LLEE Working Paper Series

ENDOGENOUS FIRMS' EXIT, INEFFICIENT BANKS AND BUSINESS CYCLE DYNAMICS

Lorenza Rossi

Working Paper No. 117
May 2015

Luiss Lab of European Economics
Department of Economics and Business
LUISS Guido Carli
Viale Romania 32, 00197, Rome -- Italy
http://dptea.luiss.edu/research-centers/luiss-lab-european-economics

© *Lorenza Rossi.* The aim of the series is to diffuse the research conducted by Luiss Lab Fellows. The series accepts external contributions whose topics is related to the research fields of the Center. The views expressed in the articles are those of the authors and cannot be attributed to Luiss Lab.

Endogenous Firms' Exit, Inefficient Banks and Business Cycle Dynamics

Lorenza Rossi
University of Pavia[1]

Abstract

I consider a NK-DSGE model with endogenous firms' exit and entry together with a monopolistic competitive banking sector, where defaulting firms do not repay loans to banks. I show that the exit margin is an important shock transmission channel. It implies: i) an endogenous countercyclical number of firms destruction; ii) an endogenous countercyclical bank markup and spread. The interaction between i) and ii) generates a stronger propagation mechanism with respect to a model with efficient banks. Compared to a model with exogenous exit the model generates a correlation between output and firms' entry closer to the data.

KEYWORDS: firms' endogenous exit, firms dynamics, monopolistic banking, inefficient financial markets, countercyclical bank markup, interest rate spread.

JEL CODES: E32; E44; E52; E58

[1]Department of Economics and Management, via San Felice al Monastero, 5. 27100 - Pavia. Phone: +39 0382 986483. Email: lorenza.rossi@eco.unipv.it. A previous version of this paper - November 2014 - was entitled: "Banking Frictions and Endogenous Firms Exit".

The author thanks Alice Albonico, Henrique Basso, Alessandra Bonfiglioli, Pablo Burriel, Andrea Caggese, Lilia Cavallari, Andrea Colciago, Jim Costain, Davide De Bortoli, Giovanni Di Bartolomeo, Stefano Fasani, Luca Fornaro, Jordi Galì, Carlos Thomas, Patrizio Tirelli and Lauri Vilmi, for their helpful comments and suggestions. I am grateful to all the participants of: the Workshop on "Macro Banking and Finance" - University of Milano "Bicocca", September 2013, the Workshop on "Macroeconomics, Financial Frictions and Asset Prices" - University of Pavia, October 2013, the 2014 X Dynare Conference (Bank of France). Finally I thank the seminar participants at: CREI (University of Pompeu Fabra), the Institute for Economic Analysis (Universitat Autonoma de Barcelona), the Bank of Spain, CEIS (University of Tor Vergata) seminar, CRENOS (University of Sassari) and LUISS Guido Carli (Rome). I especially thank Carla La Croce for her helpful research assistance, without which this project would not get started.

This work is supported by the EU 7th framework collaborative project "Integrated Macro-Financial Modelling for Robust Policy Design (MACFINROBODS)" grant no. 612796.

1 Introduction

I consider a New-Keynesian Dynamic Stochastic General Equilibrium model - henceforth, NK-DSGE model - characterized by endogenous firms' entry and exit together with a monopolistic competitive banking sector, where defaulting firms do not repay loans to banks. The latter cannot ensure against the risk of firms' default and thus banks can incur in balance sheet losses. At the same time banks cannot default. Firms' exit is modeled by considering a modified version of the mechanism proposed by Melitz (2003) and Ghironi and Melitz (2005) for exporting firms. In this context, firms exit probability becomes endogenous and the number of firms' failures in face of real and financial shocks is countercyclical, as in the data. A direct consequence of this fact is that the propagation mechanism of real and financial shocks, via the extensive margin of the good-market, becomes stronger than in a model with exogenous exit, as for example in Bilbiie, Ghironi and Melitz (2012) - henceforth, BGM. Besides this, the endogeneity of firms' exit generates an additional shock transmission channel through the banking sector. Indeed, the indirect consequence of firms endogenous default is that, every time firms' exit probability increases, banks optimally try to preserve their profits by increasing their markup and thus their interest rate on loans. In other words, banks' markup becomes countercyclical, i.e. it increases in face of recessionary shocks, while it decreases in response to expansionary shocks. The countercyclical dynamics of banks' markup further amplifies the initial impact of the shock. Finally, the endogenous exit margin generates an unconditional correlation between output and firms' entry more in line with the data than what predicted by the model with exogenous exit.

The countercyclicality of firms exit, both in terms of number and rates, together with the countercyclicalities of the banks' loan spread and markup are three important stylized facts well documented in the empirical literature. With respect to exit dynamics, Campbell (1998), using a sample of US manufacturing firms, found a strong negative correlation between the growth rate of real GDP and business' failures, implying that firm exit is countercyclical. Using a different dataset, Totzek (2009) and Vilmi (2011) found similar results. The countercyclicality of banks' loan spread is also found in several papers. An example are Hannan and Berger (1991), Asea and Blomberg (1998) and more recently Lown and Morgan (2008), Nikitin and Smith (2009) and Kwan (2010). In particular, Kwan (2010) reported that the commercial and industrial loan rate spread has been of about 66 basis points higher (or 23% higher) than its long-term average in the aftermath of the recent financial crisis. Finally, starting from Rousseas (1985) a strong evidence has been reported in favor of the countercyclicality of banks' markup. Rousseas (1985) was indeed the first to claim that banks desire to increase their markup to restore their profits, every time they fear a fall in the economic activity, firms defaults and thus losses in their balance sheets. Dueker and Thornton (1997), Angelini and Cetorelli (2003), and more recently, Olivero (2010) and Aliaga-Diaz and Olivero (2012), all show that banks' markup is countercyclical. To give additional support on these stylized facts Table 1 shows the unconditional correlations of the US real GDP with the following variables: firms' entry and exit, loans spread and two alternatives measures of the bank markup, using US quarterly data from 1992Q3 onward.[2] The same table compares data unconditional correlations with the unconditional ones obtained under my baseline model with endogenous exit and inefficient banks (labelled *Baseline*), and under the same model with an exogenous and constant exit probability modeled as in BGM (labelled *Exogenous Exit*).[3]

[2] Firms entry and exit are measured using data downloaded from the Bureau of Labor and Statistics (BLS) on establishment opened/closed by all the private sectors (in terms of numbers and rates). Exit and entry rates are given by the ratio between establishment opened/closed and the total number of establishment. Data on real GDP, the banks prime rate and the FED FUND rate have been downloaded from FRED database. Data on C&I loan rate spread come from the Board of Governors of the FED System. As in Rousseas (1985) the bank markup is computed by taking the ratio between US banks' prime rate and the FED FUND rate. As a robusteness check I also compute an alternative measure of the markup as the ratio between the US rate on Commercial and Industrial Loans and the FED FUND rate (statistics in paranthesis). All data have been hp-filtered with a smooting parameter $\lambda = 1600$.

[3] The unconditional correlations of the baseline model and those of the model with exogenous exit are obtained by calibrating structural parameters as indicated in Section 3.1. The model is hit by two exogenous AR(1) shocks: a standard TFP shock and a shock to bank capital (net worth). I set the standard deviation of the TFP shock to 0.0035 and its persistence to 0.94, as found by Smets and Wouters (2007). The standard deviation and persistence of the bank capital shock are set respectively to 0.031 and 0.81 and are taken by Gerali et al (2010). The latter is the only estimation available for bank capital shocks.

Table 1	Uncoditional Correlations with Output		
	US Data	**Baseline**	**Exogenous Exit**
Entry rate	0.19	0.59	0.90
Entry Level	0.08	0.66	0.93
Exit rate	-0.34	-0.14	0
Exit Number	-0.10	-0.14	0.55
Bank Markup	-0.37 (-0.29)	-0.24	0
Loan Spread	-0.20	-0.72	-0.88

Table 1 shows that data correlations are in line with the stylized facts reported above. Furthermore, it shows that my baseline model with endogenous exit outperforms the one with exogenous exit. Indeed, while the former implies a negative correlation of the exit rate with the real GDP, very close to the data, the latter implies that the exit rate is constant by construction. This in turn implies that the number of firms exiting the market increases during booms and decreases during downturns. This result is clearly at odds with the evidence, however it is common to all models characterized by endogenous firms creation and a constant exit rate, as for example the seminal paper of BGM. The reason is the following. Suppose that a positive technology shock hits the economy. Firms' profits opportunities increase and households invest in new firms. Therefore, firms creation as well as their number increase. Total output increases and the economy enters into a boom. Since the exit probability is constant and firms' destruction is proportional to the total number of firms, exit increases during a boom instead of decreasing. A direct consequence of this counter-fact is that the propagation mechanism of real and financial shocks via the extensive margin of the good-market is weaker than what suggested by my baseline model. Furthermore, the model with endogenous exit does a better job in replicating the correlation between real GDP and firms' entry. Finally, Table 1 shows that while both the models match the sign of the cyclicality of the loans spread, banks markup is countercyclical and the value of the correlation is very close to the data, only in the model with endogenous exit. The markup is indeed acyclical in the model with exogenous exit.

The impact of firms' dynamics on business cycle has been studied in many papers. The seminal paper of BGM considers a model with endogenous firms entry and shows that the sluggish response of the number of producers (due to the sunk entry costs) generates a new and potentially important endogenous propagation mechanism for real business cycle models. Etro and Colciago (2010) characterize endogenous good market structure under Bertrand and Cournot competition in a DSGE model and show that their model improves the ability of a flexible price model in matching impulse response functions and second moments for US data. Colciago and Rossi (2015) extend this model accounting for search and matching frictions in the labor market.[4] All these papers together with Lewis and Poilly (2012), Jaimovich and Floetotto (2008), also provide evidence that the number of producers varies over the business cycle and that firms dynamics may play an important role in explaining business cycle statistics. Bergin and Corsetti (2008) and Cavallari (2013) use a similar framework for analyzing an open economy. All these models consider a constant exit probability and are not able to disentangle the role of firms exit with respect to that of firms entry, thus missing an important characteristic of the business cycle.

To the best of my knowledge very few papers try to model firms exit in a DSGE framework. An exception are Totzek (2009), Vilmii (2011), Hamano (2013) and Cesares and Poutineau (2014). The closest to my paper are Totzek (2009) and Cesares and Poutineau (2014). Both papers considers a standard DSGE model without banking, further the exit condition and timing differ from the ones considered in this paper.[5] Importantly, none of these papers makes a comparison with the model with exogenous exit

[4] They show that their model can contribute to explain the volatility of the labor market variables and also stylized facts concerning the countercyclicality of price markups, the procyclicality of firms profits, the overshooting of the labor share of income and job creation by new firms.

[5] Totzek (2009) as well as Vilmi (2011) and Cesares and Poutineau (2014) assume that firms exit occurs at the end of the production period. In my model, exit occurs as soon as firms realize that their productivity is below the threshold and before starting producing. This implies that the average productivity changes along the business cycle and, as will be discussed in the paper, it also implies a stronger response of output. Importantly, Cesares and Poutineau (2014) assume that the stochastic discount factor is not affected dynamically by the endogenous firms exit probability. This also implies that the exit probability does not affect firms' decision on entering the market as well as firms pricing decisions. Furthermore, the authors consider a medium scale model with a large number of frictions that makes the model more suitable for policy analysis, however it makes the results and transmission channel of the exit margin more difficult to interprete. I take my model as simple as possible in order to better understand the role of the exit margin and its interaction with the banking sector.

decisions, as this paper does. Further, these models simply assume perfect and frictionless financial markets and do not consider the role played by any financial intermediary.[6]

The remainder of the paper is organized as follows. Section 2 spells out the model economy. Section 3 contains the main results and Section 4 concludes. Technical details are left in the supplemental Appendix.

2 The Model

The model is composed by four agents: households, firms, banks and the monetary authority which is responsible for setting the policy rate.

2.1 Firms

The supply side of the economy is composed by: i) the intermediate good-producing firms equally distributed into a continuum of $k \in (0,1)$ symmetric sectors. They produce a continuum of differentiated goods under monopolistic competition and sticky prices à la Rotemberg (1982). ii) The retail sector is composed by $j = k$ firms. They compete under perfect competition and bundle the intermediate good produced by each intermediate sector k.[7] The aggregate output is a CES aggregator of the retailers' goods.

2.1.1 Firms: the Intermediate Sectors

Each sector k is composed by a continuum of differentiated intermediate goods $i \in N$, where N represents the mass of available goods produced by the sector. For the sake of simplicity, I assume one-to-one identification between a product and a firm. Firms in each sector k enjoy market power and set prices $P^I_{i,k,t}$ as a markup over their marginal costs. Further, firms face a quadratic costs of adjusting prices modelled as in Rotemberg (1982), so that prices are sticky. Since all sectors are identical I consider a representative

[6] Bergin at al (2014) study a model with endogenous firms entry and financial shocks. They show that entry contributes to the propagation of financial shocks. Using a different franmework, La Croce and Rossi (2014), find similar results. Both models however consider endogenous business creation but exogenous firms destruction.

[7] The retail sector is introduced only for technical reasons, i.e. to simplify the relationship between banks and firms. Removing this sector would not alter at all the model results.

sector and I remove the index k. In this context, the production function of firm i is,

$$y_{i,t}^I = A_t z_{i,t} l_{i,t} \tag{1}$$

where A_t is the aggregate productivity, $l_{i,t}$ is the amount of labor hours employed by firm i, while $z_{i,t}$ is a firm specific productivity, which is assumed to be Pareto distributed across firms, as in Ghironi and Melitz (2005).

The intermediate goods firm chooses the amount of labor and the optimal price in order to maximize its expected profits. The maximization of profits is defined as

$$\max E_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left[j_{i,t}^I \right], \tag{2}$$

$$s.t. \qquad y_{i,t}^I = A_t z_i l_{i,t}, \tag{3}$$

where $\Lambda_{0,t}$ is the real stochastic discount factor, that will be defined below.

Real profits, $j_{i,t}^I$ are given by:

$$j_{i,t}^I = \frac{P_{i,t}^I}{P_t} y_{i,t}^I - f^F + b_{i,t} - w_t l_{i,t} - \left(1 + r_{t-1}^b\right) \frac{1}{\pi_t} b_{i,t-1} - pac_{it}^I, \tag{4}$$

where $y_{i,t}^I = \left(\frac{P_{i,t}^I}{P_t}\right)^{-\theta} Y_t$ is the demand for the intermediate good i, with P_t being the CPI index, Y_t is the aggregate output and $b_{i,t}$ is the real amount of borrowing of firm i from the banking sector. In particular, in each period t, firms borrow $b_{i,t}$ to pay the fixed cost f^F to the households[8]. The latter is paid back to the bank at the end of the period at the net interest rate r_{t-1}^b.[9]

---

[8] Since we assume that households are the owners of firms and their plants, the fixed cost can be viewed as a constant cost that a firm pay to the household in each period for using its plant. In addition to this the fixed cost can be viewed a cost for paying energy or any other utility. Alternatively, the fixed cost can be a constant lump-sum tax payed by firms to the Government. Considering the latter assumption would not alter the results of the paper.

[9] Notice that I impose $f^F = b_{i,t}$, so that in each period firms always ask for the same amount of loans. However the aggregate amount of loans changes over the business cycle, since it corresponds to $N_t f^F$. Although this assumption could be seen as a quite strong simplification (considered for technical reasons), it allows us to disentangle the role played by the exit margin in explaining the dynamics of both real and financial variables. La Croce and Rossi (2014) show that with a working capital loan, i.e. with $b_{i,t} = w_t l_{i,t}$ the

The variable $\pi_t = \frac{P_t}{P_{t-1}}$ is the gross inflation rate, while $w_t l_{i,t}$ is total real cost of labor. Finally, the term $pac_{it}^I = \frac{\tau}{2}\left(\frac{P_{i,t}^I}{P_{i,t-1}^I} - 1\right)^2 \frac{P_{i,t}^I}{P_t} y_{i,t}^I$ represents the Rotemberg (1982) price adjustment costs, modelled as in in BGM (2012). Firms profits can be rewritten as:

$$\begin{aligned} j_{i,t}^I &= y_{i,t}^I = \left(\frac{P_{i,t}^I}{P_t}\right)^{1-\theta} Y_t - f^F + b_{i,t} - w_t l_{i,t} - \left(1 + r_{t-1}^b\right)\frac{1}{\pi_t} b_{i,t-1} \\ &\quad - \frac{\tau}{2}\left(\frac{P_{i,t}^I}{P_{i,t-1}^I} - 1\right)^2 \left(\frac{P_{i,t}^I}{P_t}\right)^{1-\theta} Y_t, \end{aligned} \tag{5}$$

and thus the optimal demand for labor is

$$mc_{i,t} = \frac{w_t}{A_t z_{i,t}}, \tag{6}$$

while the optimal price equation implies

$$\rho_{i,t} = \mu_{i,t} mc_{i,t}, \tag{7}$$

where $\rho_{i,t} = \frac{P_{i,t}^I}{P_t}$ is the relative price and $\mu_{i,t}$ is the firm markup, equal to

$$\mu_{i,t} = \frac{\theta}{(\theta - 1)\left(1 - \frac{\tau}{2}\left(\frac{P_{i,t}^I}{P_{i,t-1}^I} - 1\right)^2\right) + \Omega_{i,t}}, \tag{8}$$

with $\Omega_{i,t} = \left(\frac{P_{i,t}^I}{P_{i,t-1}^I} - 1\right)\frac{P_{i,t}^I}{P_{i,t-1}^I} - E_t \Lambda_{t,t+1} \tau \left(\frac{P_{i,t+1}^I}{P_{i,t}^I} - 1\right)\frac{P_{i,t+1}^I}{P_{i,t}^I}\frac{\rho_{i,t+1}}{\rho_{i,t}}\frac{y_{i,t+1}^I}{y_{i,t}^I}$, and the stochastic discount factor defined as:

$$\Lambda_{t,t+1} = \beta E_t \left\{\left(\frac{C_{t+1}}{C_t}\right)^{-1}\left(1 - \eta_{t+1}\right)\right\}. \tag{9}$$

Notice that, since the exit probability changes along the business cycle, it now affects the dynamics of the stochastic discount factor.

dynamics of a model with exogenous exit is not qualitatively altered. Also the quantitive results change slightly. For this reason I believe that the main results of the model with endogenous exit and the comparison done with the two alternative models, would remain unaltered at least qualitatively.

Distribution of Productivity Draws According to Melitz (2003) and Ghironi and Melitz (2005), firm productivity draws are Pareto distributed. The cumulative distribution function (CDF) implied for productivity $z_{i,t}$ is $G(z_{i,t}) = 1 - \left(\frac{z_{\min}}{z_{i,t}}\right)^{\xi}$, while I denote by $g\left(z_{i,t}\right) = \xi \frac{z_{\min}^{\xi}}{z_{i,t}}$ the probability distribution function (PDF). The parameters $z_{\min}$ and $\xi > \theta - 1$ are scaling parameters of the Pareto distribution, representing respectively the lower bound and the shape parameter, which indexes the dispersion of productivity draws. As ξ increases dispersion decreases and firm productivity levels are increasingly concentrated towards their lower bound $z_{\min}$.

Endogenous Entry and Exit The timing of the entry and exit decisions is the following. Prior to entry firms are identical and face a fixed sunk cost of entry $f^E > 0$.[10] As in Ghironi and Melitz (2005), entrants are forward looking, so that the entry condition will be

$$\tilde{v}_t = \widetilde{j}_t^I + \beta E_t \left(1 - \eta_{t+1}\right) \tilde{v}_{t+1} = f^E, \tag{10}$$

where $\tilde{v}_t$ is the average firms value, given by the sum of current average profits, $\widetilde{j}_t^I$, and the next period discounted average value of firms, i.e. $\beta E_t \left(1 - \eta_{t+1}\right) \tilde{v}_{t+1}$. Notice that $\tilde{v}_{t+1}$, is discounted not only by β but also by the probability of firms default in the next period η_{t+1}, which dynamically affects firms decision on entry, thus creating an important transmission channel between exit and entry decisions. Indeed, the higher the probability of firms' default, the lower is firms expected average value and thus the lower will be firms entry.

At the beginning of each period t all firms, i.e. both new entrants and incumbent firms, draw their productivity level from the same Pareto distribution. Firms' draws are i.i.d. The incumbent firm i, decides to produce as long as its specific productivity $z_{i,t}$ is above a cutoff level $\overline{z}_t$, which is the level of productivity that makes the sum of current and discounted future profits (i.e. the firms value) equal to zero. Otherwise, they will exit the market before producing. The cut off level of productivity, $\overline{z}_t$, is therefore determined by the following exit condition:

$$v_t\left(\bar{z}_t\right) = j_{\bar{z},t}\left(\bar{z}_t\right) + \beta \left(1 - \eta_{t+1}\right) v_{t+1}\left(\bar{z}_{t+1}\right) = 0, \tag{11}$$

[10] Notice that this cost is paid only upon entry and differs from the fixed production cost f^F which is paid in every period.

with

$$j_{\bar{z},t}\left(\bar{z}_t\right) = y_t\left(\bar{z}_t\right) - w_t l_{\bar{z},t} - \left(1 + r_{t-1}^b\right)\frac{1}{\pi_t} b_{\bar{z},t-1} - pac_{\bar{z},t}, \tag{12}$$

and where $\eta_{t+1} = 1 - \left(\frac{z_{\min}}{\bar{z}_{t+1}}\right)^{\xi}$ is the endogenous probability of exiting the market. As in Ghironi and Melitz (2005), the lower bound productivity $z_{\min}$ is low enough relative to the production costs so that $\overline{z}_t$ is above $z_{\min}$. In each period, this ensures the existence of an endogenously determined number of exiting firms: the number of firms with productivity levels between $z_{\min}$ and the cutoff level $\overline{z}_t$ are separated and exit the market without producing.

Equation (12) can be easily rewritten as follows[11]

$$j_{\bar{z},t}\left(\bar{z}_t\right) = \left(\mu_t\left(\bar{z}_t\right) - 1\right) mc_t\left(\widetilde{z}_t\right)\left(\frac{\widetilde{z}_t}{\bar{z}_t}\right)^{1-\theta} y_t^I\left(\widetilde{z}_t\right) - \left(1 + r_{t-1}^b\right)\frac{1}{\pi_t} b_{i,t-1} - pac_t\left(\overline{z}_t\right), \tag{13}$$

with

$$pac_t\left(\overline{z}_t\right) = \frac{\tau}{2}\left(\frac{\rho_{\overline{z},t}}{\rho_{\overline{z},t-1}}\pi_t - 1\right)^2 \rho_{\widetilde{z},t}^{1-\theta}\left(\rho_{\widetilde{z},t} A_t \widetilde{z}_t L_t\right), \tag{14}$$

where $\rho_{\overline{z},t}$ is the relative price of the firm with the cut-off level productivity $\overline{z}_t$, with

$$\rho_{\overline{z},t} = \mu_{\overline{z},t} mc_{\widetilde{z},t}\frac{\widetilde{z}_t}{\overline{z}_t},$$

being the optimal pricing rule of firm $\overline{z}$, and

$$\mu_{\overline{z},t} = \frac{\theta\left(\frac{\overline{z}_t}{\widetilde{z}_t}\right)^{\theta} y_{\widetilde{z},t}^I}{(\theta - 1)\left(\frac{\overline{z}_t}{\widetilde{z}_t}\right)^{\theta} y_{\widetilde{z},t}^I\left(1 - \frac{\tau}{2}\left(\frac{\rho_{\overline{z},t}}{\rho_{\overline{z},t-1}}\pi_t - 1\right)^2\right) + \tau\Omega_{\overline{z},t}}, \tag{15}$$

being the markup of the cut-off firm. Finally $\Omega_{\overline{z},t}$ is defined as

$$\begin{aligned}\Omega_{\overline{z},t} \quad &= \quad \left(\frac{\overline{z}_t}{\widetilde{z}_t}\right)^{\theta} y_{\widetilde{z},t}^I \frac{\rho_{\overline{z},t}}{\rho_{\overline{z},t-1}}\pi_t\left(\frac{\rho_{\overline{z},t}}{\rho_{\overline{z},t-1}}\pi_t - 1\right) \\ &\quad - E_t\Lambda_{t,t+1}\left(\frac{\overline{z}_{t+1}}{\widetilde{z}_{t+1}}\right)^{\theta} y_{\widetilde{z},t+1}^I\left(\frac{\rho_{\overline{z},t+1}}{\rho_{\overline{z},t}}\pi_{t+1} - 1\right)\left(\frac{\rho_{\overline{z},t+1}}{\rho_{\overline{z},t}}\right)^2 \pi_{t+1}. \end{aligned} \tag{16}$$

The variables $mc_{\widetilde{z},t}$, $\rho_{\widetilde{z},t}$ and $\mu_{\widetilde{z},t}$ are respectively, the marginal costs, the relative price and the markup of the firm with the average productivity $\widetilde{z}_t$, that will be defined in the next paragraph.

[11] See the technical appendix for details.

Finally, as in BGM we assume that new entrants at time t will only start producing at time $t+1$ so that a one-period time-to-build lag is introduced in the model. However, as for the incumbent firms they will stay in the market only if their firms specific productivity $z_{i,t} \geq \overline{z}_t$, otherwise they will be separated before period $t+1$ arrives. Under the latter assumption and the conditions of entry and exit, the number of firms in the economy at period t will be:

$$N_{t+1} = \left(1 - \eta_{t+1}\right)\left(N_t + N_t^E\right). \tag{17}$$

Firm Averages Following Ghironi and Melitz (2005), the average productivity is:[12]

$$\tilde{z}_t \equiv \left[\frac{1}{1 - G(\bar{z}_t)} \int_{\bar{z}_t}^{\infty} z_{i,t}^{1-\theta} dG\left(z_{i,t}\right)\right]^{\frac{1}{\theta-1}}, \tag{18}$$

where $1 - G(\bar{z}_t) = \left(\frac{z_{\min}}{\bar{z}_t}\right)^{\xi}$ is the share of firms with a level of productivity $z_{i,t}$ above the cut off level $\overline{z}_t$. In other words, it is the firms' probability to remain in the market and produce at time t.

This implies that firms average profits coincide with the profits of the firms that obtain the average productivity $\widetilde{z}_t$, i.e.:

$$\widetilde{j}_t^I = j^I\left(\widetilde{z}_t\right) = \left(\frac{\theta-1}{\theta}\frac{A_t\widetilde{z}_t}{w_t}\right)^{\theta-1} Y_t - w_t l_t - \frac{\left(1 + r_{t-1}^b\right)}{\pi_t} b_{t-1} - pac\left(\widetilde{z}_t\right) \tag{19}$$

with

$$pac\left(\widetilde{z}_t\right) = \frac{\tau}{2}\left(\frac{\rho_{\widetilde{z},t}}{\rho_{\widetilde{z},t-1}}\pi_t - 1\right)^2 \rho_{\widetilde{z},t}^{1-\theta}\left(\rho_{\widetilde{z},t} A_t \widetilde{z}_t L_t\right). \tag{20}$$

The optimal price equation of the firm with the average productivity, $\widetilde{z}_t$, is then

$$\rho_{\widetilde{z},t} = \mu_{\widetilde{z},t} mc_{\widetilde{z},t} \tag{21}$$

where

$$\rho_{\widetilde{z},t} = N_t^{\frac{1}{\theta-1}}, \tag{22}$$

[12] From now on I denote weighted averages of a variable x with $\widetilde{x}$.

is its relative price, while $mc_{\widetilde{z},t}$ and $\mu_{\widetilde{z},t}$ are respectively its real marginal cost and markup, given by

$$
\begin{aligned}
mc_{\widetilde{z},t} &= \frac{w_t}{A_t \widetilde{z}_t}, && (23)\\
\mu_{\widetilde{z},t} &= \frac{\theta y^I_{\widetilde{z},t}}{(\theta-1)\, y^I_{\widetilde{z},t}\left(1-\frac{\tau}{2}\left(\frac{\rho_{\widetilde{z},t}}{\rho_{\widetilde{z},t-1}}\pi_t-1\right)^2\right)+\tau\Omega_{\widetilde{z},t}}, && (24)
\end{aligned}
$$

with

$$
\begin{aligned}
\Omega_{\widetilde{z},t} &= y^I_{\widetilde{z},t}\frac{\rho_{\widetilde{z},t}}{\rho_{\widetilde{z},t-1}}\pi_t\left(\frac{\rho_{\widetilde{z},t}}{\rho_{\widetilde{z},t-1}}\pi_t-1\right)- \\
&\quad E_t\Lambda_{t,t+1}y^I_{\widetilde{z},t+1}\left(\frac{\rho_{\widetilde{z},t+1}}{\rho_{\widetilde{z},t}}\pi_{t+1}-1\right)\left(\frac{\rho_{\widetilde{z},t+1}}{\rho_{\widetilde{z},t}}\right)^2\pi_{t+1}. && (25)
\end{aligned}
$$

2.1.2 Firms: Retailers

For the sake of simplicity I assume one-to-one relation between the number of retail sectors and the number of intermediate good-producing sectors. Thus, there is a continuum of firms in the retail sector, indexed with $k \in (0,1)$, which aggregate the intermediate goods of each intermediate sector at no cost according to the CES technology

$$
y_{k,t} = \left[\int_{i\in N}\left(y^I_{i,t}\right)^{\frac{\theta-1}{\theta}} di\right]^{\frac{\theta}{\theta-1}} \tag{26}
$$

with a price level

$$
P_{k,t} = \left[\int_{i\in N}\left(P^I_{i,t}\right)^{(1-\theta)} di\right]^{\frac{1}{1-\theta}} \tag{27}
$$

and sell the product under perfect competition.

2.2 Aggregate Output and Price

Aggregate output is given by the following CES technology:

$$
Y_t = \left[\int_0^1 \left(y_{k,t}\right)^{\frac{\theta-1}{\theta}} dk\right]^{\frac{\theta}{\theta-1}} \tag{28}
$$

the aggregate price index is:

$$P_t = \left[\int_0^1 P_{k,t}^{1-\theta} dk \right]^{\frac{1}{1-\theta}} \tag{29}$$

Further, notice that since in equilibrium there exist N_t firms which are Pareto distributed according to $g(z_i)$, then the price level of the retail firm can be rewritten as:

$$P_t = N_t^{\frac{1}{1-\theta}} P_t^I(\tilde{z}_t) \tag{30}$$

where the average price in the retail sector can be expressed also in terms of average producer intermediate price.

Analogously, the aggregate output is

$$Y_t = \int_0^1 \left[N_t^{\frac{\theta}{\theta-1}} \left[\frac{1}{1-G(\overline{z}_t)} \int_{\overline{z}_t}^{\infty} \left(y_{i,t}^I \right)^{\frac{\theta-1}{\theta}} dG(z_i) \right]^{\frac{\theta}{\theta-1}} \right] dk \tag{31}$$

Imposing symmetry in the retail sector, I obtain

$$Y_t = N_t^{\frac{\theta}{\theta-1}} y_t^I(\tilde{z}_t) = N_t^{\frac{1}{\theta-1}} N_t A_t \tilde{z}_t l_t = \rho_t A_t \tilde{z}_t L_t \tag{32}$$

2.3 Households

Households maximize their expected utility, which depends on consumption and labor hours as follows

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \left[\ln C_t - \frac{L_t^{1+\phi}}{1+\phi} \right], \tag{33}$$

where $\beta \in (0,1)$ is the discount factor and the variable L_t represents hours worked, while C_t is the usual consumption index:

$$C_t = \left[\int_0^1 C_{k,t}{}^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}}, \tag{34}$$

where $C_{k,t} = \left[\int_{i \in N} C_{i,t}{}^{\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}}$ is the good bundled by the retail sector and $C_{i,t}$ the production of the intermediate good-producing firm i. The parameter θ (being $\theta > 1$) is the elasticity of substitution between the goods produced in each sector. Households consume and work. They also decide how much to invest in new firms and in the shares of incumbent firms and how much to lend to the banking sector. Following BGM (2012) the households budget constraint is

$$w_t L_t + F^F + \frac{r_{t-1}^d}{\pi_t} D_{t-1} + N_t \gamma_t \left(\widetilde{v}_t + j_t^I \left(\tilde{z} \right) \right) = C_t + \left(D_t - \frac{D_{t-1}}{\pi_t} \right) + N_{H,t} \widetilde{v}_t \gamma_{t+1}, \tag{35}$$

where I denote with γ_t the share in a mutual fund of firms held by the representative household. During period t, the representative household buys γ_{t+1} shares in a mutual fund of $N_{H,t}$ firms, where $N_{H,t} = N_t + N_t^E$ represents firms already operating at time t and the new entrants. The mutual fund pays $N_t j_t^I \left(\tilde{z} \right)$ profits in each period, which is equal to the total profit of all firms that produce in that period. The main difference between new and old firms is that establishing a new firm requires an entry cost while the shares of an old firm are traded on the stock market. Households' resources are composed by wage earnings, $w_t L_t$, the total amount of fixed costs paid by firms, F^F, net interest income on previous deposits, $r_{t-1}^d \frac{D_{t-1}}{\pi_t}$, the value of the shares of firms they own, $\widetilde{v}_t N_t \gamma_t$, and firms' dividends from firms survived from the previous period, $N_t \gamma_t j_t^I \left(\tilde{z} \right)$. The flow of expenses includes consumption, C_t, deposits to be made this period, $D_t - \frac{D_{t-1}}{\pi_t}$, and financial investments in firms already operating in the market and in new firms, $N_{H,t} \widetilde{v}_t \gamma_{t+1}$.

Combining households FOCs, imposing symmetric equilibrium across sectors, and with $\gamma_t = \gamma_{t+1} = 1$, yields:

$$w_t = C_t L_t^{\phi}, \tag{36}$$

$$E_t \beta \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-1} \right\} = \frac{\pi_{t+1}}{\left(1 + r_t^d \right)}, \tag{37}$$

$$\widetilde{v}_t = E_t \beta \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-1} \left(1 - \eta_{t+1} \right) \left[\widetilde{v}_{t+1} + \widetilde{j}_{t+1}^I \right] \right\}, \tag{38}$$

which are respectively the households' labor supply, the Euler equation for consumption and the Euler equation for share holding.

2.4 The Banking Sector

2.4.1 Loans and Deposits Branches

The structure of the banking sector is a simplified version of Gerali et al. (2010). I assume that the bank is composed by two branches: the loan branch and the deposit branch. Both are monopolistic competitive, so that deposits from households and loans to entrepreneurs are a composite CES basket of a continuum of slightly differentiated products $j \in (0,1)$, each supplied by a single bank with elasticities of substitution equal to ε^b and ε^d respectively. As in the standard Dixit–Stiglitz (1977) framework, loans and deposits demands are:

$$b_{j,t} = \left(\frac{r_{j,t}^b}{r_t^b}\right)^{-\varepsilon_t^b} b_t \qquad \text{and} \qquad d_{j,t} = \left(\frac{r_{j,t}^d}{r_t^d}\right)^{-\varepsilon_t^d} d_t \tag{39}$$

where $b_{j,t}$ is the aggregate demand for loans at bank j, that is $b_{j,t} = \int_0^1 b_{k,j,t}dk = \int_0^1 \left[\int_{i\in N} b_{i,j,t}di\right]$, where $b_{k,j,t}$ is the total amount of loans demanded to bank j by sector k and b_t is the overall volume of loans to firms. Similarly, $d_{j,t}$ is the households aggregate demand for deposits to bank j, while d_t is the households overall demand for deposits.

The amount of loans issued by the loan branch can be financed through the amount of deposits, D_t, collected from households from the deposit branch or through bank capital (net-worth), denoted by K_t^b, which is accumulated out of retained earnings. Thus, the bank sector obey a balance sheet constraint,

$$B_t = D_t + K_t^b, \tag{40}$$

with the low of motion of the aggregate banking capital given by:

$$\pi_t K_t^b = (1-\delta^b)\frac{K_{t-1}^b}{\varepsilon_t^k} + j_t^b \tag{41}$$

where δ^b represents resources used in managing bank capital, while j_t^b are overall profits made by the retail branches of the bank, and ε_t^k represents a bank capital shock following an AR(1) process:

$$\varepsilon_t^k = (1-\rho_b)\,\varepsilon^k + \rho_d \varepsilon_{t-1}^k + u_t^k \tag{42}$$

where u_t^k is normally distributed white noises with zero mean and variance σ_k^2.

Loans Rates and Deposits Rates Banks play a key role in determining the conditions of credit supply. Assuming monopolistic competition, banks enjoy market power in setting the interest rates on deposits and loans. This lead to explicit monopolistic markups and markdowns on these rates.

Each bank j belonging to the loan branch can borrow from the deposit bank j at a rate R^b_{jt}. I assume that banks have access to unlimited finance at the policy rate r_t from a lending facility at the central bank: hence, by the non-arbitrage condition $R^b_{j,t} = r_t$. The loan branch differentiates the loans at no cost and resell them to the firms applying a markup over the policy rate.[13] As in Curdia and Woodford (2009) I assume that banks are unable to distinguish the borrowers who will default from those who will repay, and so must offer loans to both on the same terms. At the same time they are able to predict the fraction of loans that will not be repaid, i.e. they are able to predict firms exit probability. The problem of the loan bank j is therefore

$$\max_{\left\{r^b_{j,t}\right\}} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left[r^b_{j,t} b_{j,t} \left(1 - \eta_{t+1}\right) - r_t B_{j,t} - b_{j,t}\eta_{t+1} \right] \tag{43}$$

$$s.t. \quad b_{j,t} = \left(\frac{r^b_{j,t}}{r^b_t} \right)^{-\varepsilon^b_t} b_t$$

where $b_{j,t} = \left(\frac{r^b_{j,t}}{r^b_t} \right)^{-\varepsilon^b} b_t$ is the demand for loans of bank j, $r^b_{j,t} b_{j,t} \left(1 - \eta_{t+1}\right)$ are bank j total expected net revenues, while $r_t B_{j,t}$ is the net cost due to the interest rate paid on the deposit rates. The additional term $b_{j,t}\eta_{t+1}$ is the amount of the notional value of the loans that it is not repaid by firms. This is a death weight loss for the bank and represents an extra-cost. From the FOC, after imposing symmetry across banks, i.e. $r^b_{j,t} = r^b_t$, and thus $b_{j,t} = b_t$ and $B_{j,t} = B_t = N_t f^F$, I get the equation for the optimal interest rate:

$$r^b_t = \left(\frac{\varepsilon^b}{\left(\varepsilon^b_t - 1\right)\left(1 - \eta^e_{t+1}\right)} \right) \left(r_t + (1 - \Phi)\, \eta^e_{t+1} \right) \tag{44}$$

where $\mu^{Lb}_t = \frac{\varepsilon^b}{\left(\varepsilon^b - 1\right)\left(1 - \eta_{t+1}\right)}$ is the bank markup and $r_t + \eta^e_{t+1}$ is its marginal

[13] All banks essentially serve all firms, providing slightly differentiated deposit and loan contracts.

cost.[14] The bank marginal cost is the sum of two components: i) r_t, i.e. the net interest rate that the bank has to pay to the deposit branch for each loan. This is the only effective cost per loan in the case the bank is able to have back the notional value of the loan from defaulting firms. ii) η^e_{t+1} represents instead the expected additional cost per loan faced by the bank due to firms defaulting and not repaying the loan.

Notice that $\frac{d\left(\mu_t^{Lb}\right)}{d\eta_t} = \frac{1}{\varepsilon-1}\frac{\varepsilon+1}{\left(\eta_{t+1}-1\right)^2} > 0$, implying a positive relationship between firms' exit and the value of the bank markup. Indeed, as the expected probability of exit increases, retail banks increase their markup and set higher interest rate. The intuition is straightforward. An increase in the firms' exit probability imply that the probability that a firm do not repay the loan increases. As a consequence the bank that has issued that loan faces lower expected profits. To restore its profits the bank is forced to increase the interest rate on loan.

The deposit branch collects deposits from households and gives them to the loans unit, which pays r_t. The problem for the deposit branch is then

$$\max_{\left\{r^d_{j,t}\right\}} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t} \left[r_t D_{j,t} - r^d_{j,t} d_{j,t} - \frac{\kappa_d}{2}\left(\frac{r^d_{j,t}}{r^d_{j,t-1}} - 1\right)^2 r^d_t d_t \right] \tag{45}$$

$$s.t.$$

$$d_{j,t} = \left(\frac{r^d_{j,t}}{r^d_t}\right)^{-\varepsilon^d} d_t \text{ and } D_{j,t} = d_{j,t} \tag{46}$$

where $d_{j,t} = \left(\frac{r^d_{j,t}}{r^d_t}\right)^{-\varepsilon^d} d_t$ is the demand for deposits of bank j. From the FOC, after imposing symmetry across banks, i.e. $r^d_{j,t} = r^d_t$, and thus $d_{j,t} = d_t$ and $D_{j,t} = D_t$, I get the optimal interest rate for deposits,

$$r^d_t = \frac{\varepsilon^d}{\varepsilon^d - 1} r_t \tag{47}$$

$\frac{d\left(\frac{\varepsilon}{\varepsilon-1}\right)}{d\varepsilon} = -\frac{1}{(\varepsilon-1)^2} < 0$, i.e. the interest rate on deposits is markdown over the policy rate r_t.

[14] Indeed, in the symmetric equilibrium total costs are given by $CT^b_t = r_t b_t + b_t \eta_{t+1}$. Thus bank's marginal costs are $MC^b_t = \frac{dCT^b_t}{db_t} = r_t + \eta_{t+1}$.

Aggregate bank profits are the sum of the profits of the branches of the bank. Thus, they are also affected by the firms' exit probability and given by:

$$j_t^b = r_t^b B_t \left(1 - \eta_{t+1}\right) - r_t^d D_t - B_t \eta_{t+1}. \tag{48}$$

where $B_t \eta_{t+1}$ is the total amount of the loans not repaid to the banks.

2.5 Monetary Policy

To close the model I need to specify an equation for the Central Bank behavior. I simply assume that the monetary authority set the nominal interest rate r_t by following a standard Taylor-type rule given by

$$\ln\left(\frac{1+r_t}{1+r}\right) = \phi_R \ln\left(\frac{1+r_{t-1}}{1+r}\right) + (1-\phi_R)\left[\phi_\pi \ln\left(\frac{\pi_t}{\pi}\right) + \phi_y \ln\left(\frac{Y_t}{Y}\right)\right] \tag{49}$$

where $\ln\left(\frac{\pi_t}{\pi}\right)$ and $\ln\left(\frac{Y_t}{Y}\right)$ are respectively the deviations of inflation and output from their steady state values, ϕ_π and ϕ_y being the elasticities of the nominal interest rate with respect to these deviations. Finally, ϕ_r is the interest rate smoothing parameter.

3 Business Cycle Dynamics

In what follows I will study the impulse response functions (IRFs) to a productivity shock and to a shock to the bank capital (net-worth). In order to investigate the role played by endogenous firms destruction, I will compare the dynamics of the baseline model (i.e. of a model with endogenous exit and monopolistic banks), with that of a model with the same banking structure, but with exogenous exit, modelled as in BGM. Finally, in the second part of this Section I will compare the performance of the baseline model with an alternative model where exit is still endogenous but banks are efficient. This allows to better understand the interaction between the endogenous exit margin and the banking sector. Under the alternative model the banking sector is efficient since banks compete under perfect competition and, importantly, they can fully ensure against the risk of incurring in bank capital losses due to firms default. Since banks' profits are zero in this model, bank capital is also equal to zero. For this reason, the comparison with this model is done only in response to a technology shock. Importantly, the calibration strategy is the same across the models.

3.1 Calibration

Calibration is set on a quarterly basis. The discount factor, β, is set at 0.99. As in BGM (2012), I set the steady state value of the exit probability η to be 0.025. This matches the U.S. empirical evidence of 10% of firms destruction per year. The elasticity of substitution among intermediate goods, θ, is set equal to 4, a value which is in line with Ghironi and Melitz (2005) and BGM (2012). It also ensures that the condition for the shape parameter $\xi > \theta - 1$ is satisfied in the model with endogenous exit. Analogously, as in BGM (2012), Etro and Colciago (2010) and Colciago and Rossi (2012), I set the entry cost $f^E = 1$. The fixed costs f^F is set such that in all the economies considered they correspond to 10% of total output produced. In the model with endogenous exit ξ is set equal to 13.15. This value ensures that the steady state exit rate is 0.025, as for the model with exogenous exit. The lower bound of productivity distribution, $z_{\min}$, is equal to 1. I set the Frisch parameter $\phi = 1/2$. The steady state of productivity A is equal to 1.

I calibrate the banking parameters as in Gerali et al. (2010). For the deposit rate, I calibrate $\varepsilon^d = -1.46$. Similarly, for loan rates I calibrate $\varepsilon^b = 3.12$. The steady-state ratio of bank capital to total loans, i.e. the capital-to-asset ratio, is set at 0.09. As done for the computation of the correlation with real GDP, I set the standard deviation of the TFP shock to 0.0035 and its persistence to 0.94, as found by Smets and Wouters (2007). The standard deviation and persistence of the bank capital shock are set respectively to 0.031 and 0.81 and are taken from Gerali et al (2010). Finally, I consider a Taylor rule, with $\phi_R = 0.5$, $\phi_\pi = 2.15$ and $\phi_y = 0.125$. This rule guarantees the uniqueness of the equilibrium; furthermore these parameters are in the range of the values estimated for the US economy.[15]

[15] See for example Smets and Wouters (2007). The qualitative results and the comparison with the exogenous exit model and with the model with efficient banks are not altered by the choice of the Taylor rule.

3.2 Impulse Response Functions: Endogenous versus Exogenous Exit

Figures 1-2 show the impulse response functions (IRFs) to a positive technology shock and to a negative shock to the bank capital (net-worth). To capture the importance of the endogenous exit mechanism, I compare the IRFs of the baseline *Endogenous Exit* model (black dotted lines) with those of an *Exogenous Exit* model (blue solid lines). In both models the banking structure is characterized by monopolistic competition in the loans and the deposits branch and by the assumption that firms exiting the market do not repay the loan.

3.2.1 Technology Shock

Figure 1 shows the IRFs to a positive aggregate productivity shock, A_t, in the two models considered. In both models a positive technology shock lowers real marginal costs and creates expectations of future profits which lead to the entry of new firms. The entry margin results in a strong and persistent increase in output. This is the standard propagation mechanism implied by the BGM model. With the introduction of the endogenous exit margin, the number of firms exiting the market becomes countercyclical and the propagation of the shock is much stronger. The reason is threefold. First, the increase in the TFP leads to higher profits and thus to a lower cut-off level of productivity, $\bar{z}_t$ in the model with endogenous exit. This implies a reduction in firms' exit probability and thus a decrease in the number of firms exiting the market, further amplifying the response of output. Second, since firms entry decisions negatively depend on firms exit probability, also the response of new entrants is stronger in the endogenous exit model. Third, a decrease in the exit probability implies an higher probability for firms to repay the loan, which induces banks to reduce their markups. The countercyclical markup results in countercyclical spread between the loan rate and the policy rate.[16] The reduction in the loan spread reduces firms' cost for borrowing, further reducing firms profits and thus giving an extra boost to output. Finally, the model with endogenous exit not only implies a stronger propagation mechanism than the standard BGM model framework, but it also matches three important stylized facts: i) the countercyclicality of the

[16] The spread between the loan rate and the deposit rate is also countercyclical. Notice that, the IRFs of the inflation rate, the interest rates and the spread are all in annual terms.

number of firms exiting the market; ii) the countercyclicality of the bank markup; iii) the countercyclicality of the loan spread. The counterfactual on firms destruction, implied by the model with exogenous exit, depends exclusively on having assumed an exogenous and constant exit probability. The latter also implies an exogenous and constant banks' markup.

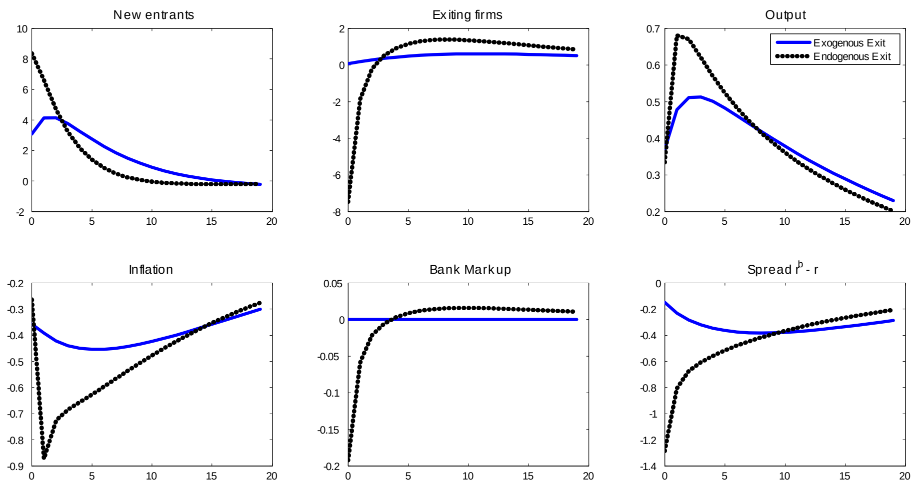

Figure 1: IRFs to a positive technology shock.

3.2.2 Bank Capital Shock

Figure 2 shows the IRFs to a negative shock to the bank capital. As before economies characterized by endogenous firms exit show higher volatilities of real and financial variables than those implied by a standard BGM model with monopolistic banking. Bank capital contraction results in lower profits so that banks are forced to increase the interest rate on loans in order to restore their profits. Since firms borrow from banks at the loan rate, as long as the interest rate on loans increases firms profits decrease. As a result, firms entry decreases in both economies. The fall of new entrants is stronger in the endogenous exit model. Also in this case both firms' exit and banks' markup turn out to be countercyclical in the model with endogenous exit, while they are mildly procyclical (or acyclical) in the model with exogenous exit. As a consequence, the model with endogenous exit experiences a higher loan spread and a deeper contraction of the real activity.

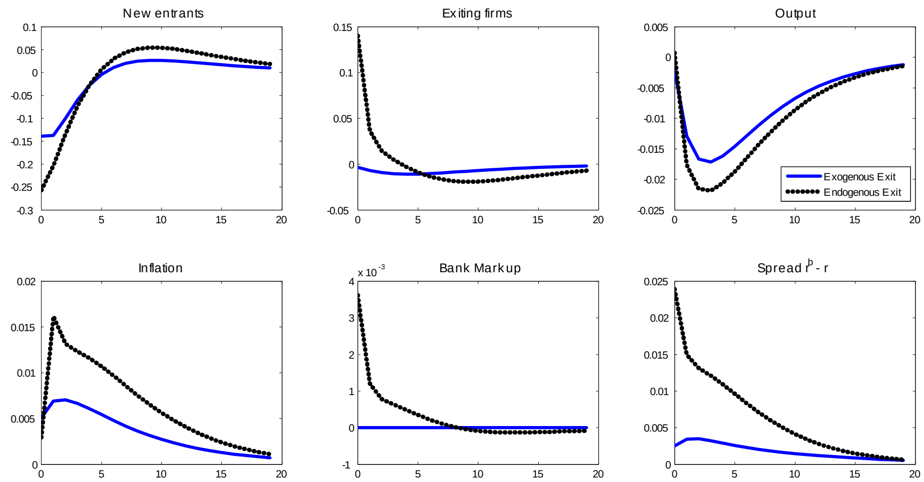

Figure 2: Irfs to a negative bank capital shock.

3.3 Impulse Response Functions: Efficient versus Inefficient Banks

To better understand the interaction between the endogenous exit mechanism and the banking sector, I now compare the performance of the baseline model with a version of the model characterized by an efficient banking sector. I label the first model as *Endogenous Exit MB,* while I label the second model as *Endogenous Exit EB*. In the second model banks compete under perfect competition. Further, I assume that banks can completely ensure against the risk of not having the loans repaid. These two assumptions imply that the bank markup is zero and that both the loan rate and the deposit rate collapse to the policy rate. Further, since banks profits are zero the bank balance sheet constraint becomes $D_t = B_t$, i.e. the banks net worth is zero. Figure 3 shows the IRFs in response to a positive technology shock. In the model with inefficient banking sector, the banks' markup is countercyclical. This leads to a stronger amplification mechanism of the shock than in the model with efficient banks. The reason is the following. In the model with inefficient banks firms anticipate the positive effect of their expected death probability on the loan rate, and discount less their future profits. This in turn implies that firms set lower prices and produce more output. The stronger reduction in inflation is then followed by a stronger decrease in

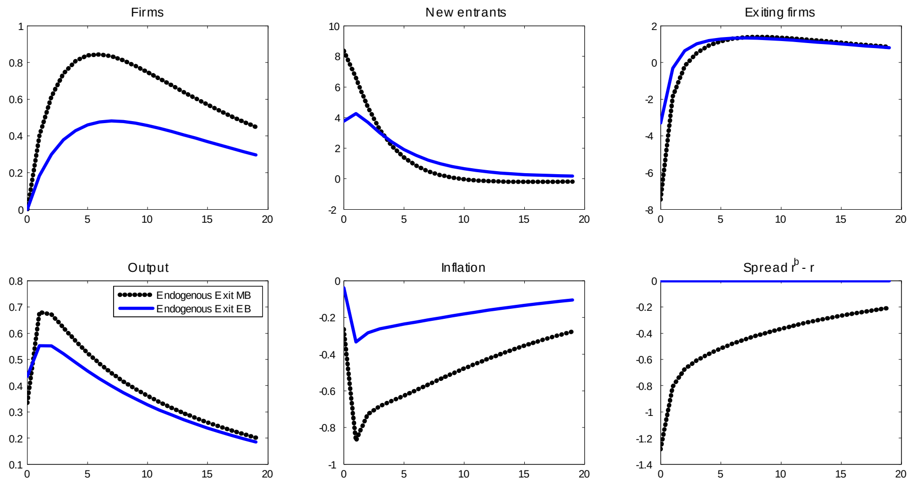

Figure 1: Figure 3: IRFs to a positive technology shock.

the policy rate and by an even stronger fall in the loan rate, so that the loan spread decreases. This leads to a reduction in firms profits, higher entry and lower exit and thus to a further increase in output with respect to the model with efficient banks.

4 Conclusion

I developed a NK-DSGE model with inefficient banks, together with endogenous firms' exit and entry decision. I analyzed the relationship between firms dynamics and banking in response to both real and financial shocks. I found the following main results. First, in response to both real and financial shocks, economies characterized by endogenous firms exit present higher volatility of both real and financial variables than those implied by a standard BGM model with inefficient banks. Second, the endogenous exit margin implies countercyclical exit of the number of firms along with countercyclical banks' markups and loan spread, thus being in line with the empirical evidence. Further, I showed that economies characterized by endogenous exit affect the decision of firms to enter the market, amplifying the response of new entrants. Also, the model generates a correlation between output and firms' entry closer to the data compared to a model with exogenous exit. Finally, the comparison to a model with efficient banks showed that inefficient banks, thanks to the implied countercyclicality of their markup, contribute to amplify the initial impact of the shock.

My model is only a first attempt to understand the interactions between firms dynamics, and in particular the dynamics of the exit margin, and banking. I strongly believe that further investigation, both from a theoretical and empirical point of view, is needed on this issue. In this respect, my model can be extended along several dimensions. First, I could try to introduce a different borrowing mechanism. Considering non-conventional monetary policy is also a possible extension. The estimation of the model through Bayesian techniques as well as a VAR analysis is also a future step of my research. Finally, investigating the role of firms endogenous exit in affecting welfare and optimal monetary policy is also part of my research agenda.

5 References

Aliaga-Díaz, Roger & Olivero, María Pía, (2012). Do Bank Capital Requirements Amplify Business Cycles? Bridging The Gap Between Theory And Empirics, *Macroeconomic Dynamics*, vol. 16(03), 358-395.

Angelini, Paolo, Cetorelli, Nicola, (2003). The Effects of Regulatory Reform on Competition in the Banking Industry, *Journal of Money, Credit and Banking*, Blackwell Publishing, vol. 35(5), 663-84.

Asea, Patrick K. and Brock Blomberg. (1998). Lending Cycles. *Journal of Econometrics* 83 (1–2):89–128.

Bergin, Paul, Corsetti, Giancarlo, (2008). The external margin and monetary policy. *Journal of Monetary Economics* 55(7), 1222–1237.

Bergin Paul, Ling Feng, Ching-Yi Lin, (2014). Financial Frictions and Firm Dynamics, NBER Working Paper No. 20099.

Bilbiie Florin O. Fabio Ghironi and Marc J. Melitz, (2012). Endogenous Entry, Product Variety, and Business Cycles, *Journal of Political Economy*, University of Chicago Press, vol. 120(2), 304 - 345.

Campbell, J. R., (1998). Entry, Exit, Embodied Technology, and Business Cycle. *Review of Economic Dynamics*; 1 (2); 371-408.

Cavallari, Lilia, (2013). Firms' entry, monetary policy and the international business cycle, *Journal of International Economics*, Elsevier, vol. 91(2), 263-274.

Casares, Miguel, Poutineau, Jean-Christophe (2014). A DSGE model with endogenous entry and exit, mimeo

Colciago, Andrea, Rossi, Lorenza, (2015). Firms Entry, Oligopolistic Competition and Labor Market Dynamics, De Nederlandsche Bank Working Paper No. 465.

Curdia, Vasco, Woodford, Michael, (2009). Credit Frictions and Optimal Monetary Policy, BIS Working Papers n. 278.

Dixit, A. K. and J. E. Stiglitz (1977). Monopolistic competition and optimum product diversity. *American Economic Review*, 67 (3), 297–308.

Dueker Michael J., Daniel L. Thornton, (1997), Do Bank Loan Rates Exhibit a Countercyclical Mark-up?, Working Paper 1997-004A, Federal Reserve Bank of ST. Louis.

Etro Federico, Colciago Andrea, (2010). Endogenous Market Structures and the Business Cycle, *The Economic Journa*l, Royal Economic Society, vol. 120(549), 1201-1233.

Gerali A., S. Neri, L. Sessa and F. M. Signoretti, (2010) Credit and banking in a DSGE model of the euro area, *Journal of Money, Credit and Banking*, 42(1), 107-141.

Ghironi, Fabio, Melitz, Mark. J., (2005). International Trade and Macroeconomic Dynamics with Heterogeneous Firms. *Quarterly Journal of Economics*; 120(3), 865-915.

Hamano, Masashige, Zanetti, Francesco (2014). Endogenous Establishment Destruction and Macroeconomic Dynamics, mimeo University of Oxford.

Hannan T.H. and Berger, A.N, (1991). The Rigidity of Prices: Evidence from the Banking Industry, *American Economic Review*, vol. 81(4), 938-45.

Jaimovich, N., Floetotto, M., (2008). Firm Dynamics, Mark-up Variations and the Business Cycle. *Journal of Monetary Economics*; 55 (7); 1238-1252.

Kwan, H. Simon, (2010). Financial Crisis and Bank Lending, Working Paper Series 2010-11, Federal Reserve Bank of San Francisco.

La Croce Carla, Lorenza Rossi, (2014), "Endogenous Entry, Banking, and Business Cycle," DEM Working Papers Series 72, University of Pavia, Department of Economics and Management.

Lewis, Vivien and Poilly, Céline, (2012). Firm entry, markups and the monetary transmission mechanism, *Journal of Monetary Economics*, Elsevier, vol. 59(7),670-685.

Lown, Cara S. and Donald P. Morgan. 2006. The Credit Cycle and the Business Cycle: New Findings Using the Loan Officer Opinion Survey. *Journal of Money, Credit and Banking* 38 (6):1575–1597.

Melitz, M.J., (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica*; 71(6), 1695-1725.

Nikitin Maxim, Smith R. Todd, (2009). Bank Spreads and Business Cycles, Manuscript, University of Alberta.

Olivero, María Pía, 2010. Market power in banking, countercyclical margins and the international transmission of business cycles, *Journal of International Economics*, Elsevier, vol. 80(2), 292-301.

Rotemberg, Julio, (1982). Monopolistic Price Adjustment and Aggregate Output, *Review of Economic Studies*, 49, 4, 517-31.

Rousseas, S. (1985) A markup theory of bank loan rate. *Journal of Post Keynesian Economics*, 8(1), 135-144.

Smets, Frank, and Rafael Wouters. (2007). Shocks and Frictions in US Business Cycles: A Bayesian DSGE Approach. *American Economic Review*, 97(3): 586-606.

Totzek, Alexander (2009). Firms' Heterogeneity, Endogenous Entry, and Exit Decisions. Economics Working Paper 2009-11. Department of Economics, Christian-Albrechts Universitaet, Kiel.

Vilmi Lauri, (2011), The Effects of Endogenous Firm Exit on Business Cycle Dynamics and Optimal Fiscal Policy, Sveriges Riksbank, Working Paper Series 250.