
Share of consumption in GDP	$\frac{C}{Y} = \frac{\theta(r+\delta)}{\theta(r+\delta)+\delta}$
Share of labor income in GDP	$\frac{wL}{Y} = \frac{(\theta-1)(r+\delta)\frac{1}{1+i^I}+\delta\frac{1}{1+i^E}}{\theta(r+\delta)+\delta}$
Share of profits in total capital	$\frac{dN}{vN} = \frac{r+\delta}{1-\delta}$
Share of capital to GDP	$\frac{vN}{Y} = \frac{1-\delta}{\theta(r+\delta)+\delta}$
Ratio of loans to GDP	$\frac{B}{Y} = \frac{(\theta-1)(r+\delta)\frac{1}{1+i^I}+\delta\frac{1}{1+i^E}}{\theta(r+\delta)+\delta}$
Ratio of incumbents loans to total loans	$\frac{b^I}{B} = \frac{(\theta-1)(r+\delta)}{(\theta-1)(r+\delta)+\delta\frac{1+i^I}{1+i^E}}$
Ratio of entrants loans to total loans	$\frac{b^E}{B} = \frac{\delta}{(\theta-1)(r+\delta)\frac{1+i^E}{1+i^I}+\delta}$
Ratio of bank capital to total loans	$\frac{K}{B} = \nu_b$

Table 1.3: **Long Run Ratios**

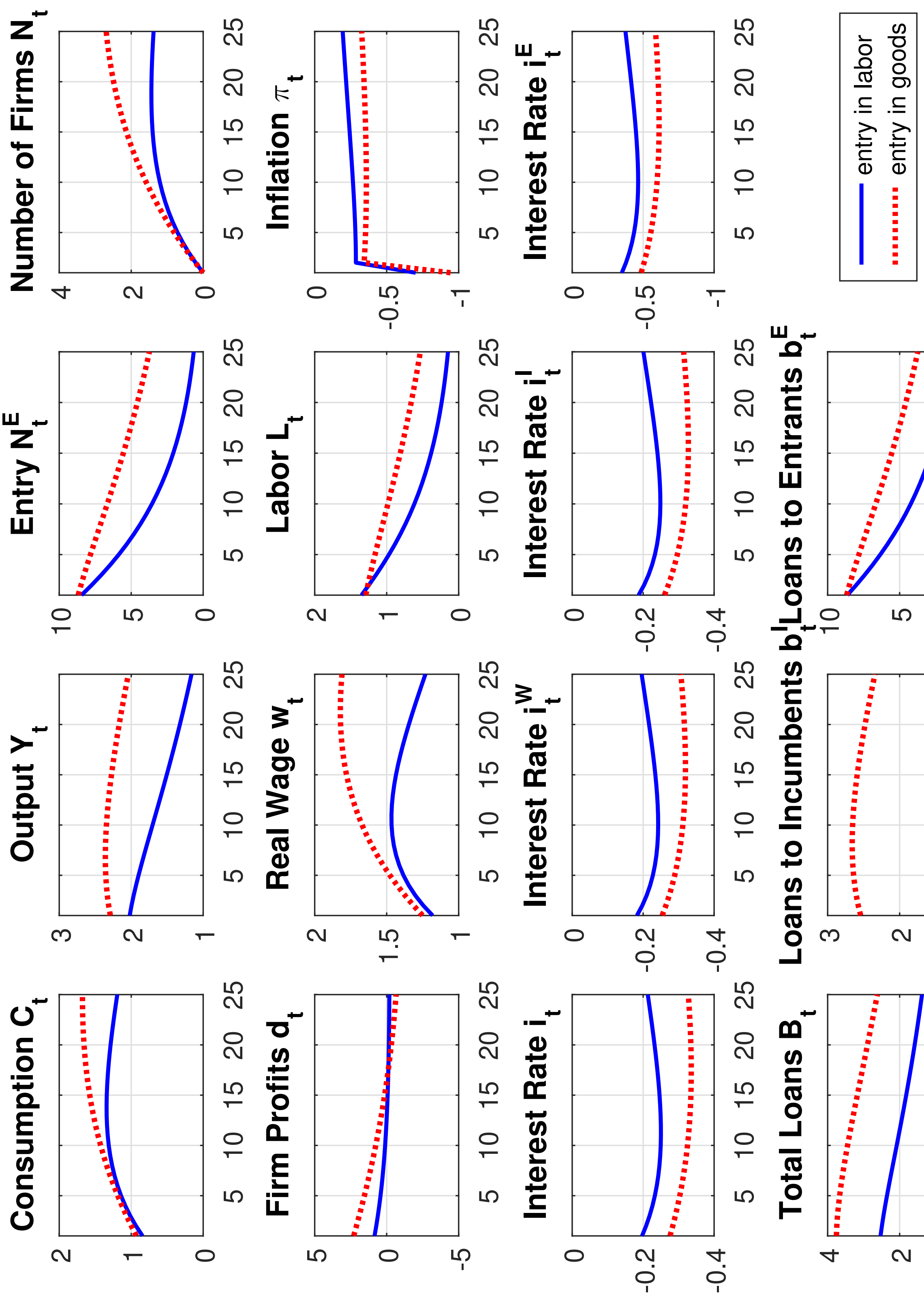

Figure 1.8: IRFs for 1% positive productivity shock.

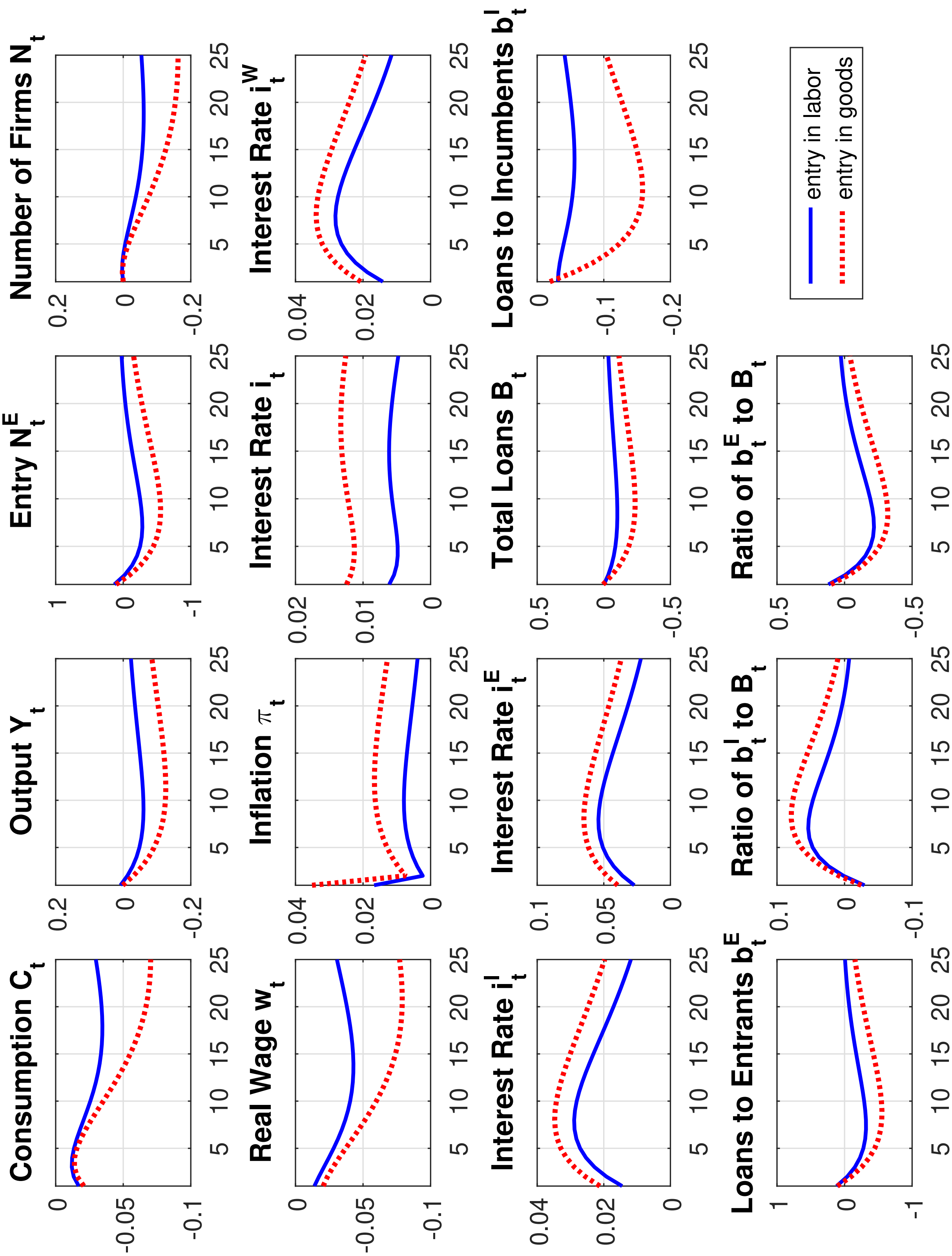

Figure 1.9: IRFs for 1% negative bank capital shock.

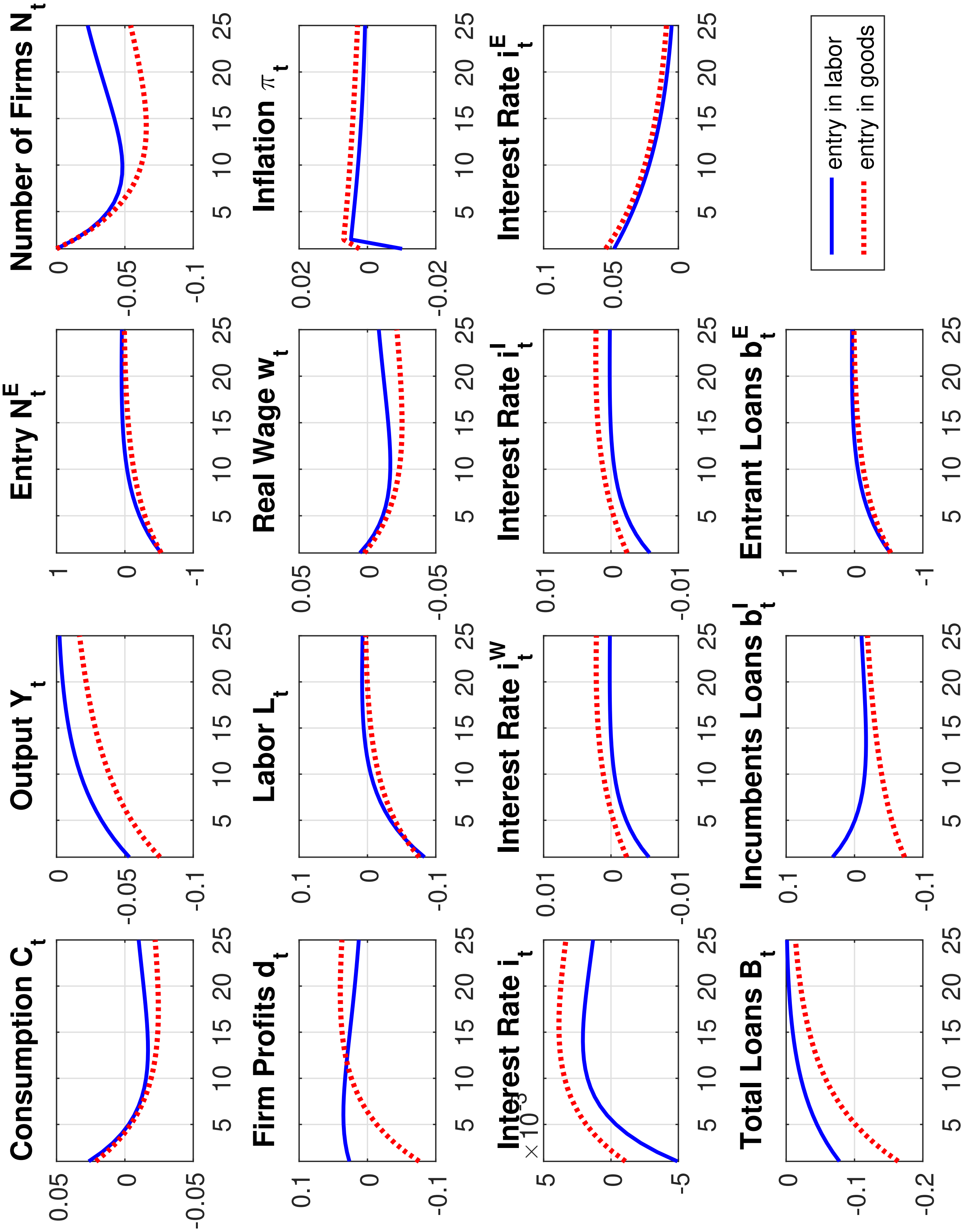

Figure 1.10: IRFs for 1% positive bank mark-up shock.

Chapter 2

Loan Defaults in Endogenous Firm Entry Framework

2.1 Introduction

The years leading to 2008 financial crisis were characterized by a rise in house prices that significantly led to increase in lending volumes. Households had easier access to bank loans thanks to the higher collateral value of their houses. However, the burst in housing market bubbles triggered a wave of loan defaults originated in the household sector and generated losses in the banking sector, which in turn played a crucial role in amplifying the impact of the shock on the economy due to its importance to the production sector as a credit supplier. One of the consequences was a reduction in collateral value, business investment, and birth of new firms. In fact, the business cycle patterns of default volumes and firm creation suggest the presence of an important link between the two, thus understanding the interaction between them during the crisis would further help to explain the role of the extensive margin activity in the aggregate fluctuations. The aim of this work is to focus on the response of firm entry to default and house demand shocks and to study its endogeneity as a transmission channel, in addition to emphasizing the role of the investor's financial constraint and the bank in amplifying the default shock on the number of entrants.

I start by analyzing the cyclical behavior and the empirical patterns of some relevant time series from US quarterly data, namely: establishment birth levels, loan defaults (charge-offs), and house prices, covering the sample period from 1992:Q3 to 2019:Q4. Data on US business formation are obtained from Bureau of Labor Statistics[1] and are reported at the establishment level [2]. On the other hand, the loan charge-offs data are recorded by the Federal Reserve Board[3], while House Price Index (HPI) is provided by Federal Housing Finance Agency. Because we are interested in the short run fluctuations I detrend the log-variables using HP filter[4], a common procedure that makes the series stationary since all these quantities grow in time, and for the rest of the analysis I use the cyclical components after multiplying them by 100 to interpret them as percentages. Figure 2.1 displays these cyclical components with their standerdized counterparts, the latter is to get clearer visual insight about cyclical patterns and correlations. The first row illustrates the procyclicality of firm entry (measured as establishment birth levels), and that it is more volatile than GDP. In the second row, the negative comovement between

[1] The provided data on business formation start from 1992.

[2] They define the establishment as "an economic unit that produces goods or services, usually at a single physical location, and engaged in one or predominantly one activity". Therefore, although a firm can be a multi-establishment enterprise, we will use the two terms "firm" and "establishment" interchangeably hereafter.

[3] I use data for household loans, and for all commercial banks.

[4] Following standard practice for quarterly data, the chosen value for the smoothing parameter is 1600.

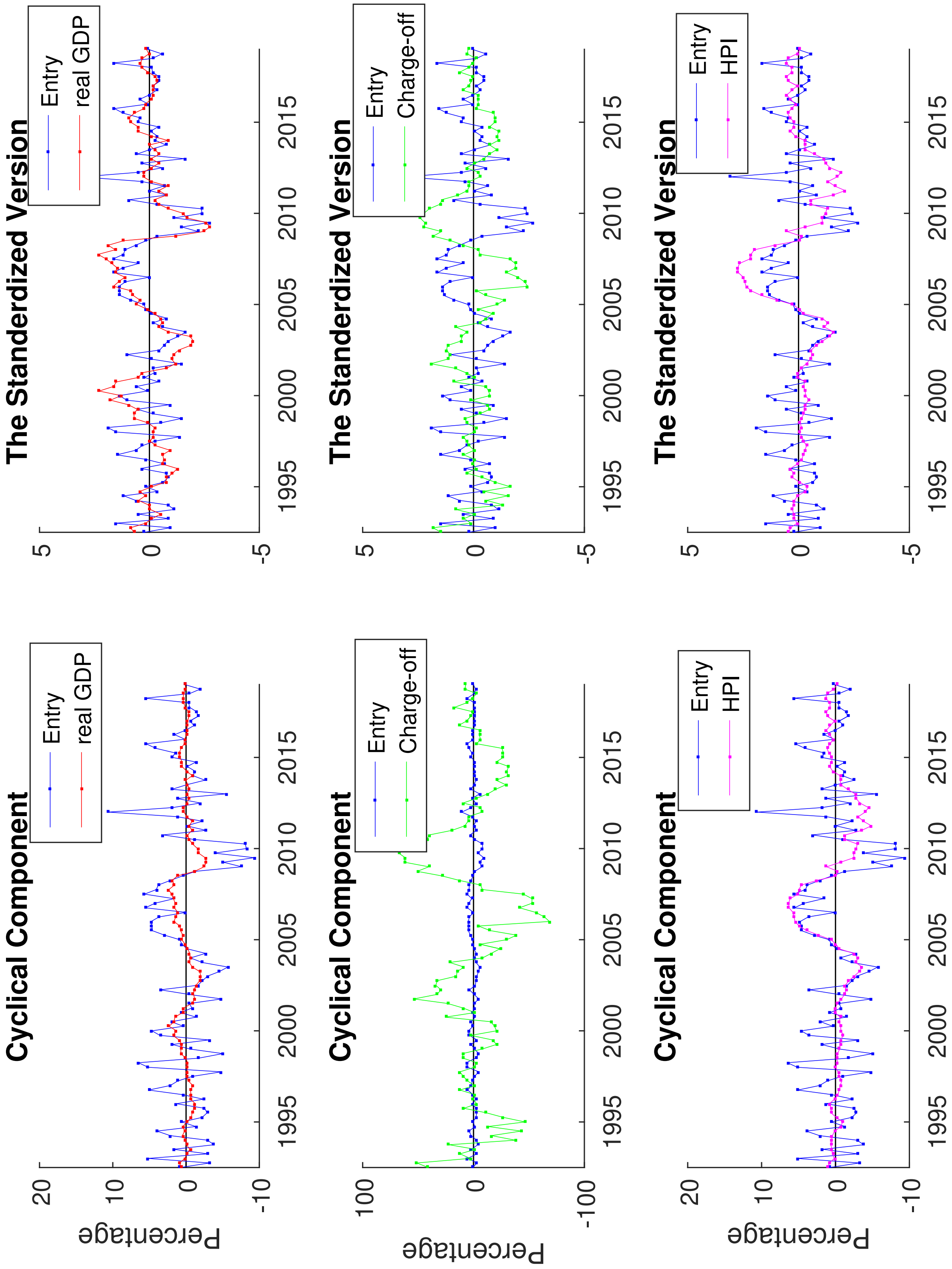

Figure 2.1: The cyclical components (reported in percentages) of HP filtered time series of the log-variables, and their standerdized counterparts. US data, sample period from 1992:Q3 to 2019:Q4.

The Cyclical Components	Full sample 1992:Q3-2019:Q4	Before financial crisis 1992:Q3-2005:Q4	Build up, recession, and after 2006:Q1-2019:Q4
Birth Levels (Entry)			
Standard deviation	3.43%	3.07%	3.76%
Autocorrelation (1st order)	0.38	0.18	0.47
GDP			
Standard deviation	1.01%	0.94%	1.09%
Correlation with Entry	0.56	0.31	0.73
Autocorrelation (1st order)	0.88	0.87	0.86
Consumption			
Standard deviation	0.83%	0.75%	0.90%
Correlation with Entry	0.49	0.19	0.68
Autocorrelation (1st order)	0.91	0.88	0.91
Loan Charge-off			
Standard deviation	27.95%	22.57%	32.49%
Correlation with Entry	-0.50	-0.33	-0.60
Autocorrelation (1st order)	0.80	0.59	0.90
HPI			
Standard deviation	2.31%	1.46%	2.89%
Correlation with Entry	0.41	0.40	0.42
Autocorrelation (1st order)	0.95	0.79	0.92

Table 2.1: **Descriptive statistics from US**

entry and default volumes (charge-off) can be observed, the charge-off being much more volatile than birth, while the last row shows that entry and house prices (HPI) comove positively. It needs to be highlighted that these correlations got stronger and became more evident in the years building up to the financial crisis, which suggests the increased role of their interaction's impact on real economy and business cycle.

In addition, Table 2.1 reports some useful statistics regarding unconditional moments based on the entire sample and on a decomposition of two subsamples: the first one covers the period before the Great Recession (1992:Q3-2005:Q4), while the second one covers the span that contains the year building up to the crisis, the recession years, and the period that comes after (2006:Q1-2019:Q4). The table documents that all variables expressed higher volatility (measured by their standard deviation) in the second sub-sample. Additionally, it shows a remarkable stylized fact: stronger procyclicality of entry (the increase in its correlation with real GDP and consumption) in the period 2006-2019 and substantial increase in its negative correlation with loan charge-off levels, meanwhile the positive correlation between entry and HPI has also risen. Moreover, Figure 2.2 presents rolling window statistics from US quarterly data of 12 years per sample (48 quarters). An important characteristic that emerges from this figure is the increase in volatility and procyclicality of entry as the window rolls over time approaching the crisis periods. Another striking pattern observed is the increase in correlation of entry with both loan charge-off and HPI around 1994 as the sample starts to contain quarters from the years leading to the Great Recession, while the strength of these correlations peaks around 2000. This examination documents that changes in house prices and loan

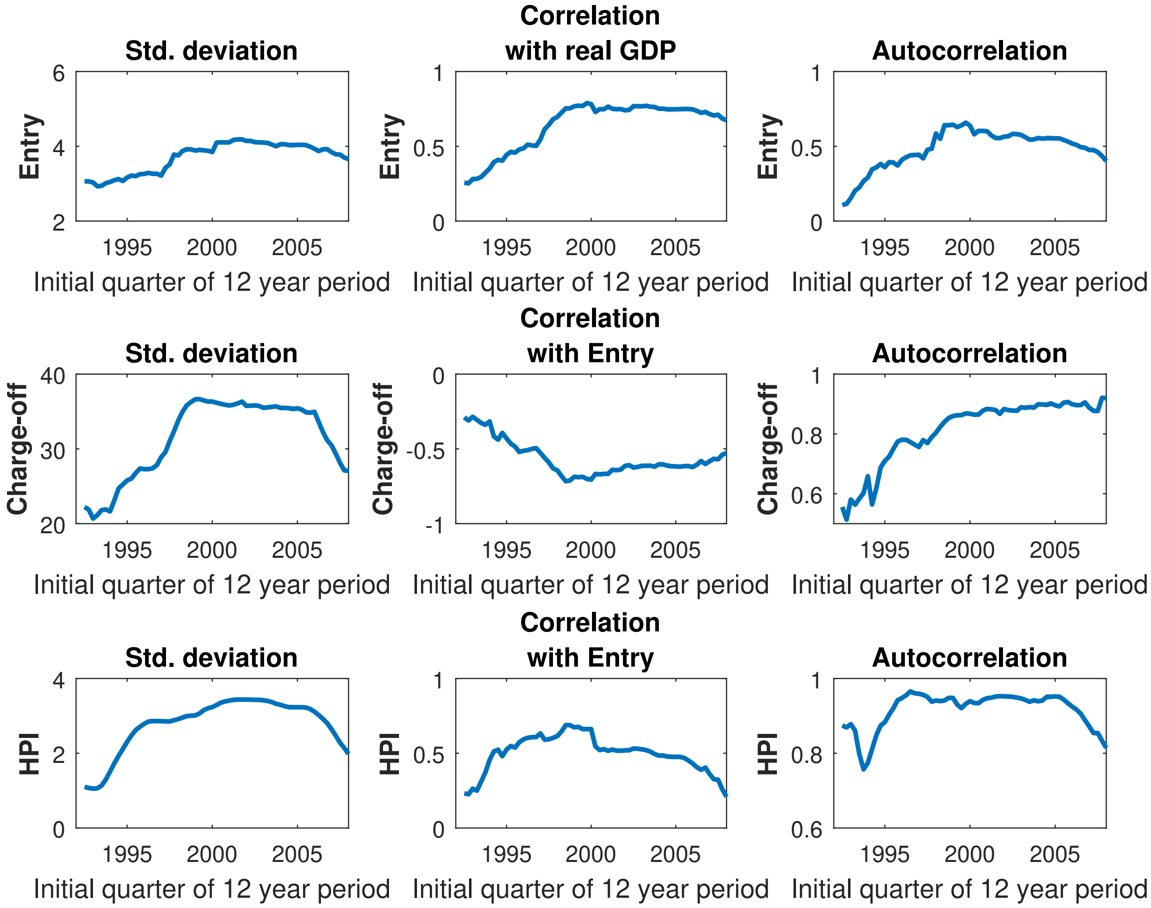

Figure 2.2: US statistics (rolling window 12 years). The analysis is done for the cyclical components of the HP filtered time series.

default amounts impacted the birth of new firms before and during the Great Recession, with increasing role of firm entry in aggregate fluctuations of economic activity. Furthermore, I provide VAR evidence in the next section illustrating the positive response of entry, output, and consumption to house price shock, and their negative reaction to loan default shock, which eventually indicates that firm entry was significantly hit by financial shocks and became a non-negligible source of amplification. Given the presented evidence and the direct link between collateral value and house prices, the role of the endogeneity of the financial constraints cannot be ignored in this story. Therefore, I develop a DSGE model that describes such interaction between loan defaults, asset price variations, and firm creation, which is able to qualitatively replicate the VAR results.

Many leading studies were devoted to understand the several transmission channels that led to the sharp decline in economic activity, and variety of financial frictions were introduced into the standard business cycle models. The default on debts by the borrowers was explicitly modeled by Iacoviello (2015) to assess its repercussions on business fluctuations[5]. He argues that defaults by a group of agents on its obligations lead to redistribution of wealth from the productive sector of the economy to the unproductive one. This shock is at the core of this study; such a shock transfers resources from savers to borrowers which would reduce the former's ability to lend, and will be reflected in the collapse of collateral value of the constrained investor borrowers, thus discouraging them to invest specifically in new varieties which is our main interest [6]. Through the baseline model, I explain the mechanism of this

[5] In Iacoviello (2015) the number of firms is fixed.

[6] In the text I use the terms "new firm creation" and "new varieties" interchangeably.

shock originated only from the unproductive borrower. Then I consider two distinct default shocks in the extended model with bank: one triggered by the unproductive agent, the other one by the investor borrower; a feature that allows us to compare the impacts of the shocks based on their origin.

The baseline model I present in this paper is characterized by endogenous firm entry and populated by three types of households who are heterogeneous across their patience levels: one lender and two borrowers. The default shock -although exogenous in the model- can be understood as a consequence to a sharp fall in house prices that makes the value of the house stock lower than the debt value itself. Having no financial intermediate, the shock would affect negatively the net worth of the lender who in turn decreases loan supply to the constrained investor who is utilizing house as collateral. But since financial institutions are the primary sources of credit supply to business investment, any loss that these suppliers suffer would have more severe impact on the economy through the rise in borrowing costs. Therefore I extend the model by incorporating a banking sector as a financial intermediate. Losses generated in the banking sector would further amplify the adversity of the shock by increasing the lending cost which is followed by a drop in the collateral value, hence constrained agents would experience a decrease in the amount of extended loans that are necessary to finance their investment activities. Moreover, I assign a weight to each type of agent in the economy which has non-negligible influence on the size of the shock's impact. The importance of the size that each type of agent represents was investigated in the works by Bilbiie (2008) and Galí et al. (2007), where it had profound implications on monetary and fiscal policies. I also explore separately the direct impact of a house price shock (house demand shock) on the value of the collateral and the whole economy through firm creation. On top of that, I examine how variations in the creditworthiness of an agent -captured by loan-to-value ratio- would magnify the amplification mechanism.

The model distinguishes itself from previous works that incorporate financial frictions and collateral through several dimensions. Most importantly, the model investigates the aftermath of the above mentioned shocks on business activity through endogenous firm creation, and highlights the role of the collateral in business formation. It also gives us the advantage to track the origin of the default surprise by identifying two different shocks: each one related to each type of the borrower agents. It also explores the ramifications of having heterogeneous mass of agents, an ingredient that to the best of my knowledge was ignored in the endogenous entry literature. The main findings that the model delivers are: 1) In the baseline version, the lender will suffer a loss in the face of a debt default by the unproductive borrower, which implies a decline in loan supply. The other constrained agent experiences a drop in the value of her house collateral inducing her to reduce investment in new varieties, and the overall decrease in total demand of output will be amplified through the endogenous firm entry channel. In addition, when the defaulter household's weight in the economy is larger, the loss endured by the lender becomes bigger, which leads to more reduction in entry. However in this case, the amplified impact of the shock on output through endogenous entry is dampened. This is because defaulters -who have higher propensity to consume- raise their demand for goods on impact, something that partly increases profit expectations. As robustness exercises I also consider investment in non-residential (commercial) houses, and another definition of firm entry. 2) In the extended version, banks -acting as credit suppliers- have crucial role in magnifying and propagating the financial shocks. Triggered by loan defaults, the losses suffered by the bank affect negatively the decision on new firm investment which is transmitted to the entrepreneur through higher borrowing cost and lower asset prices (house prices) implying tightened borrowing constraint. 3) The default shock when it is originated from the unproductive borrower implies larger contraction in entry and output than the one triggered by the investor borrower. 4) Positive house demand shock directly affects the credit accessibility by improving the collateral value, which leads to higher investment in new firms. On top of that, fluctuations in creditworthiness of the borrowers implies an amplified impact of both default and house demand shocks on firm entry.

This work belongs to the literature that sheds light on the importance of endogeneity of firm entry as a transmission channel of shocks. The model developed by Bilbiie et al. (2012) (henceforth BGM) has shown how the endogenous entry serves as a vital propagation mechanism of business cycle fluctuations in the face of changes in aggregate productivity. La Croce and Rossi (2018) studied how firm entry amplifies the adversity of financial shocks on GDP through the incumbent firms who rely on bank loans to cover their operational costs, where they face higher marginal costs in response to a credit crunch originated in an imperfect banking system which yields lower expected profits and a reduction in the number of potential entrants. Bergin et al. (2018) have studied the negative effects of a recession on firm entry through its linkage to lower equity prices as a result of negative financial shock. Siemer (2016) documented that the unprecedented contraction in the number of entrants between 2007 and 2010 was largely due to financial constraints and bank dependency, and was responsible for the slow recovery of the economy. However, these studies did not incorporate housing market, the importance of which was fundamental in the Great Recession. They also did not address the role of endogeneity of investor household's collateral constraint when facing credit deterioration. More precisely, the contribution of this paper lies in the approach that aims to capture the impact of loan default and house demand shocks on firm entry dynamics through the fall or rise in constrained investor's collateral value, which occurs due to fluctuations in borrowing cost and asset prices. In addition, our model identifies the origin of the debt default hence is able to distinguish the shock's impact depending on the type of the defaulter household (unproductive or investor), an element that was absent in those studies.

Endogeneity of asset prices that reflects on the collateral value of the borrower is a familiar idea of a financial accelerator described in Kiyotaki and Moore (1997). Therefore if the borrower is an investor entrepreneur, then investment volumes would shrink in a reaction to a fall in home prices, given that loans are collateralized by houses. Many empirical studies have explored the link between collateral constraints and entrepreneurial activities in firm creation. Balasubramanyan and Coulson (2013) identified a causal link between house prices and the amount of very small business starts by quantitatively modeling the interaction between them from 2005 to 2009. Using variations in house prices as shocks to the value of collateral, Schmalz et al. (2017) found that a rise in collateral value increases the probability to become an entrepreneur. Another documentation of the collateral lending role was done by Adelino et al. (2015), showing that regions with a higher run up in house prices in the pre-crisis period witnessed a significant increase in self-employment and small business starts. Similar observations were made by Berggren et al. (2017) on startups across Sweden. The authors concluded that the frequency of startups increases by 0.15% to a 1% increase in home prices. Moreover, Schott (2015) has assessed the impact of house prices decline on the jobless recovery in US through the low number of new firms. Having said that, it is not surprising that the recession -which was initiated by sharp decline in house prices and followed by volumes of loan defaults that were originated in the household sector- affected entry and was amplified due to endogenous firm creation. In light of the presented evidences -including the VAR results- and the studies reviewed so far, I consider the model in this work a relevant theoretical framework that is successfully able to predict the dynamics of firm entry in the face of default and house demand shocks as well as highlighting the role of its endogeneity as a vital transmission channel, and to demonstrate the role of the bank and collateral value in the contraction or expansion of business formation.

The paper is organized in the following way: Section 2.2 provides empirical motivation by running Structural-VAR model, 2.3 outlines the theoretical model with its baseline version to demonstrate the implications of loan default surprise, section 2.4 presents robustness exercises, section 2.5 extends the model to assess the bank sector's role, section 2.6 reports the second moments delivered by the model, and section 2.7 concludes.

2.2 Empirical Motivation

In this section I present the estimates of impulse response functions (IRFs) of some key variables to house price and default shocks by running Structural Vector Auto Regressive (SVAR) model in order to provide further empirical motivation. I consider the detrended[7] time series from US data with a sample that covers the period from 1992:Q3 to 2019:Q4 in the following order: House Price Index (HPI_t), Loan Charge Offs ($CHRG_t$), Real Consumption (C_t), Birth levels of Establishments (NE_t), and Real Gross Domestic Product (GDP_t). Ordering HPI_t first and $CHRG_t$ second is based on Cholesky decomposition that allows house price and default shocks to be the most exogenous ones[8]. As a common practice given that the work is done with quarterly data, I choose the lag length to be 4. I report the IRFs in Figures 2.3 and 2.4 along with 90% bootstrapped confidence bands.

The analysis suggests that the theoretical model has to deliver the following interactions:

1) Positive reaction of consumption, firm entry, and total output in response to house price shock, in addition to drop in loan charge off volumes.

2) In the face of default surprise, reduction in consumption, birth levels, GDP, and a fall in asset prices.

In the rest of the chapter I develop a DSGE model that matches the qualitative results of the SVAR model, then I compare the generated second moments of some key variables with their data counterparts.

2.3 The Baseline Model

The economy in the baseline model is populated by three types of households: patient lender, "unproductive" impatient borrower, and impatient investor (entrepreneur)[9]. The patience of each agent is reflected in their perspective of the future and captured by the discount factors. The patient type is a lender, the impatient one is a borrower, while the entrepreneur is a borrower who invests in new varieties (firm creation). All the agents invest in residential houses, and the borrowers use them as collateral to get loans. Improvement in the endogenous value of the collateral would encourage consumption and investment by the entrepreneur, an idea that can be traced back to Kiyotaki and Moore (1997) and Iacoviello (2005). However in those papers, investment was meant to be in land and houses. Here, we examine the channel between the boost in collateral value and the expansion in new firm investment. On the other hand, the production sector is characterized by endogenous firm entry as in BGM. This configuration allows us to assess the consequences of loan defaults on economic activity through the extensive margin.

For the sake of simplification, we identify just one exogenous loan default shock that hits the budget constraints of only the patient and impatient households, in a way that reallocates wealth from the lender to the unproductive borrower. Then in the extended version of the model we consider another default shock that is triggered by the investor borrower as well. To get an intuition of the transmission mechanism of such a financial shock, suppose the value

[7] I use the cyclical components introduced in the previous section. Other filtering or detrending techniques such as taking the first-differences do not sensibly alter the results.

[8] The order of the remaining variables does not affect the results substantially.

[9] From now on, when the term "impatient" is used alone to describe the type of an agent, it is meant for the "unproductive" borrower type.

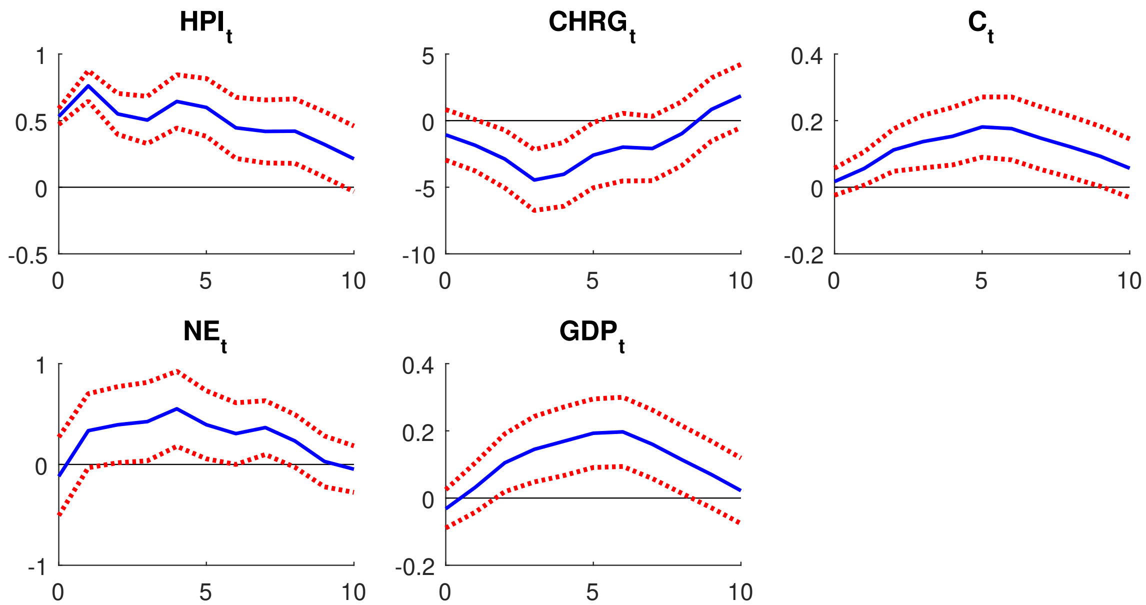

Figure 2.3: IRFs to house price (HPI) shock in the SVAR model.

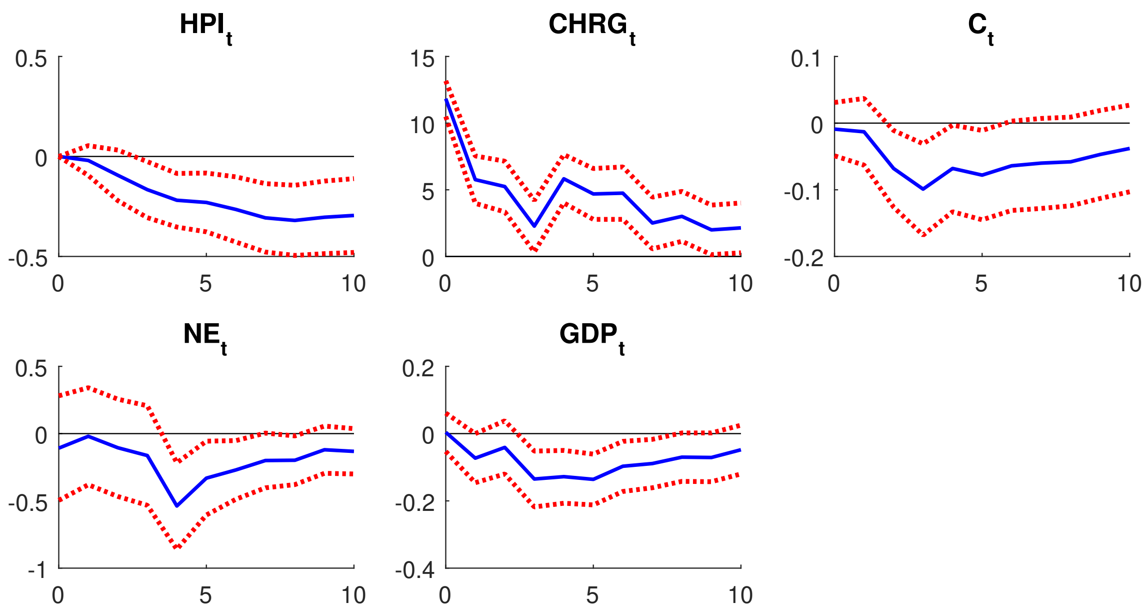

Figure 2.4: IRFs to default ($CHRG$) shock in the SVAR model.

of the collateral -in this case houses- drops below the value of the debt, for some exogenous reasons that induce a sharp fall in home prices. Consequently, the borrower agent defaults on their contractual obligations, and the lender suffers a sudden loss because of the anticipated repayments are not met. Since the lender is considered to be a productive agent who finances the entrepreneur, who in turn invests in new varieties, then credit supply falls and firm entry drops. This happens because the accessibility of the investor agents -who borrow against their houses- to the credit market will be affected adversely as a result of asset price fall, hence a decrease in their collateral value. On the other hand the presence of banks as financial intermediaries (to be seen in the extended version of the model) will further amplify that impact on investment and output through the rise in lending costs.

In the upcoming subsections we present each agent's problem and the associated optimal conditions[10]. We assign a mass α^P to the patient (lender) type, a mass α^I to the impatient household, and a mass α^E to the entrepreneur, such that the total mass of households is set to one, hence: $\alpha^P + \alpha^I + \alpha^E = 1$. Also, let β^P, β^I, and β^E be the discount factors for the patient, impatient, and investor households respectively, such that $\beta^P > \beta^I$ and $\beta^P > \beta^E$, necessary assumptions to guarantee that the impatient types borrow in equilibrium.

2.3.1 Patient Household

A representative patient household consumes, works, lends, and invests in residential houses. This agent maximizes the following expected utility:

$$U^P = E_0 \sum_{t=0}^{\infty} \beta^{Pt} \big[\log C_t^P + j \log h_t^P - \frac{L_t^{P1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}} \big] \tag{2.1}$$

where C_t^P is a basket of consumption goods produced by the incumbent firms and aggregated through CES preferences:

$$C_t^P = \Big[\int_{N_t} C_{i,t}^{P\frac{\theta-1}{\theta}} di \Big]^{\frac{\theta}{\theta-1}} \tag{2.2}$$

$\theta > 1$ is the elasticity of substitution across goods. Accordingly, the "appropriate" CPI is:

$$P_t = \Big[\int_{N_t} P_{i,t}^{1-\theta} di \Big]^{\frac{1}{1-\theta}} \tag{2.3}$$

The demand for each consumption good by the patient household can be obtained by minimizing total expenditure $\int_{N_t} P_{i,t} C_{i,t}^P di$, hence it becomes:

$$C_{i,t}^P = (\frac{P_{i,t}}{P_t})^{-\theta} C_t^P \tag{2.4}$$

The patient household is subject to the following budget constraint in real terms:

$$C_t^P + D_t + q_t(h_t^P - h_{t-1}^P) \leq w_t L_t^P + R_{t-1} D_{t-1} - \frac{\alpha^I}{\alpha^P} \epsilon_t^I \tag{2.5}$$

D_t represents desired loans supplied by the patient household to the two impatient households, while R_t denotes the gross returns on those loans. L_t^P is labor supply by the patient household to incumbent firms and w_t is the real wage. h_t^P is the amount of residential house stock that she wants to buy, while q_t is the house price.

Lastly, ϵ_t^I is the loan default shock that hits the income side of the lender (patient) household negatively when house price falls below the value of the debt owed, hence this shock appears

[10]A superscript P, I or E is indexed to the variables associated with each type of household.

as a positive term simultaneously in the income side of the unproductive impatient borrower, and follows an AR(1) process:

$$\epsilon_t^I = \rho_\epsilon \epsilon_{t-1}^I + u_{\epsilon^I,t} \tag{2.6}$$

Note that the coefficient of the default shock is a function of the shares of the household types, therefore the size of each share affects the shock's impact on the patient household. In fact, the larger is the size of impatient type α^I, the larger is the impact.

The Lagrangian of the patient household's maximization problem is the following:

$$\mathcal{L}^P = E_0 \sum_{t=0}^{\infty} {\beta^P}^t \big[\log C_t^P + j \log h_t^P - \frac{{L_t^P}^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}}$$
$$+ \lambda_t^P \big(w_t L_t^P + R_{t-1} D_{t-1} - C_t^P - D_t - q_t (h_t^P - h_{t-1}^P) - \frac{\alpha^I}{\alpha^P} \epsilon_t^I \big) \big]$$

In each period t the household chooses C_t^P, D_t, L_t^P, h_t^P and the first order conditions are:

$$[C_t^P] : \lambda_t^P = \frac{1}{C_t^P} \tag{2.7}$$

$$[D_t] : 1 = E_t \big[\Lambda_{t,t+1}^P R_t \big] \tag{2.8}$$

$$[L_t^P] : \frac{w_t}{C_t^P} = {L_t^P}^{\frac{1}{\varphi}} \tag{2.9}$$

$$[h_t^P] : q_t = j \frac{C_t^P}{h_t^P} + E_t \big[\Lambda_{t,t+1}^P q_{t+1} \big] \tag{2.10}$$

where λ_t^P is the Lagrange multiplier in period t attached to the budget constraint, $E\big[.\big]$ is the expectation operator, and $\Lambda_{t,t+1}^P \equiv \beta^P \frac{C_t^P}{C_{t+1}^P}$ is patient household's consumption based discount factor. Equation (2.8) represents the consumption Euler equation, (2.9) is the labor supply, while (2.10) is demand for houses.

2.3.2 Impatient Household: The "Unproductive" Borrower

A representative impatient household consumes, works, borrows, invests in residential houses and uses them as collateral, hence he maximizes the following expected utility:

$$U^I = E_0 \sum_{t=0}^{\infty} {\beta^I}^t \big[\log C_t^I + j \log h_t^I - \frac{{L_t^I}^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}} \big] \tag{2.11}$$

where C_t^I is basket of consumption goods produced by the incumbent firms and aggregated through CES preferences:

$$C_t^I = \Big[\int_{N_t} {C_{i,t}^I}^{\frac{\theta-1}{\theta}} di \Big]^{\frac{\theta}{\theta-1}} \tag{2.12}$$

The demand for each consumption good by the impatient household can be obtained by minimizing total expenditure $\int_{N_t} P_{i,t} C_{i,t}^I di$, hence it becomes:

$$C_{i,t}^I = \big(\frac{P_{i,t}}{P_t} \big)^{-\theta} C_t^I \tag{2.13}$$

The impatient household is subject to the following budget constraint in real terms:

$$C_t^I + R_{t-1} B_{t-1}^I + q_t (h_t^I - h_{t-1}^I) \leq w_t L_t^I + B_t^I + \epsilon_t^I \tag{2.14}$$

There is a limit on the amount that the impatient household can borrow, hence he is also subject to the following borrowing constraint:

$$B_t^I \leq \frac{mE_t\big[q_{t+1}\big]h_t^I}{R_t} \tag{2.15}$$

B_t^I represents the amount of loans demanded by the impatient household, and h_t^I is the amount of residential house stock that he wants to buy. Note that the stock of house is utilized as collateral, and the due debt (the borrowing amount with interest) cannot exceed a certain fraction of the expected value of the houses owned by the impatient household in the current period, therefore m can be defined as the loan-to-value ratio.

As discussed earlier, ϵ_t^I shows up as a positive term in the right side of the impatient household's budget constraint. The rationale is that when house price falls sharply, then default becomes the preferred option for the borrower, the repercussion of which is a redistribution of wealth from the productive sector (lender household) to the unproductive sector (the unproductive borrower household). Finally, L_t^I is labor supply by the impatient household to the incumbent firms.

The Lagrangian of the household's maximization problem is the following:

$$\begin{aligned}\mathcal{L}^I = E_0 \sum_{t=0}^{\infty} {\beta^I}^t \big[\log C_t^I + j \log h_t^I - \frac{{L_t^I}^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}} \\ + \lambda_t^I \big(w_t L_t^I + B_t^I - C_t^I - R_{t-1}B_{t-1}^I - q_t(h_t^I - h_{t-1}^I) + \epsilon_t^I\big) \\ + \mu_t^I \big(\frac{mE_t\big[q_{t+1}\big]h_t^I}{R_t} - B_t^I\big)\big]\end{aligned}$$

In each period t the household chooses C_t^I, L_t^I, B_t^I, h_t^I, and the first order conditions are:

$$[C_t^I] : \lambda_t^I = \frac{1}{C_t^I} \tag{2.16}$$

$$[L_t^I] : \frac{w_t}{C_t^I} = {L_t^I}^{\frac{1}{\varphi}} \tag{2.17}$$

$$[B_t^I] : \mu_t^I C_t^I = 1 - E_t\big[\Lambda_{t,t+1}^I R_t\big] \tag{2.18}$$

$$[h_t^I] : q_t = j\frac{C_t^I}{h_t^I} + E_t\big[\Lambda_{t,t+1}^I q_{t+1}\big] + E_t\big[\mu_t^I C_t^I \frac{mq_{t+1}}{R_t}\big] \tag{2.19}$$

where λ_t^I and μ_t^I are the Lagrange multipliers in period t attached to the budget and borrowing constraints respectively, and $\Lambda_{t,t+1}^I \equiv \beta^I \frac{C_t^I}{C_{t+1}^I}$ is impatient household's consumption based discount factor. Equation (2.17) represents the impatient household's labor supply, while (2.19) is the demand for houses.

Our assumption that $\beta^P > \beta^I$ would ensure that in equilibrium there will be flow of loans. In fact, the equation (2.18) at the steady state would imply: $\mu^I = \frac{1}{C^I}(\frac{\beta^P - \beta^I}{\beta^P}) > 0$, which indicates that the borrowing constraint holds in equality.

By substituting (2.18) in (2.19) the house demand equation can be expressed in the following way:

$$q_t = j\frac{C_t^I}{h_t^I} + E_t\big[\Lambda_{t,t+1}^I q_{t+1}\big] + E_t\big[\frac{mq_{t+1}}{R_t}\big(1 - \Lambda_{t,t+1}^I R_t\big)\big] \tag{2.20}$$

The fact that houses can be used as collateral is reflected in the last term of the house valuation in the above equation, a term which is strictly positive in steady state since $\beta^P > \beta^I$.

2.3.3 Impatient Investor: The Entrepreneur

A representative entrepreneur consumes, works, borrows, owns the firms and invests in new varieties (buys shares and receives dividends), invests in residential houses and uses them as collateral, hence she maximizes the following expected utility:

$$U^E = E_0 \sum_{t=0}^{\infty} \beta^{E^t} \big[\log C_t^E + j \log h_t^E - \frac{L_t^{E^{1+\frac{1}{\varphi}}}}{1+\frac{1}{\varphi}} \big] \tag{2.21}$$

where C_t^E is basket of consumption goods produced by the incumbent firms and aggregated through CES preferences:

$$C_t^E = \Big[\int_{N_t} C_{i,t}^{E^{\frac{\theta-1}{\theta}}} di \Big]^{\frac{\theta}{\theta-1}} \tag{2.22}$$

The demand for each consumption good by the investor household can be obtained by minimizing total expenditure $\int_{N_t} P_{i,t} C_{i,t}^E di$, hence it becomes:

$$C_{i,t}^E = (\frac{P_{i,t}}{P_t})^{-\theta} C_t^E \tag{2.23}$$

The impatient investor is subject to the following budget constraint in real terms:

$$C_t^E + R_{t-1} B_{t-1}^E + q_t (h_t^E - h_{t-1}^E) + v_t (N_t + N_t^E) x_{t+1} \leq w_t L_t^E + B_t^E + (d_t + v_t) N_t x_t \tag{2.24}$$

also subject to the borrowing constraint:

$$B_t^E \leq \frac{m E_t [q_{t+1}] h_t^E}{R_t} \tag{2.25}$$

B_t^E represents the amount of loans demanded by the entrepreneur, and h_t^E is the stock of residential house that she owns. Similar to the other borrower, house is used as collateral, where the repayment amount does not exceed a certain fraction of next period's expected value of the current stock of houses.

As in BGM the household buys equity shares from both producing firms (incumbents) and start up firms (entrants). x_t represents the share invested in the firms by the household, v_t is firm's real value of share, N_t is the number of operating firms, N_t^E is the number of new entries (or number of new varieties) and d_t is the real dividends received from each incumbent.

The Lagrangian of the entrepreneur's maximization problem is the following:

$$\begin{aligned}
\mathcal{L}^E = E_0 \sum_{t=0}^{\infty} \beta^{E^t} \big[& \log C_t^E + j \log h_t^E - \frac{L_t^{E^{1+\frac{1}{\varphi}}}}{1+\frac{1}{\varphi}} \\
& + \lambda_t^E \big(w_t L_t^E + B_t^E + (d_t + v_t) N_t x_t - C_t^E - R_{t-1} B_{t-1}^E - q_t (h_t^E - h_{t-1}^E) - v_t (N_t + N_t^E) x_{t+1} \big) \\
& + \mu_t^E \big(\frac{m E_t [q_{t+1}] h_t^E}{R_t} - B_t^E \big) \big]
\end{aligned}$$

In each period t the household chooses C_t^E, L_t^E, B_t^E, h_t^E, x_{t+1}, and the first order conditions are:

$$[C_t^E] : \lambda_t^E = \frac{1}{C_t^E} \tag{2.26}$$

$$[L_t^E] : \frac{w_t}{C_t^E} = L_t^{E^{\frac{1}{\varphi}}} \tag{2.27}$$

$$[B_t^E] : \mu_t^E C_t^E = 1 - E_t \big[\Lambda_{t,t+1}^E R_t \big] \tag{2.28}$$

$$[h_t^E] : q_t = j \frac{C_t^E}{h_t^E} + E_t \big[\Lambda_{t,t+1}^E q_{t+1} \big] + E_t \big[\mu_t^E C_t^E \frac{m q_{t+1}}{R_t} \big] \tag{2.29}$$

$$[x_{t+1}] : v_t = E_t \big[(1-\delta) \Lambda_{t,t+1}^E (d_{t+1} + v_{t+1}) \big] \tag{2.30}$$

where λ_t^E and μ_t^E are the Lagrange multipliers in period t corresponding to the budget and borrowing constraints respectively, and $\Lambda_{t,t+1}^E = \beta^E \frac{C_t^E}{C_{t+1}^E}$ is entrepreneur household's consumption based discount factor. Equation (2.27) represents the investor household's labor supply, (2.29) is the demand for houses, while (2.30) is the Euler equation for share holding. To get (2.30) we used the law of motion of the number of firms: $N_{t+1} = (1-\delta)(N_t + N_t^E)$, where δ is the fraction of existing firms that exits the market ($(1-\delta)$ is the survival rate). From (2.30) we can solve for the value of the firm by forward looking, without speculative bubbles:

$$v_t = E_t \sum_{s=1}^{\infty} (1-\delta)^s \Lambda_{t,t+s}^P d_{t+s} \tag{2.31}$$

This expression indicates that firm's current value (both for entrants and incumbents) is equal to the expected future stream of profits, as both types face the same survival rate and technology in the subsequent periods.

The impatience of the investor can be reflected in her discount factor by setting $\beta^B > \beta^E$, suggesting that the borrowing constraint holds in equality, since equation (2.28) at the steady state yields: $\mu^E = \frac{1}{C^E}(\frac{\beta^B - \beta^E}{\beta^B}) > 0$.

We rearrange (2.29) by using (2.28) to obtain the following house demand equation:

$$q_t = j\frac{C_t^E}{h_t^E} + E_t\big[\Lambda_{t,t+1}^E q_{t+1}\big] + E_t\Big[\frac{m q_{t+1}}{R_t}\big(1 - \Lambda_{t,t+1}^E R_t\big)\Big] \tag{2.32}$$

2.3.4 Incumbents (Operating Firms)

There is a continuum of incumbents located on a segment with mass N_t. They produce differentiated consumption goods under monopolistic competition in a flexible price setting using only labor, with substitutability between goods $\theta > 1$. Firm i maximizes each period's real profits by choosing labor $L_{i,t}$ and the price of the good $P_{i,t}$ using the technology $Y_{i,t} = AL_{i,t}$, whereas the productivity A is common among the firms.

Firm i faces the following demand curve:

$$Y_{i,t} = \Big(\frac{P_{i,t}}{P_t}\Big)^{-\theta} Y_t \tag{2.33}$$

where Y_t is the total consumption output and P_t is the price index.

Let $mc_{i,t}$ be the real marginal cost that faces the incumbent, and the Lagrangian associated to the maximization problem is:

$$\mathcal{H} = \Big(\frac{P_{i,t}}{P_t}\Big)^{1-\theta} Y_t - w_t L_{i,t} + mc_{i,t}\Big[-\Big(\frac{P_{i,t}}{P_t}\Big)^{-\theta} Y_t + AL_{i,t}\Big]$$

Hence, the first order conditions are:

$$[L_{i,t}] : mc_{i,t} = \frac{w_t}{A} \tag{2.34}$$

$$[P_{i,t}] : \frac{P_{i,t}}{P_t} = \frac{\theta}{\theta-1} mc_{i,t} \tag{2.35}$$

where equation (2.35) represents the relative price that firm i chooses at period t.

Finally, the firms' outputs will be aggregated to produce the final good according to the CES technology[11]:

$$Y_t = \Big[\int_{N_t} Y_{i,t}^{\frac{\theta-1}{\theta}} di\Big]^{\frac{\theta}{\theta-1}} \tag{2.36}$$

[11] One can formulate this by introducing final good producers operating in perfectly competitive market.

We impose symmetry among the operating firms, hence from the aggregate output (2.36) we find:

$$Y_t = N_t^{\frac{\theta}{\theta-1}} Y_{i,t} \tag{2.37}$$

This can be combined with the demand schedule (2.33) to obtain the variety effect on pricing:

$$\rho_t = N_t^{\frac{1}{\theta-1}} \tag{2.38}$$

where we denoted $\rho_t \equiv \frac{P_{i,t}}{P_t}$ to the relative price. Note that N_t enters the equations describing the final output and relative price, where the latter formulation reflects consumer's love for variety. Symmetry among the operating firms also yields to the following total labor demand:

$$L_t = N_t L_{i,t} \tag{2.39}$$

This allows us to rewrite the aggregate consumption output (2.37) in terms of N_t in the following form:

$$Y_t = N_t^{\frac{1}{\theta-1}} A L_t \tag{2.40}$$

whereas firm profits can be calculated in the following way:

$$d_t = \frac{1}{\theta}\frac{Y_t}{N_t} \tag{2.41}$$

In order to understand and be able to distinguish between the extensive and intensive margins in the total economic activity, it is useful to rewrite (2.40) in slightly different manner by means of (2.37) and (2.38):

$$Y_t = N_t \rho_t y_t \tag{2.42}$$

where $y_t \equiv Y_{i,t}$ is the firm level output. Note that the dynamics of N_t (number of firms) is responsible for the variations in aggregate output Y_t through its extensive margin, while variations through the intensive margin can be captured by $\rho_t y_t$.

2.3.5 Entrants (The Creation of New Varieties)

At the start of each period a prospective entrant faces a fixed sunk entry cost equals to the value of f^E units of consumption goods. The entrant computes the value of the new variety (or the value of the new created firm) according to (2.31), and entry occurs until the following condition is satisfied:

$$v_t = f^E \tag{2.43}$$

New entrants start to produce next period allowing a one period time to build lag in the model. We assume $\delta \in (0, 1)$ to be a death shock that hits all firms of both types at the end of each period, which causes a constant fraction δ of the existing firms to exit the market, implying the following law of motion for the operating number of firms in the economy:

$$N_t = (1-\delta)(N_{t-1} + N_{t-1}^E) \tag{2.44}$$

2.3.6 Markets Clearing

The loans and labor markets clear when:

$$\alpha^P D_t = \alpha^I B_t^I + \alpha^E B_t^E \tag{2.45}$$

$$L_t = \alpha^P L_t^P + \alpha^I L_t^I + \alpha^E L_t^E \tag{2.46}$$

In addition, by considering fixed supply of houses, the clearing of house market is described through the following equation:

$$\alpha^P h_t^P + \alpha^I h_t^I + \alpha^E h_t^E = 1 \tag{2.47}$$

Then we write the budget constraint of each type of household in equilibrium, where $x_t = x_{t+1} = \frac{1}{\alpha^E}$ is satisfied:

$$C_t^P + D_t + q_t(h_t^P - h_{t-1}^P) = w_t L_t^P + R_{t-1} D_{t-1} - \frac{\alpha^I}{\alpha^P}\epsilon_t^I \tag{2.48}$$

$$C_t^I + R_{t-1} B_{t-1}^I + q_t(h_t^I - h_{t-1}^I) = w_t L_t^I + B_t^I + \epsilon_t^I \tag{2.49}$$

$$C_t^E + R_{t-1} B_{t-1}^E + q_t(h_t^E - h_{t-1}^E) + \frac{1}{\alpha^E} v_t N_t^E = w_t L_t^E + B_t^E + \frac{1}{\alpha^E} d_t N_t \tag{2.50}$$

By aggregating these constraints, Walras' law implies the following equation for goods market clearing:

$$\alpha^P C_t^P + \alpha^I C_t^I + \alpha^E C_t^E + v_t N_t^E = Y_t \tag{2.51}$$

Note that total consumption $C_t \equiv \alpha^P C_t^P + \alpha^I C_t^I + \alpha^E C_t^E$ when added to the amount of goods devoted to new firm creation equals to the total output (GDP).

2.3.7 Calibration and Steady State Characteristics

The periods in the model are meant to be quarters, hence I set $\beta^P = 0.9925$, which ensures approximately 4% annual interest rate, similar to most of the works in the literature. Therefore, from equation (2.8), the return to deposits in steady state can be computed:

$$R = \frac{1}{\beta^P} \tag{2.52}$$

On the other hand, from Euler equation of share holding (2.30) the steady state expression of return to investment in new varieties can be obtained:

$$R^{inv} \equiv \frac{v + d}{v} = \frac{1}{(1-\delta)\beta^E} \tag{2.53}$$

and since $v = f^E$ from the entry condition (2.43), we pin down the steady state value of firm profits:

$$d = f^E \frac{1 - (1-\delta)\beta^E}{(1-\delta)\beta^E} \tag{2.54}$$

This allows us -by using the equations of firm profits (2.41), law of motion for the number of firms (2.44), and goods market clearing (2.51)- to calculate some important long run rations that can be found in Table 2.5.

In addition, by setting $\beta^I = 0.94$ and $\beta^E = 0.94$ we ensure that the impatient households borrow in equilibrium. This can be seen immediately by evaluating (2.18) and (2.28) in steady state where $\mu^I > 0$ and $\mu^E > 0$ are satisfied, as long as $\beta^I < \beta^P$ and $\beta^E < \beta^P$. The parameter associated with marginal utility of housing is set at $j = 0.075$ and the loan-to-value ratio at $m = 0.7$. A value $\theta = 6$ for the elasticity of substitution between the intermediate goods delivers a price markup of 20%, which is commonly used in the literature[12]. Following Bilbiie et al. (2012), for the elasticity of labor supply I set $\varphi = 4$, and firm's constant death shock $\delta = 0.025$ which implies 10 percent annual firm destruction rate, something that is in line with US empirical evidence. As for the parameter of entry cost f^E, it can be set equal to one without loss of generality, as it does not affect the impulse responses.

The steady state productivity level is set to $A = 1$, and the persistence of the stochastic AR(1) process is $\rho_\epsilon = 0.975$, while the standard deviation of the shock is set equal to 0.01.

[12]Lower value such as $\theta = 4$ as in Bilbiie et al. (2012) does not alter the qualitative conclusions.

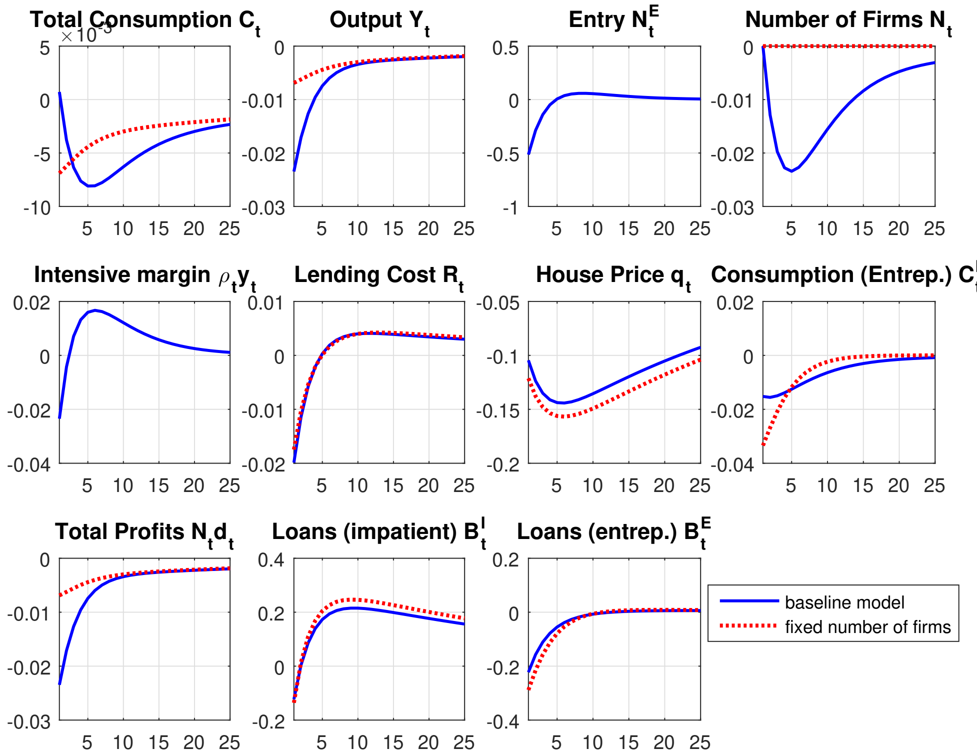

Figure 2.5: IRFs for 1% positive loan default shock ϵ^I_t. Comparison between baseline model and its counterpart with exogenous number of firms ($\alpha^P = \alpha^I = \alpha^E = 1/3$).

2.3.8 Loan Default Shock: The Role of Endogenous Entry

Figure 2.5 illustrates the comparison of impulse responses of key variables in percentage deviations from their steady state levels to 1% positive loan default shock by the unproductive household between the baseline model and the model with exogenous number of firms[13], for a case when the agents have equal weights in the economy: $\alpha^P = \alpha^I = \alpha^E = 1/3$. The goal is to assess the macroeconomic consequences of persistent losses in the productive sector on firm entry and total output. When the impatient household defaults on his contractual obligations because of, say, sharp decline in house prices or any other exogenous event, a transfer of wealth occurs from the lender to the impatient borrower household, and in this case driving away resources from the productive sector, since the patient household is the credit supplier to the entrepreneur. Although the lending cost (return to deposits)[14] drops on impact it remains above steady state during the transition periods, which drives down asset prices q_t that are used as collateral for loans. Remarkably, this response matches the result implied by the presented SVAR model following default shock. The fall in home prices deteriorates the collateral value of the investor borrower which reduces her borrowings B^E_t and her consumption levels. However, her consumption does not drop as it does in a model without investment in new varieties. Through the Euler equation for share holding (2.30), the entrepreneur is able to allocate part of the negative impact to investment, which can be seen in its log-linearized version:

$$\hat{C}^E_t = E_t\big[\hat{C}^E_{t+1}\big] - [1-(1-\delta)\beta^E]E_t\big[\hat{d}_{t+1}\big] \tag{2.55}$$

where the hatted variables represent the percentage deviations from the steady state values. The equation indicates that expected profits have negative impact on today's consumption. The anticipated fall in overall demand drives down the expected profits which makes the market

[13]Simulations are done using Dynare.

[14]The lending cost and the return to deposits are different variables in the extended model where the bank sector is introduced.

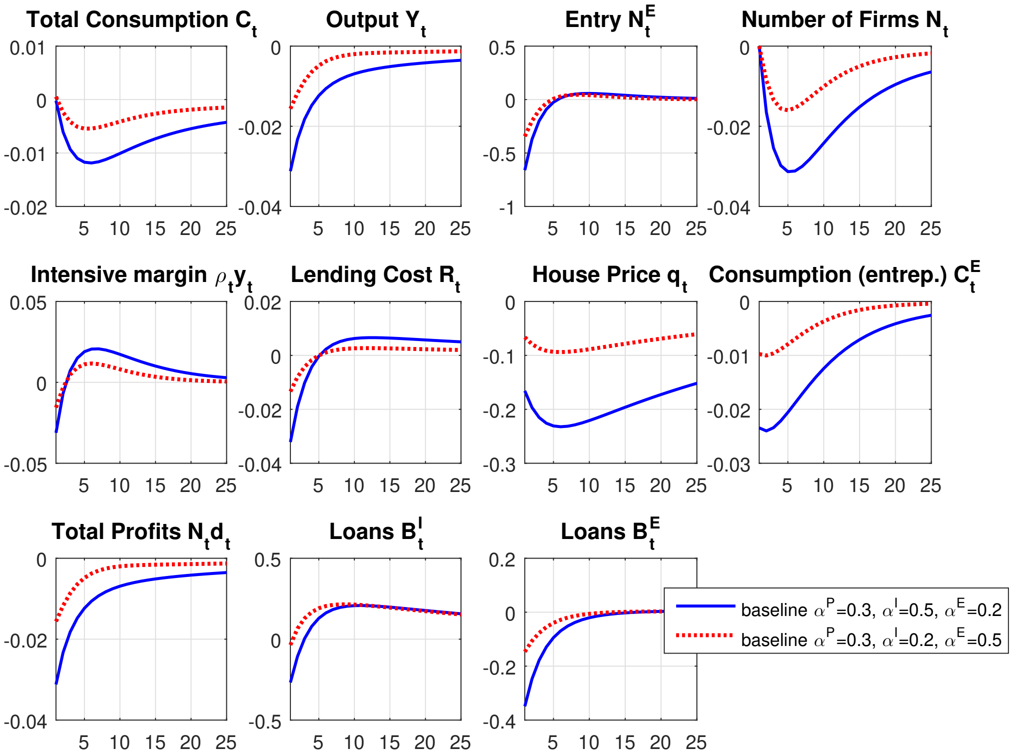

Figure 2.6: IRFs for 1% positive loan default shock ϵ^I_t. Comparison between two different set of values for the agents' masses.

less attractive for potential entrants. In other words, the entrepreneur has less incentive to invest in firm creation, therefore firm entry drops, and the decline in her consumption is muted relative to the model with fixed number of firms. Although aggregate consumption rises slightly on impact it remains below steady state afterwards. The initial rise is the result of impatient borrower's higher marginal propensity to consume, since the shock has positive income effect on his budget constraint.

Finally, the initial drop in the intensive margin drives down total output (since N_t is predetermined), and the negative impact of the shock is amplified compared to the model with fixed number of firms due to the procyclical response of business formation N^E_t. Later, it can be noticed that the recovery of the intensive margin is relatively quicker than the aggregate output's due to the contribution of the extensive margin in output's dynamics that is captured by the gradual decrease in number of operating firms N_t which delays the recovery of the economy (see equation (2.42)).

2.3.9 Loan Default Shock: The Role of Agents' Masses

Now we address the importance of the size of each household type. For this purpose, we compare the impulse responses to the default shock ϵ^I_t considering two different levels for the masses in the baseline model. Figure 2.6 shows how the model exhibits stronger decline in entry and output when value for α^I gets higher. To understand why, suppose each borrower household in the segment with mass α^I defaults on his loan that generates 1 dollar gain in his budget constraint (2.14), then each lender household in the segment with mass α^P incurs an amount of loss equal to $\frac{\alpha^I}{\alpha^P}$ dollars in her budget constraint (2.5), an expression that is strictly increasing in α^I since $\alpha^P + \alpha^I + \alpha^E = 1$, hence larger adverse impact on the productive sector.

However, given the value of each mass, the amplification through endogenous entry gets weaker if α^I is bigger. In figure 2.7 we display the dynamics of some key variables in the face of 1% default shock ϵ^I_t for two different sets of values for the shares, comparing the baseline

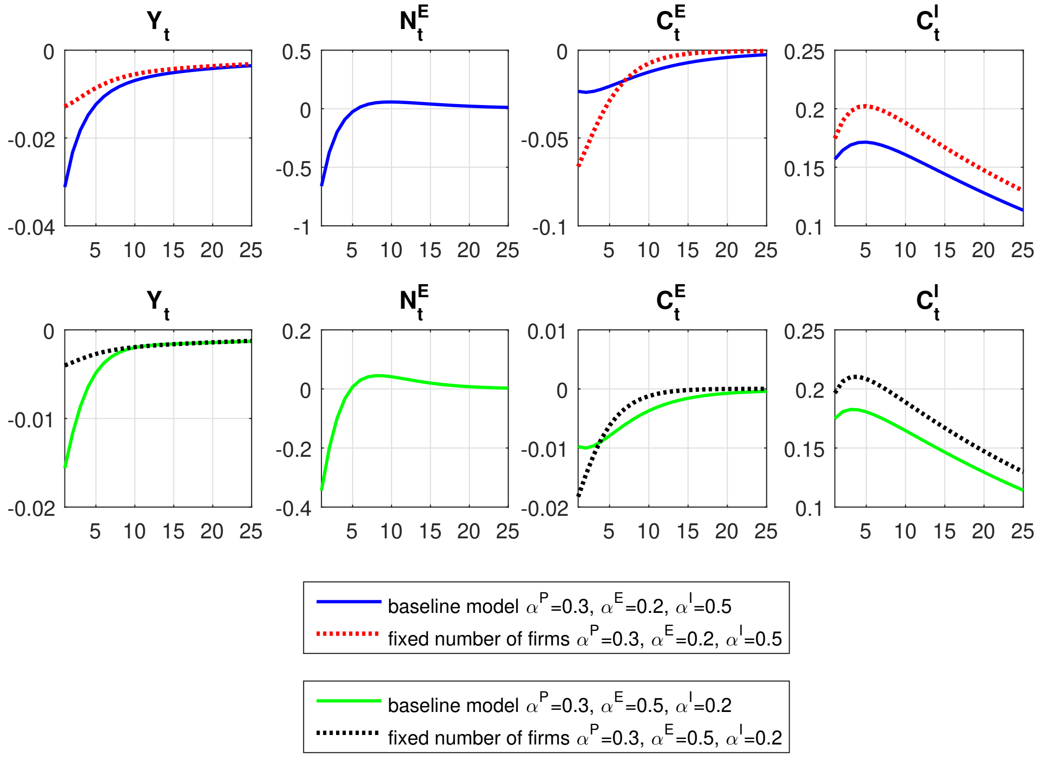

Figure 2.7: IRFs for 1% positive loan default shock ϵ_t^I. The role of endogenous entry for two different set of values for the agents' masses.

model's behavior against its counterpart with fixed number of firms. The first row shows the case when α^I is relatively high, while the second row presents the other case when α^I is low. Although endogenous entry magnifies this type of financial shock in both cases, however the amplification is muted in the first case. Notice that the drop in output is almost two times amplified in the first case, while it is more than three times in the second case. This is because one of the consequences of the redistribution shock is a positive wealth effect on the defaulter household who has higher propensity to consume, and if this type of household represents relatively large section in the economy then it would result in non-negligible rise in goods demand, which in turn raises profits expectations that attract new firm creation, partly offsetting the overall negative impact on entry and output.

2.4 Robustness Check

2.4.1 Entry in Labor Units

In this exercise we define firm entry in terms of effective labor units as in the original paper by Bilbiie et al. (2012). A potential entrant faces a fixed sunk cost that equals to the hiring cost (wages) of constant f_L^E units of effective labor. The entrant computes the value of the new variety (the value of the new created firm) according to (2.31), and entry occurs until the following condition is satisfied:

$$v_t = f_L^E \frac{w_t}{A} \tag{2.56}$$

In the current setting the entrepreneur household supplies two types of labor: one for production sector L_t^{Ec}, and one for business formation L_t^{Ee}, hence the investor's labor is being allocated between consumption goods production and entry purposes:

$$L_t^E = L_t^{Ec} + L_t^{Ee} \tag{2.57}$$

Therefore, it is easy to deduce that the technology to produce new varieties is depicted in the following form:

$$N_t^E = \frac{A\alpha^E L_t^{Ee}}{f_L^E} \tag{2.58}$$

Finally, the produced goods are consumed entirely, unlike the assumption in the baseline model where the produced goods were allocated between consumption and entry. Therefore, Walras' law implies that the goods market clears when total consumption equals output:

$$\alpha^P C_t^P + \alpha^I C_t^I + \alpha^E C_t^E = Y_t \tag{2.59}$$

Therefore, GDP can be defined as the sum of total consumption output and new varieties created:

$$GDP_t \equiv Y_t + v_t N_t^E \tag{2.60}$$

Figure 2.8 demonstrates the impulse responses to loan default ϵ_t^I for two versions of entry definitions: entry in terms of consumption goods, and entry in terms of labor units. The dynamics are similar in the two settings, in the sense that the investor household decides to dampen the fall in consumption in the expense of investment in new varieties. However, the channel is different through which the allocation between investment and other expenditures is performed. In this exercise where entry is defined in terms of effective labor, the entrepreneur decides on impact to reduce the supply of labor to the less attractive economy (the extensive margin) since profits are expected to be low, while increasing the supply of labor to the production sector (the intensive margin). As a result, firm entry drops and output falls, followed by gradual decrease in number of firms.

Compared to the baseline definition of entry (in terms of goods), the magnitudes of the contraction of entry and output are slightly muted in this exercise, which can be attributed to the way entry condition is defined in (2.56). Note that the sunk cost depends on wages that decreases gradually, an outcome that favors firm entry, unlike the baseline definition where the firm value -which coincides with the sunk cost in equilibrium- is constant. However, the amplification is still present compared to the fixed firms version.

2.4.2 Commercial Houses

In addition to residential house investment, it is worth considering the commercial (non-residential) stock of houses for the sake of robustness check. The investor household invests in commercial houses as well, that are available for incumbents to rent for their production purposes while paying rental costs to the entrepreneur for this type of house services. The household does not get utility from commercial houses since she does not live in them (non owner-occupied houses). Through this consideration the model is modified in several dimensions which is left to be presented in the Appendix.

Figure 2.9 shows the role of endogenous firm entry in the presence of commercial house investment in response to positive default shock ϵ_t^I, and demonstrates that the qualitative results achieved so far are unchanged.

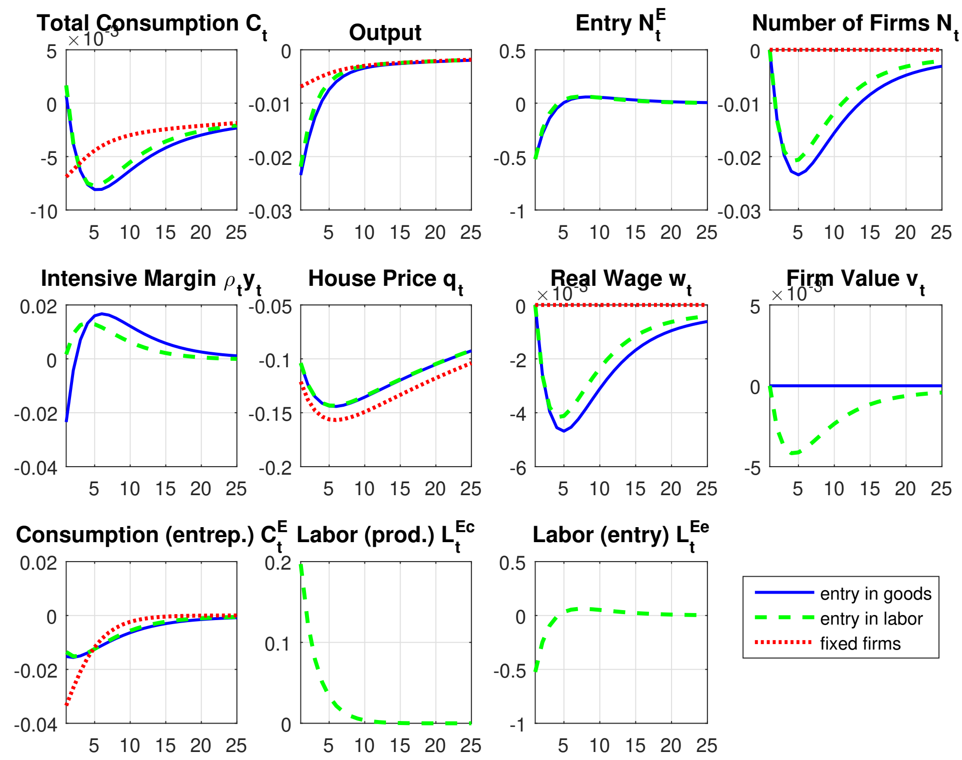

Figure 2.8: IRFs for 1% positive loan default shock ϵ_t^I. Comparison between two entry definitions ($\alpha^P = \alpha^I = \alpha^E = 1/3$).

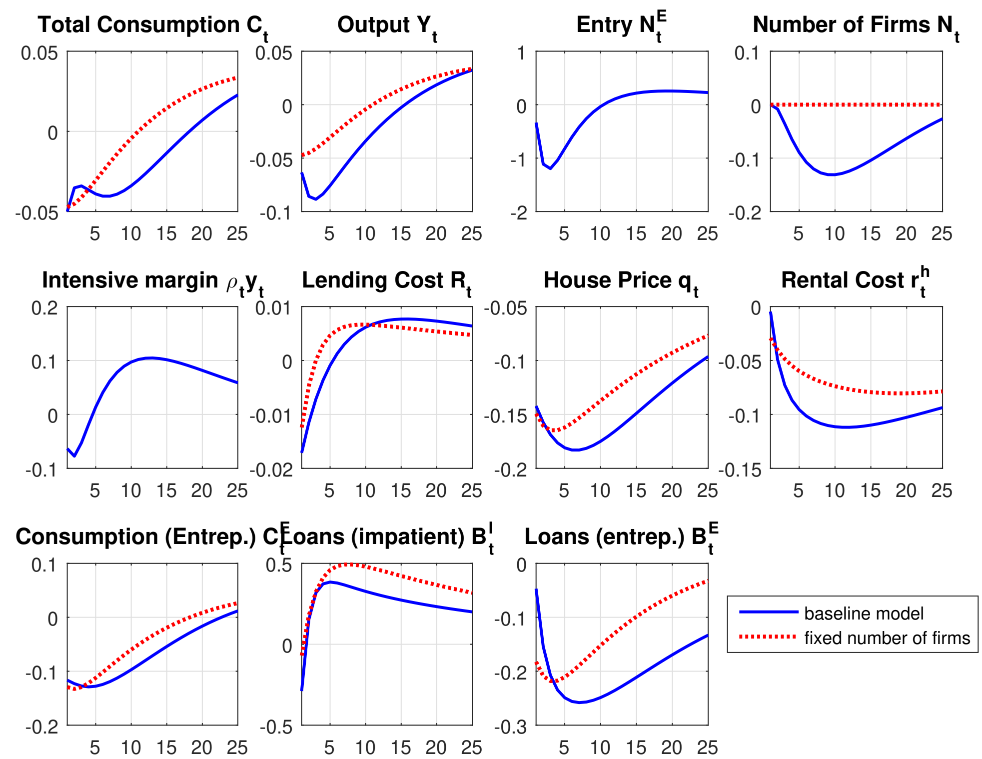

Figure 2.9: IRFs for 1% positive loan default shock ϵ_t^I. The role of endogenous entry in the presence of commercial houses ($\alpha^P = \alpha^I = \alpha^E = 1/3$).

2.5 The Extended Model

In this section, I address the role of financial intermediaries in the transmission of two types of default shocks (triggered by the two distinct borrowers) by introducing a banker agent to the model. The latter demands deposits from the patient household and extends loans to the other two borrower agents[15]. The presence of bank in the model is to make it more realistic, and as a financial intermediate it plays an important amplifying role of financial shocks, something that will be shown below. Hence, the current variant of the model includes banker and three household agents: the patient lender, the impatient borrower, and the impatient investor (entrepreneur), while their discount factors respectively are: β^B, β^P, β^I and β^E, with assigned values that justify each agent's level of patience. In addition, the shares of the agents in the economy are: α^B, α^P, α^I and α^E, that satisfy: $\alpha^P + \alpha^I + \alpha^E + \alpha^B = 1$ since the total mass is normalized to unity. The default shock triggered by the investor borrower ϵ_t^E is modeled similarly to the one set off by the unproductive agent ϵ_t^I. Compared to the baseline model, the problems of the household agents are unchanged apart from the borrowing cost which will be deviated from the deposit return creating a spread between the two rates. In the following I present the bank sector[16], and I leave the complete equations of the full model to the Appendix.

2.5.1 The Bank Sector

Due to loan defaults, how does the redistribution of resources work? In this block I present the bank sector as a financial intermediate between the lender and the borrower households. In the current setting, the redistribution shocks ϵ_t^I and ϵ_t^E appear as negative terms in the banker's problem instead of the patient household's, which implies that a loan default originated in the borrower household's sector triggers a loss in the net worth of the banker, which in turn affects the entrepreneurial activities negatively given that the investor household depends on bank loans to finance expenditures.

Let the bank sector have a mass of α^B. A representative banker maximizes the following expected utility:

$$U^B = E_0 \sum_{t=0}^{\infty} \beta^{B^t} \log C_t^B \tag{2.61}$$

Similar to the problems of the households, C_t^B is basket of consumption goods produced by the incumbent firms and aggregated through CES preferences:

$$C_t^B = \Big[\int_{N_t} C_{i,t}^{B\,\frac{\theta-1}{\theta}} di \Big]^{\frac{\theta}{\theta-1}} \tag{2.62}$$

The demand for each consumption good by the banker can be obtained by minimizing total expenditure $\int_{N_t} P_{i,t} C_{i,t}^B di$, hence it becomes:

$$C_{i,t}^B = \big(\frac{P_{i,t}}{P_t}\big)^{-\theta} C_t^B \tag{2.63}$$

As in Iacoviello (2015) the banker is characterized to be an impatient agent relative to the lender household, but a patient one when dealing with a borrower agent. This can be guaranteed by choosing proper values for the discount factors. In fact, they should satisfy the following: $\beta^I < \beta^B < \beta^P$ and $\beta^E < \beta^B < \beta^P$.

[15] It is also possible to add the channel where banks extend loans to the incumbents as well, who borrow in order to cover their productions costs. Therefore fluctuations, say rise, in the borrowing cost reduce profits expectation which in turn attracts less entrants. See La Croce and Rossi (2018) and Ravenna and Walsh (2006)

[16] The superscript B is used for the variables associated with the banker.

Let D_t^B denotes the amount of deposits that bank collects from the patient household, with R_t to be the borrowing cost that is determined from the patient household's problem. Also, let B_t^B be the total amount of bank loans supplied to the two impatient households, while R_t^B is its gross return.

This allows us to write the budget constraint of the banker:

$$C_t^B + R_{t-1}D_{t-1}^B + B_t^B \leq D_t^B + R_t^B B_{t-1}^B - \frac{\alpha^I}{\alpha^B}\epsilon_t^I - \frac{\alpha^E}{\alpha^B}\epsilon_t^E \tag{2.64}$$

The banker is also subject to a borrowing constraint in the form of regulatory commitments. We assume that the amount of liabilities issued cannot exceed a certain fraction of the amount of assets[17]:

$$D_t^B \leq m^B B_t^B \tag{2.65}$$

The right hand side represents the fraction of the assets utilized as collateral.

The Lagrangian of the banker's maximization problem is the following:

$$\mathcal{L}^B = E_0 \sum_{t=0}^{\infty} {\beta^B}^t \big[\log C_t^B + \lambda_t^B\big(D_t^B + R_t^B B_{t-1}^B - C_t^B - R_{t-1}D_{t-1}^B - B_t^B - \frac{\alpha^I}{\alpha^B}\epsilon_t^I - \frac{\alpha^E}{\alpha^B}\epsilon_t^E\big) + \mu_t^B\big(m^B B_t^B - D_t^B\big)\big]$$

In each period t the banker chooses C_t^B, D_t^B, B_t^B, and the first order conditions are:

$$[C_t^B] : \lambda_t^B = \frac{1}{C_t^B} \tag{2.66}$$

$$[D_t^B] : 1 - C_t^B \mu_t^B = E_t\big[\Lambda_{t,t+1}^B R_t\big] \tag{2.67}$$

$$[B_t^B] : 1 - m^B C_t^B \mu_t^B = E_t\big[\Lambda_{t,t+1}^B R_{t+1}^B\big] \tag{2.68}$$

where λ_t^B and μ_t^B are the Lagrange multipliers associated to the budget and borrowing constraints respectively, and $\Lambda_{t,t+1}^B \equiv \beta^B \frac{C_t^B}{C_{t+1}^B}$ is banker's consumption based discount factor. We can infer from (2.67) that the borrowing constraint (2.65) binds, since in steady state: $\mu^B = \frac{1}{C^B}\big(\frac{\beta^P - \beta^B}{\beta^P}\big) > 0$.

Furthermore when $m^B < 1$, it is obvious from (2.67) and (2.68) that loans and deposits returns are not equal in equilibrium. Moreover, lower values of m^B make loans less liquid, hence more compensation for the banker is needed, which is reflected in higher returns for loans R_t^B. Having said that, by adjustment of the loan returns, these two equations summarize the indifference behavior of the bank between collecting deposits and issuing loans.

2.5.2 Markets Clearing

The following two equations describe credit market clearing for deposits and loans respectively:

$$\alpha^P D_t = \alpha^B D_t^B \tag{2.69}$$

$$\alpha^B B_t^B = \alpha^I B_t^I + \alpha^E B_t^E \tag{2.70}$$

On the other hand, the labor and house markets clear in a similar way to the baseline version after normalizing house supply to unity:

$$L_t = \alpha^P L_t^P + \alpha^I L_t^I + \alpha^E L_t^E \tag{2.71}$$

[17] This is equivalent to the requirement for the banks to hold a capital-asset ratio equal to a specific number.

$$\alpha^P h_t^P + \alpha^I h_t^I + \alpha^E h_t^E = 1 \tag{2.72}$$

Finally, by imposing $x_t = x_{t+1} = \frac{1}{\alpha^E}$ in equilibrium, we write the budget constraints of the four agents -patient, impatient, entrepreneur, banker- respectively:

$$C_t^P + D_t + q_t(h_t^P - h_{t-1}^P) = w_t L_t^P + R_{t-1} D_{t-1} \tag{2.73}$$

$$C_t^I + R_t^B B_{t-1}^I + q_t(h_t^I - h_{t-1}^I) = w_t L_t^I + B_t^I + \epsilon_t^I \tag{2.74}$$

$$C_t^E + R_t^B B_{t-1}^E + q_t(h_t^E - h_{t-1}^E) + \frac{1}{\alpha^E} v_t N_t^E = w_t L_t^E + B_t^E + \frac{1}{\alpha^E} d_t N_t + \epsilon_t^E \tag{2.75}$$

$$C_t^B + R_{t-1} D_{t-1}^B + B_t^B = D_t^B + R_t^B B_{t-1}^B - \frac{\alpha^I}{\alpha^B}\epsilon_t^I - \frac{\alpha^E}{\alpha^B}\epsilon_t^E \tag{2.76}$$

And aggregation across those constraints leads to the goods market clearing:

$$\alpha^P C_t^P + \alpha^I C_t^I + \alpha^E C_t^E + \alpha^B C_t^B + v_t N_t^E = Y_t \tag{2.77}$$

2.5.3 Calibration and Steady State Properties

Before examining the role of the bank as a financial intermediate we have to ensure that the banker is a borrower relative to the patient household, and a lender when dealing with the impatient households. This can be done by choosing a value for the discount factor $\beta^B = 0.945$ that satisfies the following: $\beta^I < \beta^B < \beta^P$ and $\beta^E < \beta^B < \beta^P$. Accordingly, the borrowing constraint (2.65) holds in equality, as well as the collateral constraints of the two impatient households.

By evaluating equations (2.67) and (2.68) at steady state and using (2.52) we pin down the value of loan returns:

$$R^B = (1 - m^B)\frac{1}{\beta^B} + m^B \frac{1}{\beta^P} \tag{2.78}$$

Note that, by having $m^B < 1$ and $\beta^B < \beta^P$, there is positive spread in steady state between return on loans and cost of deposits $R = \frac{1}{\beta^P}$, in fact:

$$R^B - R = (1 - m^B)\left(\frac{\beta^P - \beta^B}{\beta^P \beta^B}\right) \tag{2.79}$$

2.5.4 Loan Default Shocks

Motivated by the fact that banks have played a crucial role in transmitting and magnifying the deterioration of the financial system during the recent crisis, we explore how the transmission mechanism of the financial shock that is triggered by loan defaults in the household sector works, and how it impacts firm entry by tightening the financial constraint of the investor borrower.

We start by demonstrating the dynamic equation of the spread by combining (2.67) with (2.68):

$$R_{t+1}^B - R_t = (1 - m^B)\frac{C_t^B \mu_t^B}{\Lambda_{t,t+1}^B} \tag{2.80}$$

This equation indicates that higher multiplier μ_t^B reflects higher returns on loans, because banks would require larger compensations on the extended loans when borrowing constraint gets tighter. Moreover, a shock such as the loan default ϵ_t^I or ϵ_t^E that causes losses of, say x dollars, in the net worth of the bank (assets minus liabilities) implies a decline of $\frac{x}{1-m^B} > x$ dollars in the amount of supplied loans, based on the logic of leverage ratio requirement.

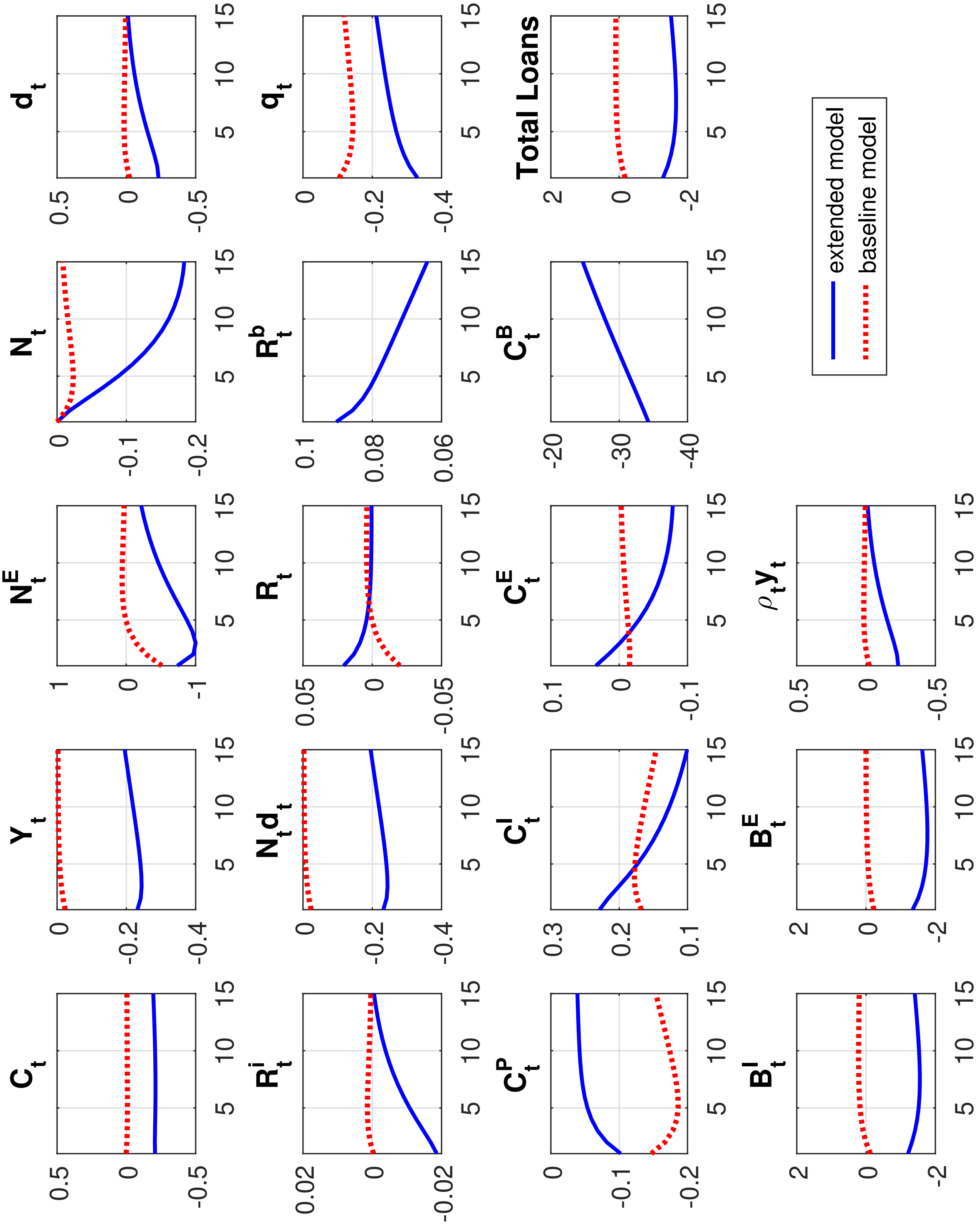

Figure 2.10: IRFs for 1% positive loan default shock ϵ_t^I. Displaying the role of the bank.

Default by the Unproductive Borrower: The Role of the Bank

I highlight the importance of bank's presence in the model by displaying the impulse responses of some key variables to default shock ϵ_t^I in Figure 2.10 based on the extended and the baseline versions of the model[18].

The redistribution shock diminishes the net worth of the bank, who reacts by reducing loan supply. If the entrepreneur depends on bank loans to finance her expenditures, then such losses in the bank sector will be transmitted to her through higher borrowing costs in equilibrium, which directly reduces the demand for loans. Furthermore, this will have a drag on dampening effect on house prices, which according to (2.32) depends negatively on future borrowing costs that are expected to be above steady state for most of the transition, consequently house price falls, hence further reducing the borrowing amount by deteriorating the collateral value that dictates the limit of the entrepreneur's borrowing ability. As a result, the entrepreneur reduces consumption and investment triggering contraction in the number of entrants which increases the negative impact on output, followed by gradual decline in total number of firms in the subsequent periods.

Note that the version without banks have similar dynamics but are less volatile. In such scenario the patient household lends directly to the borrowers, absent any spread between deposit and loan returns. In the no-bank version, the lending cost R_t is determined by patient household's consumption pattern, and remains above the steady state for most of the periods, but it does not rise as its counterpart R_t^B does in the full model. Therefore, house price and loan volumes fall less sharply, and the drop in entry is muted.

Default by the Investor Borrower: The Role of the Shock's Origin

Now we analyze the consequences of loan default ϵ_t^E triggered by the investor borrower. The unfavourable impact on the bank sector is similar to the one provoked by ϵ_t^I (default originated from the unproductive borrower). However ϵ_t^E reallocates resources from the banker to the entrepreneur, thus dampening the negative effect on investment created by the rise in borrowing costs. This result can be noted in Figure 2.11, which displays the dynamics in response to the two default shocks, and shows that redistribution of wealth caused by ϵ_t^E generates muted contraction in consumption, entry, and output compared to ϵ_t^I. The initial rise in investor's consumption is because of her higher propensity to consume, but the eventual deterioration in her collateral value and the decline in aggregate demand force her to decrease investment activities. On the other hand Figure 2.12 demonstrates the amplifying role of endogenous entry in the face of the default shock ϵ_t^E.

2.5.5 House Demand Shock

Given the importance of houses as assets that can also be used as collateral to obtain loans, particularly in the build up to the financial crisis, we are interested in assessing the model's performance in capturing the impact of house price variations on the economy through entry channel. To achieve this, I replace the parameter j by an AR(1) process j_t which allows us to capture exogenous disturbances to marginal utility of housing that shift the house demand. Let's also assume that such random variations of house prices are common among all households, hence a shock to j_t can be called house demand, house price or house preference

[18] For the upcoming exercises, the values of the agents' shares are equal in each version: $\alpha^P = \alpha^I = \alpha^E = 1/3$ in the baseline version, and $\alpha^P = \alpha^I = \alpha^E = \alpha^B = 1/4$ in the extended one. However, the model implies similar qualitative results for other combination of mass values as well.

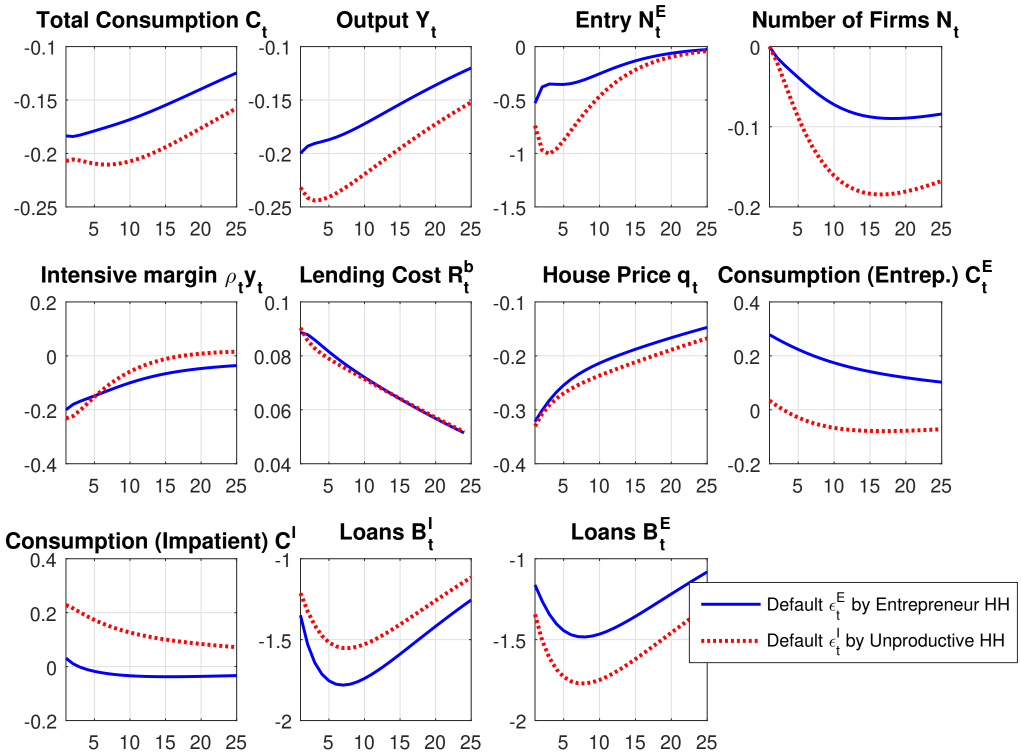

Figure 2.11: IRFs for 1% positive loan default shock ϵ^I_t and ϵ^E_t. The Role of the Shock's Origin.

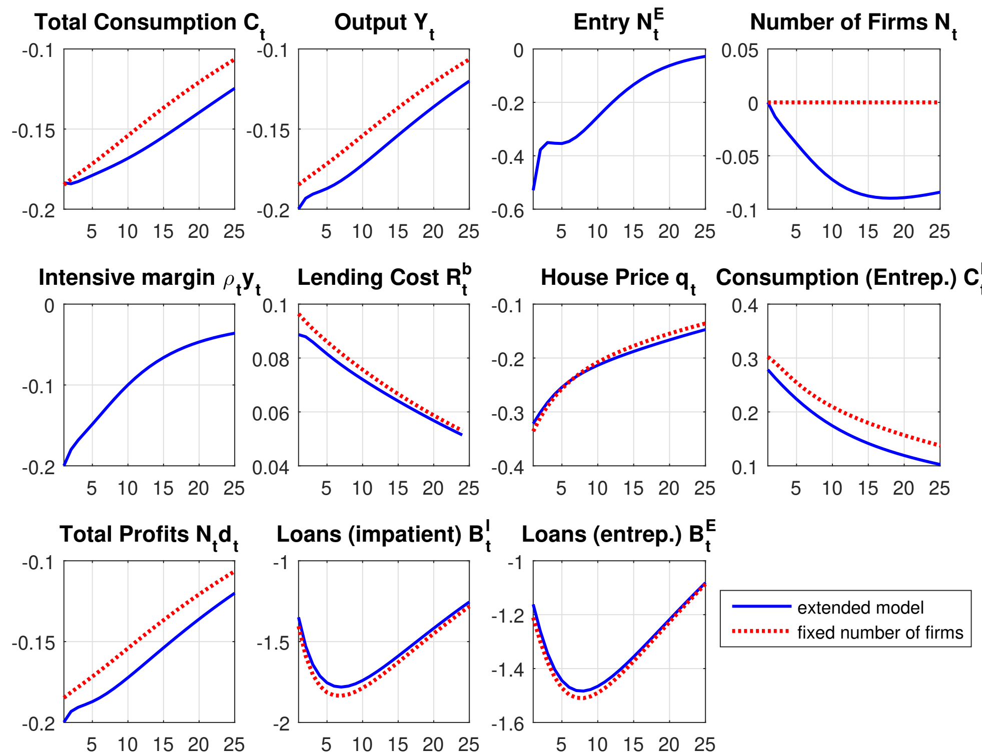

Figure 2.12: IRFs for 1% positive loan default shock ϵ^E_t. The role of endogenous entry.

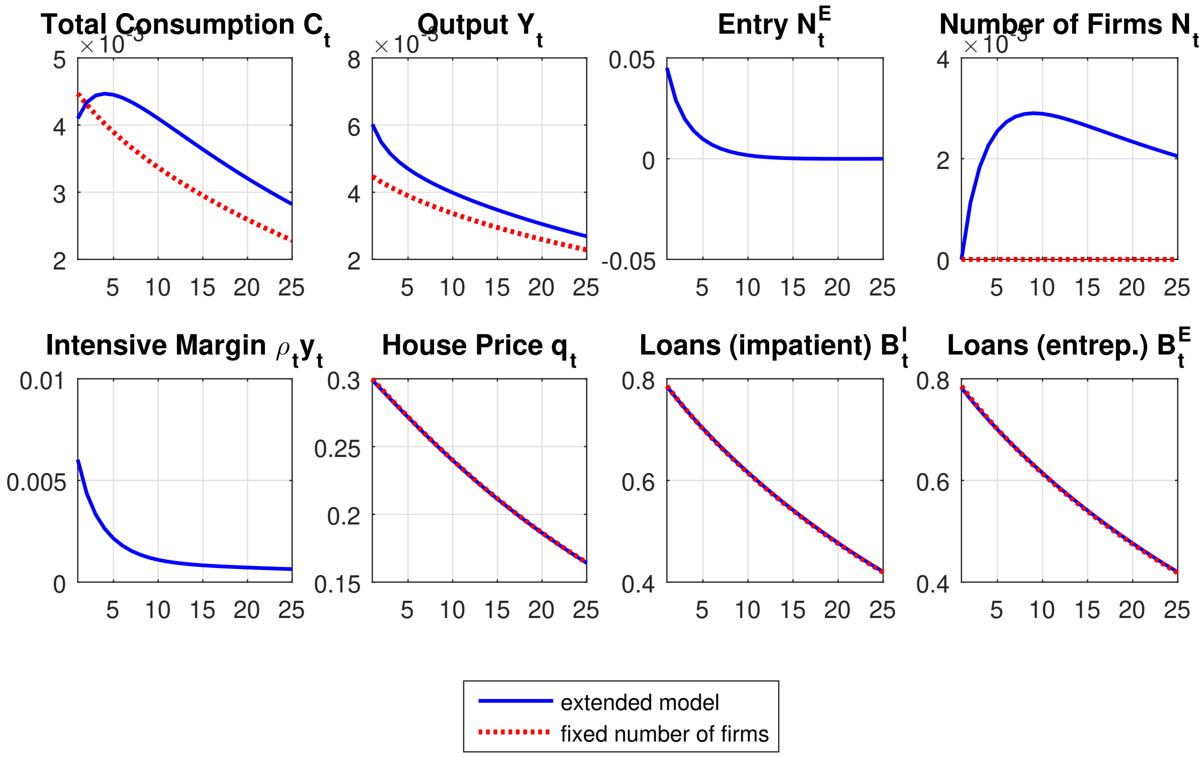

Figure 2.13: IRFs for 1% positive house demand shock. Comparison between the extended model and the model with fixed number of firms.

shock:

$$\log\left(\frac{j_t}{j}\right) = \rho_j \log\left(\frac{j_{t-1}}{j}\right) + u_{j,t} \tag{2.81}$$

where $u_{j,t}$ is i.i.d.

Figure 2.13 plots the dynamic simulation of the model in the face of house demand shock to j_t. Assume 1% unexpected positive increase in house preference that can be understood as an improvement or easing in regulations. Not surprisingly, this implies a jump in house prices that directly has an influence in boosting lending conditions since the borrowers are constrained amid utilizing their houses as collateral. The anticipated enhancements in credit access would bolster profit expectations, and the intertemporal substitution logic drives the investor household to postpone consumption in favor of investment in new varieties. Hence firm entry rises followed by gradual increase in the number of firms. The dynamics in this framework are evident compared with its counterpart with fixed number of firms where the impact is mitigated in total output, concluding that the positive response of economic activity to house preference shock is amplified through firm endogenous entry.

2.5.6 More on the Role of the Collateral

In order to further explore the role of the collateral as an amplification mechanism, it is worth comparing the impulse responses to the default and house demand shocks between two different values for loan-to-value ratio m in each case. Relatively higher values for this parameter indicate easier requirements to obtain credit. Although having similar dynamics, Figures 2.14, 2.15, and 2.16 show how more relaxed financial constraint ($m = 0.75$) implies higher volatility, where the impacts of the shocks are larger in magnitude on firm entry and output. Since the borrower investor is constrained, tighter conditions -reflected in lower values for m ($m = 0.7$)- would have more muted repercussions on entry, output and total number of firms.

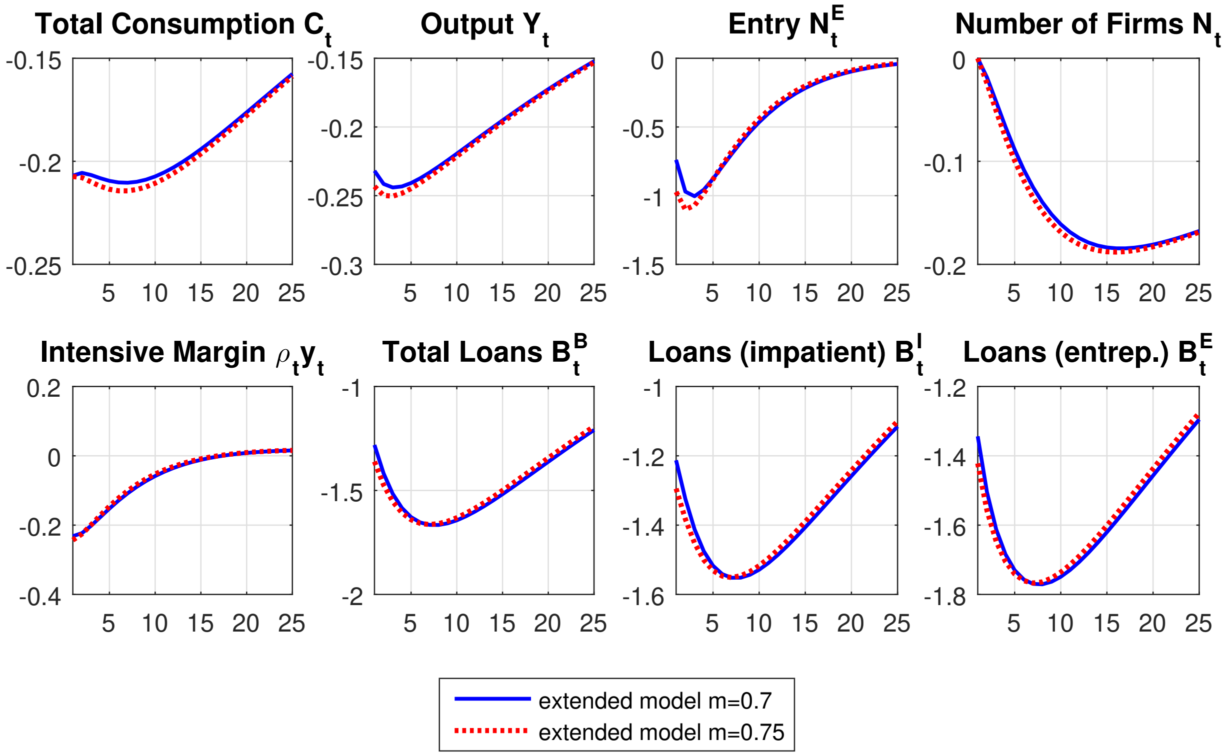

Figure 2.14: IRFs for 1% positive loan default shock ϵ_t^I.

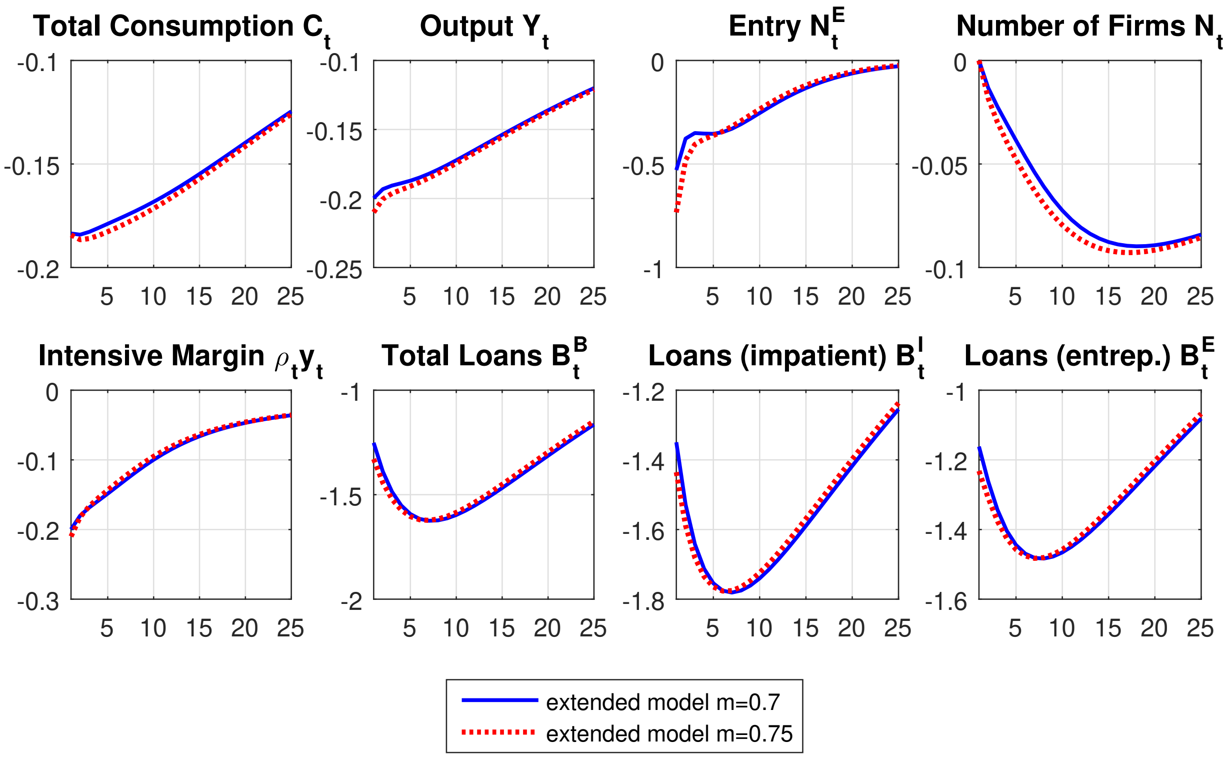

Figure 2.15: IRFs for 1% positive loan default shock ϵ_t^E.

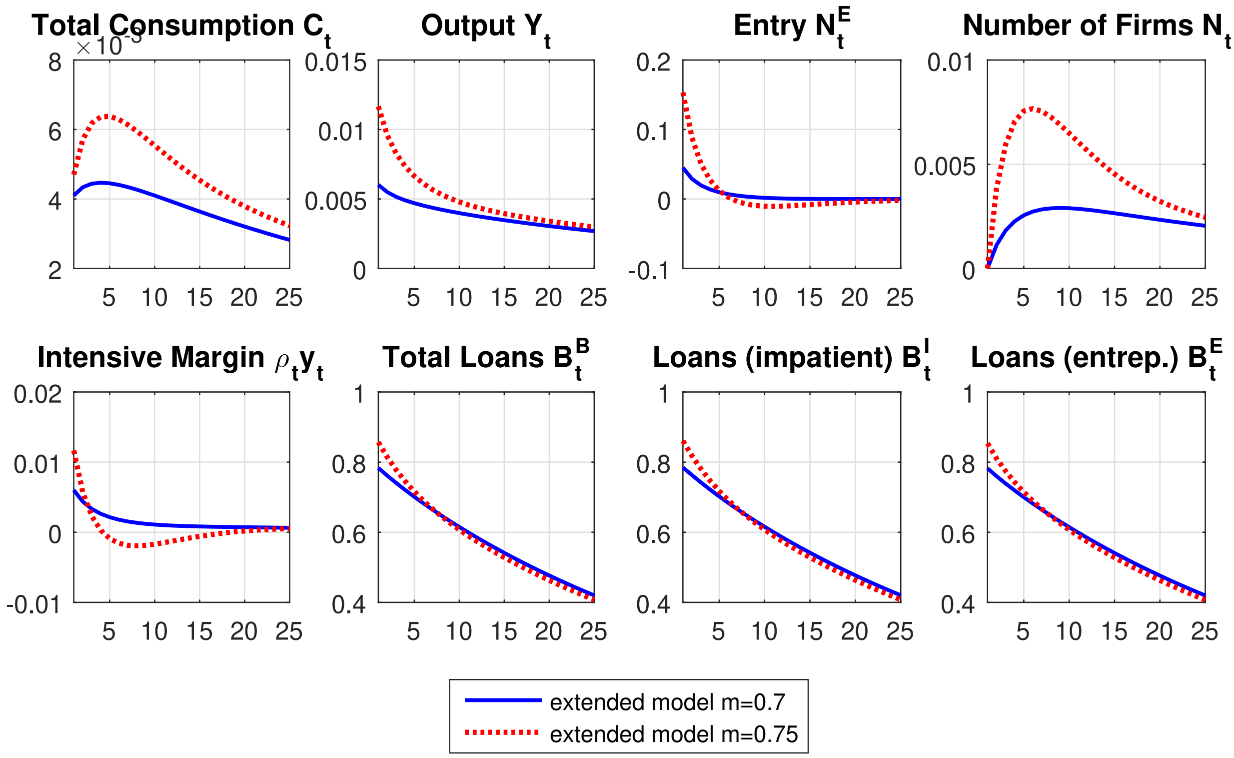

Figure 2.16: IRFs for 1% positive house demand shock.

2.6 Second Moments

Table 2.2 reports the comparison of some relevant second moments between the ones observed in the US data and the ones generated by the model. I compute the model implied second moments for the HP-filtered log-variables X_t^R defined as[19]: $X_t^R \equiv \frac{P_t X_t}{P_{i,t}} = \frac{X_t}{\rho_t}$. The moments reported in the last two columns correspond to the baseline and the extended versions of the model in the presence of default and house demand shocks with standard deviation of 1% each.

Remarkably, the extended model produces higher volatilities of output, consumption, entry, and house price compared to the baseline version although they still fall short of the ones seen in data. However, to examine the performance of the model relative to data it is better looking into the ratio of a variable's standard deviation to GDP's rather than its magnitude, since the standard deviations of the shocks are choices rather than estimates. Having said that, those ratios implied by the extended version are quite close to their data counterparts. On the other hand, the extended version predicts the procyclicality of consumption, entry, and house price although producing high levels of correlations with GDP and entry, but yet relatively closer to data than in the baseline version. Finally, the extended version outperforms the baseline model when it comes to the persistency of consumption, while it generates relatively lower first order autocorrelations for output and house price, but predicts larger number in case of entry.

[19]Following BGM, this consideration for the real variables is more consistent with the data since $P_{i,t}$ is closer to CPI index than P_t.

Variable X	**Full Sample 1992:Q3-2019:Q4**	**Baseline Model**	**Extended Model**
GDP Y^R			
Standard deviation: σ_{Y^R}	1.01%	0.06%	0.41%
Autocorrelation (1st order)	0.88	0.77	0.74
Consumption C^R			
Standard deviation: σ_X	0.83%	0.03%	0.36%
Ratio of std. deviation to GDP's: σ_X/σ_{Y^R}	0.81	0.50	0.88
Correlation with GDP	0.87	0.46	0.99
Correlation with Entry	0.49	0.05	0.90
Autocorrelation (1st order)	0.91	0.57	0.72
Entry N^E			
Standard deviation: σ_X	3.43%	1.11%	1.56%
Ratio of std. deviation to GDP's: σ_X/σ_{Y^R}	3.38	18.5	3.81
Correlation with GDP	0.56	0.91	0.93
Autocorrelation (1st order)	0.38	0.58	0.82
House Price q^R			
Standard deviation: σ_X	2.31%	0.44%	0.69%
Ratio of std. deviation to GDP's: σ_X/σ_{Y^R}	2.28	7.33	1.68
Correlation with GDP	0.57	-0.12	0.82
Correlation with Entry	0.41	0.02	0.75
Autocorrelation (1st order)	0.95	0.77	0.69

Table 2.2: **Second Moments**

2.7 Conclusion

In the aftermath of the collapse of house prices during the Great Recession and the waves of loan defaults that followed, there was documented decline in the birth of new firms. Preceding and during this episode, the dynamics of firm entry suggest the existence of important link to house prices and loan charge-off volumes. In this paper, given the role of firm creation in business cycle, I provided empirical evidence through Structural-VAR model demonstrating that entry, consumption, and output respond positively to house price shock and negatively to loan default shock. Then I built a DSGE model that brings the same responses, and delivers a transmission mechanism of the financial shocks through endogenous collateral value and firm entry. In the baseline version of the model, loan default that is triggered in the "unproductive" borrower household's sector causes unexpected losses for the lender, and is transmitted to the constrained investor borrower through lower asset prices. The reduced access to obtain credit -coupled with drop in profit expectations- attracts less entrants, and the contraction in output is amplified compared to the version with fixed number of firms. Then two exercises were conducted for robustness check considering different entry cost definition and commercial house investment. Furthermore, the model is extended to incorporate a banking sector as financial intermediate between the saver and borrower agents. The presence of banker magnifies and propagates the impact of default shock on investment through higher borrowing costs and lower asset prices. Besides, I define a second default shock originated from the borrower entrepreneur, in the face of which the model predicts a decline in entry and output, but this response is muted when compared to the one provoked by the unproductive agent. Moreover, the feedback to positive house demand shock is a rise in number of entrants following an appreciation in the collateral value. Also, the creditworthiness of the borrower plays a role in amplifying the impact of the shocks on new firm investment. In addition, heterogeneous mass of agents was introduced to the model which showed that the impact of default shock on birth and output gets larger as the share of the defaulter in the economy gets bigger, but simultaneously dampening the amplification through endogenous entry. Lastly, the extended model produces some second moments that are quite close to the ones observed in data, namely, the relative volatilities to output's (measured by the ratio of variable's standard deviation to GDP's).

The model can be enriched by incorporating some other features that were missing in this paper. In fact, the next step is to bring the model to data by estimating it in Bayesian framework, because it is crucial to obtain reasonable estimates for the model parameters that reflect actual data, specifically the shares of the agents as they had non-negligible effects on the magnitudes of the shocks.

Interpretation	**Equation**
Labor supply (patient)	$w_t = C_t^P L_t^{P\frac{1}{\varphi}}$
Labor supply (impatient)	$w_t = C_t^I L_t^{I\frac{1}{\varphi}}$
Labor supply (investor)	$w_t = C_t^E L_t^{E\frac{1}{\varphi}}$
Consump. Euler equation for patient HH	$1 = E_t\left[\Lambda_{t,t+1}^P R_t\right]$
Euler equation for share holding	$v_t = E_t\left[(1-\delta)\Lambda_{t,t+1}^E (d_{t+1} + v_{t+1})\right]$
Demand for houses by patient HH	$q_t = j\frac{C_t^P}{h_t^P} + \left[\Lambda_{t,t+1}^P q_{t+1}\right]$
Demand for houses by impatient HH	$q_t = j\frac{C_t^I}{h_t^I} + \left[\Lambda_{t,t+1}^I q_{t+1}\right] + \left[\frac{mq_{t+1}}{R_t}\left(1 - \Lambda_{t,t+1}^I R_t\right)\right]$
Demand for houses by investor HH	$q_t = j\frac{C_t^E}{h_t^E} + \left[\Lambda_{t,t+1}^E q_{t+1}\right] + \left[\frac{mq_{t+1}}{R_t}\left(1 - \Lambda_{t,t+1}^E R_t\right)\right]$
Real marginal costs	$mc_t = \frac{w_t}{A}$
Pricing	$\rho_t = \frac{\theta}{\theta-1} mc_t$
Firms' entry condition	$v_t = f_E$
Variety effect	$\rho_t = N_t^{\frac{1}{\theta-1}}$
Firm profits	$N_t d_t = \frac{1}{\theta} Y_t$
Law of motion for the number of firms	$N_t = (1-\delta)(N_{t-1} + N_{t-1}^E)$
Gross returns to investment in new firms	$R_{t+1}^{inv} \equiv E_t\left[\frac{v_{t+1}+d_{t+1}}{v_t}\right]$
Goods market clearing	$\alpha^P C_t^P + \alpha^I C_t^I + \alpha^E C_t^E + v_t N_t^E = Y_t$
Labor market clearing	$\alpha^P L_t^P + \alpha^I L_t^I + \alpha^E L_t^E = L_t$
Credit market clearing	$\alpha^P D_t = \alpha^I B_t^I + \alpha^E B_t^E$
House market clearing	$\alpha^P h_t^P + \alpha^I h_t^I + \alpha^E h_t^E = 1$
Budget constraint for patient HH	$C_t^P + D_t + q_t \Delta h_t^P = w_t L_t^P + R_{t-1} D_{t-1} - \frac{\alpha^I}{\alpha^P} \epsilon_t^I$
Budget constraint for impatient HH	$C_t^I + R_{t-1} B_{t-1}^I + q_t \Delta h_t^I = w_t L_t^I + B_t^I + \epsilon_t^I$
Budget constraint for investor HH	$C_t^E + R_{t-1} B_{t-1}^E + q_t \Delta h_t^E + \frac{1}{\alpha^E} v_t N_t^E = w_t L_t^E + B_t^E + \frac{1}{\alpha^E} d_t N_t$
Loans for impatient HH	$B_t^I = \frac{mE_t\left[q_{t+1}\right] h_t^I}{R_t}$
Loans for investor HH	$B_t^E = \frac{mE_t\left[q_{t+1}\right] h_t^E}{R_t}$
Consump. based discount factor (patient)	$\Lambda_t^P = \beta^P \frac{C_t^P}{C_{t+1}^P}$
Consump. based discount factor (impatient)	$\Lambda_t^I = \beta^I \frac{C_t^I}{C_{t+1}^I}$
Consump. based discount factor (investor)	$\Lambda_t^E = \beta^E \frac{C_t^E}{C_{t+1}^E}$
Loan default shock	$\epsilon_t^I = \rho_\epsilon \epsilon_{t-1}^I + u_{\epsilon^I,t}$

Table 2.3: **Baseline Model Summary**

Parameter	**Interpretation**	**Value**
β^P	Patient Household's discount factor	0.9925
β^I	Impatient Household's discount factor	0.94
β^E	Entrepreneur Household's discount factor	0.94
β^B	Banker's discount factor	0.945
θ	Elasticity of substitution between goods	6
φ	Elasticity of labor supply	4
δ	Firm's exit probability	0.025
f^E	Entrant's fixed cost parameter	1
m	Loan-to-value ratio	0.7
m^B	Liabilities-to-assets ratio (banker)	0.9
A	Steady state productivity	1
j	Steady state of housing's weight in utility	0.075

Table 2.4: **Calibration**

Interpretation	**Expression**
Share of profit income in GDP	$\frac{dN}{Y} = \frac{1}{\theta}$
Share of labor income in GDP	$\frac{wL}{Y} = \frac{\theta-1}{\theta}$
Share of capital in GDP	$\frac{vN}{Y} = \frac{1}{\theta}\frac{(1-\delta)\beta^E}{1-(1-\delta)\beta^E}$
Share of investment in GDP	$\frac{vN^E}{Y} = \frac{1}{\theta}\frac{\delta\beta^E}{1-(1-\delta)\beta^E}$
Share of consumption in GDP	$\frac{C}{Y} = 1 - \frac{1}{\theta}\frac{(1-\delta)\beta^E}{1-(1-\delta)\beta^E}$
Share of profit income in consumption output	$\frac{dN}{C} = \frac{1-(1-\delta)\beta^E}{\theta[1-(1-\delta)\beta^E]-\delta\beta^E}$
Share of investment in consumption output	$\frac{vN^E}{C} = \frac{\delta\beta^E}{\theta[1-(1-\delta)\beta^E]-\delta\beta^E}$
Share of profits in total capital	$\frac{dN}{vN} = \frac{(1-\delta)\beta^E}{1-(1-\delta)\beta^E}$

Table 2.5: **Long Run Ratios**

Appendix A

The Baseline Model with Commercial Houses

It is presented in this section only the modified equations in the presence of commercial house investment. Entrepreneur's budget constraint becomes:

$$C_t^E + R_{t-1}B_{t-1}^E + q_t(h_t^E - h_{t-1}^E) + q_t(h_t^C - h_{t-1}^C) + v_t(N_t + N_t^E)x_{t+1} \\ \leq w_t L_t^E + B_t^E + r_t^h h_t^C + (d_t + v_t)N_t x_t \tag{A.1}$$

h_t^C is the stock of commercial houses, and r_t^h is the rental cost of those houses. The first order condition with respect to h_t^C is:

$$[h_t^C] : q_t = R_t^h + E_t\big[\Lambda_{t,t+1}^E q_{t+1}\big] \tag{A.2}$$

Note that according to (A.2) -by solving forward without speculative bubbles- the house price becomes equal to the discounted sum of future expected rents[1]:

$$q_t = E_t\big[\sum_{k=0}^{\infty} \Lambda_{t,t+k}^E R_{t+k}^h\big] \tag{A.3}$$

On the production side, firm i maximizes each period's real profits by choosing labor $L_{i,t}$, amount of commercial house $h_{i,t}^C$, the price of the good $P_{i,t}$ using the Cobb_Douglas technology $Y_{i,t} = AL_{i,t}^{\zeta}(\alpha^E h_{i,t}^C)^{1-\zeta}$[2].

The modified Lagrangian and the first order conditions are:

$$\mathcal{H} = \big(\frac{P_{i,t}}{P_t}\big)^{1-\theta} Y_t - w_t L_{i,t} - r_t^h(\alpha^E h_{i,t}^C) + mc_{i,t}\big[-\big(\frac{P_{i,t}}{P_t}\big)^{-\theta} Y_t + AL_{i,t}^{\zeta}(\alpha^E h_{i,t}^C)^{1-\zeta}\big]$$

$$[L_{i,t}] : w_t = \zeta mc_{i,t}\frac{Y_{i,t}}{L_{i,t}} \tag{A.4}$$

$$[h_{i,t}^C] : r_t^h = (1-\zeta) mc_{i,t}\frac{Y_{i,t}}{\alpha^E h_{i,t}^C} \tag{A.5}$$

Symmetry among the operating firms allows us to write the aggregate commercial house demanded for production purposes:

$$h_t^C = N_t h_{i,t}^C \tag{A.6}$$

[1]This goes in line with the present value model that assumes the house price to be equal to the discounted present value of all future rents.

[2]We calibrate the income share of labor $\zeta = 0.64$.

Whereas the consumption output in terms of N_t takes the following form:

$$Y_t = N_t^{\frac{1}{\theta-1}} A L_t^{\zeta} (\alpha^E h_t^C)^{1-\zeta} \tag{A.7}$$

While the F.O.Cs can be rewritten:

$$w_t = \zeta(\frac{\theta-1}{\theta})\frac{Y_t}{L_t} \tag{A.8}$$

$$r_t^h = (1-\zeta)(\frac{\theta-1}{\theta})\frac{Y_t}{\alpha^E h_t^C} \tag{A.9}$$

Finally, by considering fixed supply of houses, the clearing of house market is described by the following equation:

$$\alpha^P h_t^P + \alpha^I h_t^I + \alpha^E (h_t^E + h_t^C) = 1 \tag{A.10}$$

Appendix B

The Equations of The Extended Model

Apart from firms, assume that the economy is populated by four types of agents: patient, impatient, entrepreneur and banker, each with its corresponding mass $\alpha^P, \alpha^I, \alpha^E$ and α^B and discount factors: $\beta^P, \beta^I, \beta^E$ and β^B. We normalize the total mass to one, hence imposing: $\alpha^P + \alpha^I + \alpha^E + \alpha^B = 1$.

Patient Household (Lender $\beta^B < \beta^P$)

The patient household maximizes her utility:

$$U^P = E_0 \sum_{t=0}^{\infty} {\beta^P}^t \big[\log C_t^P + j_t \log h_t^P - \frac{{L_t^P}^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}} \big]$$

subject to the following budget constraint in equilibrium:

$$C_t^P + D_t + q_t(h_t^P - h_{t-1}^P) = w_t L_t^P + R_{t-1} D_{t-1} \tag{B.1}$$

First order conditions imply the following consumption Euler, labor supply, and house demand equations:

$$1 = E_t\big[\Lambda_{t,t+1}^P R_t\big] \tag{B.2}$$

$$\frac{w_t}{C_t^P} = {L_t^P}^{\frac{1}{\varphi}} \tag{B.3}$$

$$q_t = j_t \frac{C_t^P}{h_t^P} + E_t\big[\Lambda_{t,t+1}^P q_{t+1}\big] \tag{B.4}$$

where $\Lambda_{t,t+1}^P \equiv \beta^P \frac{C_t^P}{C_{t+1}^P}$ is patient household's consumption based discount factor.

Impatient "Unproductive" Household (Borrower $\beta^I < \beta^B$)

The impatient borrower maximizes the utility:

$$U^I = E_0 \sum_{t=0}^{\infty} {\beta^I}^t \big[\log C_t^I + j_t \log h_t^I - \frac{{L_t^I}^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}} \big]$$

and subject to the following budget constraint in equilibrium:

$$C_t^I + R_t^B B_{t-1}^I + q_t(h_t^I - h_{t-1}^I) = w_t L_t^I + B_t^I + \epsilon_t^I \tag{B.5}$$

and the collateral constraint:

$$B_t^I = \frac{m E_t\big[q_{t+1}\big] h_t^I}{R_{t+1}^B} \tag{B.6}$$

The optimal behavior of the household leads to the following labor supply, loan demand, and house demand conditions:

$$\frac{w_t}{C_t^I} = L_t^{I\frac{1}{\varphi}} \tag{B.7}$$

$$\mu_t^I C_t^I = 1 - E_t\big[\Lambda_{t,t+1}^I R_{t+1}^B\big] \tag{B.8}$$

$$q_t = j_t \frac{C_t^I}{h_t^I} + E_t\big[\Lambda_{t,t+1}^I q_{t+1}\big] + \mu_t^I C_t^I \frac{mE_t\big[q_{t+1}\big]}{R_{t+1}^B} \tag{B.9}$$

where μ_t^I is the Lagrange multiplier associated with the collateral constraint, and $\Lambda_{t,t+1}^I \equiv \beta^I \frac{C_t^I}{C_{t+1}^I}$ is the consumption based discount factor.

Impatient Investor Household (Borrower Entrepreneur $\beta^E < \beta^B$)

The investor household maximizes the following utility:

$$U^E = E_0 \sum_{t=0}^{\infty} \beta^{E^t}\big[\log C_t^E + j_t \log h_t^E - \frac{L_t^{E^{1+\frac{1}{\varphi}}}}{1+\frac{1}{\varphi}}\big]$$

whose budget constraint in equilibrium is:

$$C_t^E + R_t^B B_{t-1}^E + q_t(h_t^E - h_{t-1}^E) + \frac{1}{\alpha^E} v_t N_t^E = w_t L_t^E + B_t^E + \frac{1}{\alpha^E} d_t N_t + \epsilon_t^E \tag{B.10}$$

subject to the borrowing constraint:

$$B_t^E = \frac{mE_t\big[q_{t+1}\big] h_t^E}{R_{t+1}^B} \tag{B.11}$$

The optimality conditions yield to the following labor supply, loan demand, house demand equations, and Euler equation for share holding:

$$\frac{w_t}{C_t^E} = L_t^{E\frac{1}{\varphi}} \tag{B.12}$$

$$\mu_t^E C_t^E = 1 - E_t\big[\Lambda_{t,t+1}^E R_{t+1}^B\big] \tag{B.13}$$

$$q_t = j_t \frac{C_t^E}{h_t^E} + E_t\big[\Lambda_{t,t+1}^E q_{t+1}\big] + \mu_t^E C_t^E \frac{mE_t\big[q_{t+1}\big]}{R_{t+1}^B} \tag{B.14}$$

$$v_t = E_t\big[(1-\delta)\Lambda_{t,t+1}^E (d_{t+1} + v_{t+1})\big] \tag{B.15}$$

where μ_t^E is the Lagrange multiplier corresponding to the borrowing constraint, and $\Lambda_{t,t+1}^E = \beta^E \frac{C_t^E}{C_{t+1}^E}$ is entrepreneur household's consumption based discount factor.

The Banker

The following utility is maximized by the banker:

$$U^B = E_0 \sum_{t=0}^{\infty} \beta^{B^t} \log C_t^B$$

who is subject to the equilibrium budget constraint:

$$C_t^B + R_{t-1} D_{t-1}^B + B_t^B = D_t^B + R_t^B B_{t-1}^B - \frac{\alpha^I}{\alpha^B}\epsilon_t^I - \frac{\alpha^E}{\alpha^B}\epsilon_t^E \tag{B.16}$$

The banker's borrowing constraint is given by the form:

$$D_t^B = m^B B_t^B \tag{B.17}$$

Resulted from the optimal behavior of the banker we obtain deposit demand, and loan supply conditions:

$$1 - C_t^B \mu_t^B = E_t\big[\Lambda_{t,t+1}^B R_t\big] \tag{B.18}$$

$$1 - m^B C_t^B \mu_t^B = E_t\big[\Lambda_{t,t+1}^B R_{t+1}^B\big] \tag{B.19}$$

where μ_t^B is the Lagrange multiplier associated to the borrowing constraint, and $\Lambda_{t,t+1}^B \equiv \beta^B \frac{C_t^B}{C_{t+1}^B}$ is banker's consumption based discount factor.

Incumbents (Operating Firms)

After imposing symmetry across the N_t producing firms, the formulas for marginal cost, pricing, variety effect, and profits can be characterized by the following:

$$mc_t = \frac{w_t}{A} \tag{B.20}$$

$$\rho_t \equiv \frac{P_{i,t}}{P_t} = \frac{\theta}{\theta - 1} mc_t \tag{B.21}$$

$$\rho_t = N_t^{\frac{1}{\theta-1}} \tag{B.22}$$

$$d_t = \frac{1}{\theta}\frac{Y_t}{N_t} \tag{B.23}$$

Firm Entry

The free entry condition is expressed by the following equation:

$$v_t = f^E \tag{B.24}$$

while the law of motion for the number of firms is given by:

$$N_t = (1-\delta)(N_{t-1} + N_{t-1}^E) \tag{B.25}$$

Markets Clearing

The following equations represent the goods, credit (deposits and loans), labor, and house markets clearing respectively:

$$\alpha^P C_t^P + \alpha^I C_t^I + \alpha^E C_t^E + \alpha^B C_t^B + v_t N_t^E = Y_t \tag{B.26}$$

$$\alpha^B D_t^B = \alpha^P D_t \tag{B.27}$$

$$\alpha^B B_t^B = \alpha^I B_t^I + \alpha^E B_t^E \tag{B.28}$$

$$L_t = \alpha^P L_t^P + \alpha^I L_t^I + \alpha^E L_t^E \tag{B.29}$$

$$\alpha^P h_t^P + \alpha^I h_t^I + \alpha^E h_t^E = 1 \tag{B.30}$$

Shocks

Loan defaults and house preference shocks follow AR(1) processes:

$$\epsilon_t^I = \rho_\epsilon \epsilon_{t-1}^I + u_{\epsilon^I,t} \tag{B.31}$$

$$\epsilon_t^E = \rho_\epsilon \epsilon_{t-1}^E + u_{\epsilon^E,t} \tag{B.32}$$

$$\log\Big(\frac{j_t}{j}\Big) = \rho_j \log\Big(\frac{j_{t-1}}{j}\Big) + u_{j,t} \tag{B.33}$$

where $u_{\epsilon^I,t}$, $u_{\epsilon^E,t}$, and $u_{j,t}$ are i.i.d.

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