Financial Shocks in a Model of Deep Habits in Banking

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November 10, 2023

Abstract

This paper presents a model in which firms have endogenously-persistent lending relationships with banks. Firms need to borrow to pay for their working capital requirements. A financial shock in this model leads to a reduction in lending and results in a fall in macroeconomic aggregates. This paper highlights importance of firm-bank credit relationships and offers a framework to study role of financial frictions rooted in lending relationships between firms and banks.

Keywords: Financial Shocks, Deep Habits in Banking, Macroeconomic Fluctuations

JEL Classification: E32, E44

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1 Introduction

Lending relationships between firms and banks are an empirical fact. Ongena and Smith (2000) and Kosekova, Maddaloni, Papoutsi, and Schivardi (2023) for instance, have documented that across a variety of developed economies, firms have relationships with multiple banks. Arguably, many of these relationships are for credit which has been documented by multiple papers. It's noteworthy that in developing economies where financial systems are less developed and capital markets are harder to access, firms are often more reliant on bank lendings and thus these markets might feature greater degree and intensity of lending relationships. It is, however, a field that has not yet received enough research attention. Papers that study financial shcoks in a model of lending relationships are scarce. Workhorse models of financial frictions such as Bernanke, Gertler, and Gilchrist (1999) and Gertler and Karadi (2011) completely ignore lending relationships and their endogenous persistence. A recent contribution by Cao, Giordani, Minetti, and Murro (2023) discusses the role of lending relationships and credit markets for firm entry. This paper, on the other hand, focuses on building a model where firms need external financing to pay for their working capital requirements. Their working capital requirements arise from their need to pay wages for labor and rental for capital. These firms borrow from a continuum of similar banks, an assumption supported by data (see, for example, Ongena and Smith, 2000 and Kosekova, Maddaloni, Papoutsi, and Schivardi, 2023, among others). Firms' borrowing from their banks depends on their borrowing from those banks in the previous periods. In this sense, their credit relationships[1] with banks is endogenously-persistent. A credit shock in this model takes the form of a reduction in elasticity of loans they can borrow from banks[2]. Results in this paper show that such a credit shock leads to marked decline in bank lending and has negative ripple effects on the wider economic activity. The model presented in this paper offers a parsimonious and transparent way to model lending relationships and disruption in bank-firm credit relationships.

[1] In rest of the paper, I will be using the terms lending relationships and credit relationships synonymously.

[2] On this point, see, for example, FT article 'US credit squeeze triggers rise in corporate bankruptcies' https://www.ft.com/content/7f45d897-5312-40bd-abff-039ef31c9e50 for an account of how financial shocks are causing bankruptcies.

1.1 Relationship with Literature

Using deep habits framework first developed by Ravn, Schmitt-Grohé, and Uribe (2006), Aliaga-Díaz and Olivero (2010) develop a model of deep habits in banking. They show that deep habits generate countercyclical credit spreads as in data and it amplifies macroeconomic fluctuations. Their work, however, ignores financial constraints on firms and does not study the impact of financial shocks. Even though there is a voluminous literature on effects of financial frictions, the focus of this paper – financial shocks when lending relationships matter – has generally been overlooked. The contribution of this work is to provide a framework that can offer a way to think about credit relationships and effects of disruption to these firm-bank lending relationships. Recently Shapiro and Olivero (2020) offered a similar way of modelling lending relationships and financial shocks but their focus in their paper is on studying negative relationship between credit spreads and labor force participation. My focus in this paper is on bank-firm lending relationships and macroeconomic implications of a financial shock in such a model and I abstract from endogenous labor force participation. Understanding the dynamics of firm-bank lending relationships and its implications for larger macroeconomy is important for several reasons. First, it allows a fuller understanding of how developments in banking sector affect firms and then ripple out to other sectors. This understanding is important for devising measures to respond to events that might have a bearing on firm-bank lending relationships. Second, this work provides an alternative way of studying effects of financial shocks to the economy. There exist other approaches as mentioned before and the current paper can be seen complementing them in the sense that it focuses on lending relationships between firms and banks and offers a different way of modelling and examining financial shocks and their impact. Other recent contributions which have used deep habits to model lending relationships include Sharma (2023a,c,b,e,d).

The rest of this paper is structured as follows. Section 2 outlines the model and Section 3 discusses the solution and calibration. I discuss the results in Section 4 and Section 5 concludes.

2 Model

This section presents the model in this paper. It contains households who supply labor to firms, make deposits with banks and consume non-durable goods. Households own all the firms in the economy and all the profits are rebated to them. Since lending relationship between firms and

banks is the novelty of this paper, I first begin by describing the problem of the banks.

2.1 Banking Sector

There is a continuum of banks of mass one in the economy. Banks are owned by households and all profits are rebated to them. Banks accept deposits from households and make loans to firms. Banks take interest rate on deposits as given and choose lending rates and lending amounts.

2.1.1 Loan and Deposit Demand

The amount of loans obtained from lenders by firm i is

$$x_{it} = \left[\int_0^1 \left(l_{ijt} - \omega s_{jt-1} \right)^{\frac{\xi_t - 1}{\xi_t}} \mathrm{d}j \right]^{\frac{\xi_t}{\xi_t - 1}} \tag{1}$$

where

$$s_{jt-1} = \rho^s s_{jt-2} + (1 - \rho^s)\, l_{jt-1} \tag{2}$$

and $l_{i,j,t}$ is firm i's demand for credit from lender j in period t and ξ_t is the elasticity of substitution between loan varieties. Stochastic movements in ξ_t affect credit spreads directly and may indicate exogenous financial disturbances. A reduction in substitutability relative to trend increses the countercyclicality of spreads (Airaudo and Olivero, 2019). The intution is that when there is an elevated perception of risk or an increase in asymmetric information relative to normal times, for exaple during downturns, loans may become less substitutable (Shapiro and Olivero, 2020). This is reflected in lower ξ_t. Another way of interpreting this is that fluctuations in ξ_t can signal changes in substitutability between riskier (for instance, subprime) and less risky loans (for example, regular). The case of $\omega > 0$ implies deep habits in credit markets – the firm's demand for credit depends on past borrowing. The term ωs_{jt-1} in x_{it} captures the borrower "hold-up" effect, with ω capturing the extent of the hold-up. The term s_{jt-1} is defined as $s_{jt-1} = \int_0^1 s_{i,j,t-1}\mathrm{d}i$ which corresponds to beginning of period-t cross-sectional (across firms) average stock of accumulated past loans from bank j. The stock of habit s_{jt-1} is characterized by the law of motion given above. Specifically, it is a linear function of its value in the previous period and the average level of borrowing from lender j in $t-1$, $l_{j,t-1} \equiv \int_0^1 l_{i,j,t-1}\mathrm{d}i$.

I first find firm i's optimal relative demand for loans from lender j. Formally, firm i minimizes its total borrowing costs $\int_0^1 R^l_{j,t} l_{i,t,t}\mathrm{d}j$ subject to law of motion of x_{it}, yielding firm i's optimal

demand for loans issued by lender j, l_{ijt}, as a function of the relative loan rate charged by the lender and the stock of borrowing habits related to the same loan variety. This optimal demand is given by

$$l_{i,j,t} = \left(\frac{R^l_{j,t}}{R^l_t} \right)^{-\xi_t} x_{it} + \omega s_{j,t-1} \tag{3}$$

where $R^l_t \equiv \left[\int_0^1 \left(R_{l,jt} \right)^{1-\xi_t} \mathrm{d}j \right]^{\frac{1}{1-\xi_t}}$ is the aggregate loan rate index. As this equation shows, l_{ijt} is higher the cheaper it is to borrow from lender j (i.e. the lower $\frac{R^l_{jt}}{R^l_t}$ is) and the stronger is the lender-borrower relationship (i.e. the larger ω and s_{jt-1} are).

2.1.2 Lenders

There is a continuum of lenders inxed by j on the unit interval. Each variety of loan is produced by a lender operating in a monopolistically-competitive loan market and in a perfectly-competitive deposits market. Each period, lender j chooses its demand for deposits $d_{j,t}$ and interest rate charged on loans $R^l_{j,t}$ to maximize $\mathbb{E}_0 \Xi_{t|0} \pi_{j,t}$ subject to the lender's cash flow

$$\pi_{j,t} = d_{j,t} - l_{j,t} + R^l_{j,t-1} l_{j,t-1} - R^d_{t-1} d_{j,t-1} - \kappa_t \tag{4}$$

the balance sheet condition $l_{j,t} = d_{j,t}$ and lender j's aggregate demand for loans from firms

$$l_{j,t} \equiv \int_0^1 l_{i,j,t} \mathrm{d}i = \int_0^1 \left[\left(\frac{R^l_{j,t}}{R^l_t} \right)^{-\xi_t} x_{i,t} + \omega s_{j,t-1} \right] \mathrm{d}i \tag{5}$$

where κ_t denotes the fixed cost of production and R^d is the common risk-free interest rate on deposits paid by all lenders. The first order conditions with respect to $d_{j,t}$ and $R^l_{j,t}$ are

$$\Omega_{j,t} = \mathbb{E}_t \Xi_{t+1|t} \left[\left(R^l_{j,t} - R^d_t \right) + \omega \Omega_{j,t+1} \left(1 - \rho^s \right) \right] \tag{6}$$

and

$$\mathbb{E}_t \Xi_{t+1|t} l_{j,t} = -\Omega_{j,t} \frac{\partial l_{j,t}}{\partial R^l_{j,t}} \tag{7}$$

2.2 Firms

There is a continuum of measure one of firms indexed by $i \in (0, 1)$. In each period t firm i sells output Y_{it} in a competitive goods market which it produces using labor h_{it} and capital k_{it}. The

firm uses a constant returns-to-scale production function $A_t f(h_{it}, k_{it})$ where A_t is the exogenous aggregate productivity. The firm's total operating costs are $X_{it} \equiv [w_t h_{it} + r_t k_{it}]$. A fraction $0 \leq \phi \leq 1$ of these costs must be paid in advance so the firms face a working capital constraint.

To finance working capital spending, firm i uses a composite x_{it} of imperfectly substitutable heterogeneous loans provided by a mass one of banks. In each period t, firm i chooses its demand for labor and capital to maximize the expected present discounted value of its lifetime profits. Its optimization problem is given by

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \Xi_{t|0} \pi_{i,t}$$

subject to

$$\pi_{it} = A_t f(h_{it,k_{it}}) + x_{i,t} - (1-\phi) X_{i,t} - \int_0^1 R^l_{j,t-1} l_{i,j,t-1} \mathrm{d}j$$

and the amount of working capital

$$X_{i,t} \equiv w_t h_{it} + r_t k_{it}$$

where $x_{i,t} = \phi X_{i,t}$, $\int_0^1 R^l_{j,t} l_{i,j,t} \mathrm{d}j = R^l_t x_{i,t} + \Gamma_t$, $\Gamma_t \equiv \omega \int_0^1 R^l_{j,t-1} l_{j,t-1} \mathrm{d}j$. Demand for capital by firm i equals $A_t f_{k_i}(h_{it}, k_{it}) = r_t \left[(1-\phi) + \phi \mathbb{E}_t \Xi_{t+1|t} R^l_t\right]$ which states that marginal benefit of a unit of capital equals the marginal cost where the latter considers the firm's working capital constraint. In equilibrium, the total output is $y_t = A_t f(h_t, k_t)$.

2.3 Households

There is a representative household of measure one. It takes consumption c_t, saving and labor supply decisions in this economy. It also rents physical capital to firms. The household is the ultimate owner of both firms and financial firms. Formally, the household attempts to maximize its utility

$$\max_{c_t, h_t, d_t} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, h_t) \tag{8}$$

where

$$u(c_t, h_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \frac{H_t^{1+\psi}}{1+\psi} \tag{9}$$

subject to the budget constraint

$$c_t + d_t + i_t + T_t = w_t h_t + r_t k_t + R_{d,t-1} d_{t-1} + \Pi_t \tag{10}$$

The household chooses consumption c_t, capital accumulation k_{t+1}, bank deposits d_t and employment h_t. The law of motion for capital is

$$k_t = (1 - \delta) k_{t-1} + i_t \tag{11}$$

The household's first order conditions for deposits, capital and labor are

$$u'(c_t) = \beta \mathbb{E}_t u'(c_{t+1}) R_{d,t} \tag{12}$$

$$u'(c_t) = \beta \mathbb{E}_t u'(c_{t+1}) \left[r_{t+1} + (1 - \delta) \right] \tag{13}$$

3 Quantitative Analysis

In this section, I discuss the solution of the model and the results from the analysis. Table 1 provides a summary of the paramters used in the calibration of the model. Most of the parameter values are standard and borrowed from the literarure. For the discount factor of households, I pick a value of 0.99 which is standard in the literarure and has been used, among others, Iacoviello (2005). For the share of capital in production, I choose a value of 0.34 which is common in the literature and for depreciation, I pick a value of 0.025.

Table 1: Parameter values

	Value	Description	Source/Target
β^P	0.99	Discount factor of households	Standard
α	0.34	Capital share	Shapiro and Olivero (2020)
δ	0.025	Capital depreciation rate	Shapiro and Olivero (2020)
γ^L	0.72	Deep habit formation	Aliaga-Díaz and Olivero (2010)
ρ_s	0.93	Persistence of stock of deep habits	Aliaga-Díaz and Olivero (2010)
ξ	230	Elasticity of substitution between banks	Aliaga-Díaz and Olivero (2010)
ρ_ξ	0.90	Persistence of financial shocks	Shapiro and Olivero (2020)
σ_ξ	0.1335	Volatility of financial shocks	Shapiro and Olivero (2020)
ρ_A	0.95	Persistence of technology shock	Smets and Wouters (2007)
σ_A	0.0014	Standard deviation of technology shock	Standard

For calibration of parameters governing deep habits in banking, I rely on Aliaga-Díaz and Olivero (2010), Airaudo and Olivero (2019) and Shapiro and Olivero (2020). For the deep habits in banking paramter, I choose a value of 0.72 as estimated by Aliaga-Díaz and Olivero (2010). I use this value as a benchmark and later vary it to transparently capture of effects of a finanical shock in the form of a negative shock to the deep habits in banking paramter. For the persistence of stock of deep habits, I pick a value of 0.93, again as estimated by Aliaga-Díaz and Olivero (2010).For the value of substitution between loan varieties, I select a value of 230, again as used in Aliaga-Díaz and Olivero (2010). When I study effects of a financial shock, I turn off deep habits in banking paramter and consider a negative shock to loan varieties. This represents a reduction in loan varieties available to a firm and a fall in funding opportunities, relative to the trend. For example, it could signal a tightening in credit conditions in the market or it could indicate a situation in which banks become more selective about various borrowers (prime versus non-prime, for instance) and as a result, offer lesser loan varieties. For the parameters governing the persistence and volatility of financial shocks, I rely on the value used in Shapiro and Olivero (2020).

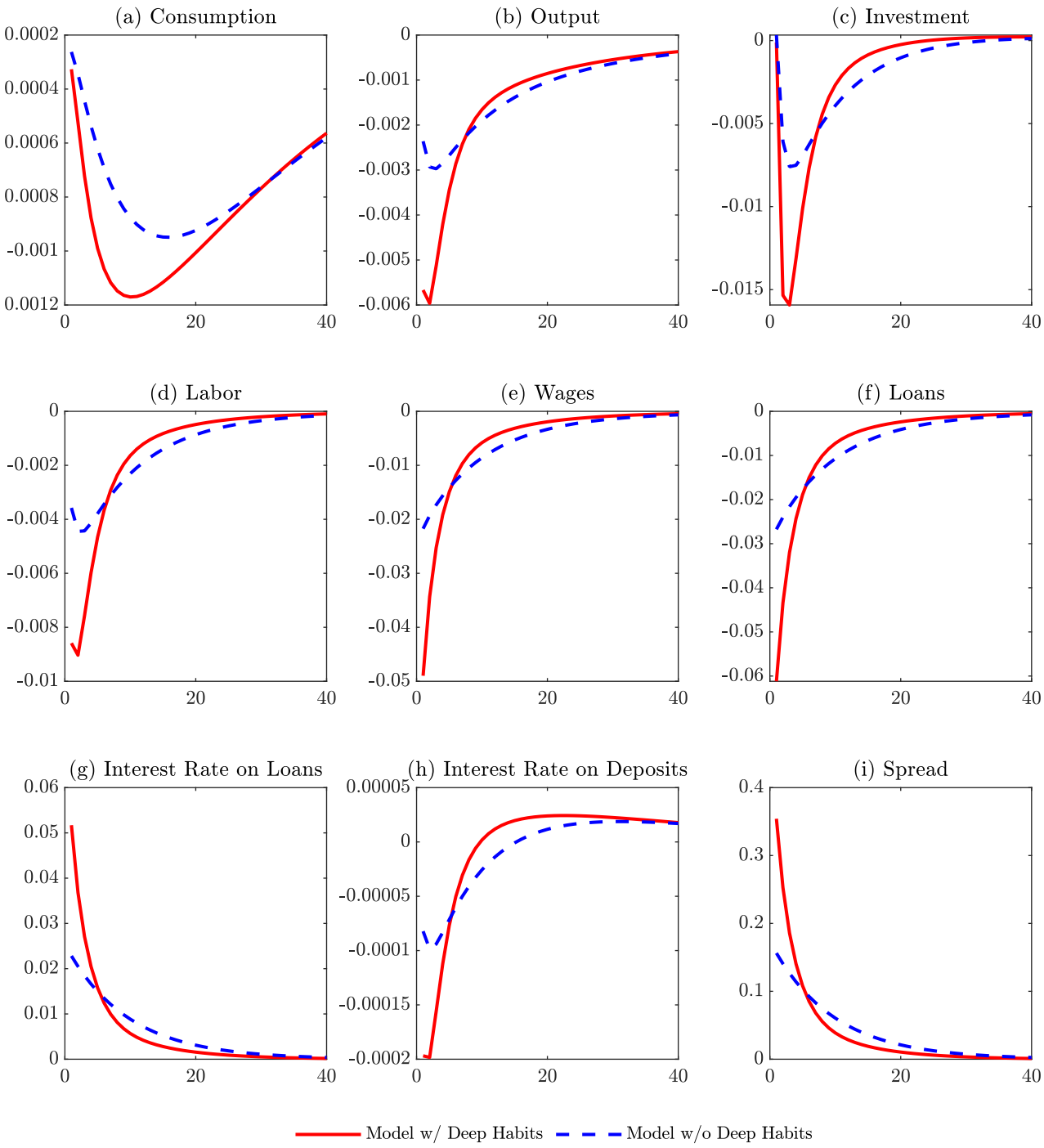
4 Results

Figure 1 shows the results of a shock to loan varieties. After a shock, spread rises which raises the cost of taking out loans. Since firms in this economy need to borrow to pay for their working capital, investment falls which then reduces labor, wages, consumption and output. These effects are much more pronounced in case of lending relationships versus the case when they are absent.

The mechanism lying behind these results is as follows. In the aftermath of a negative shock to loan varieties, banks raise their interest rates in order to over them from any potential loans losses. This effect is much greater when banks have market power in their loan varities which coincides with the case of lending relationships. Banks then use lending relationships to extract rent from their borrowers which leads to a higher spike in spread. This leads to a drop in bank credit since bank loans become expensive. Because in this model, firms depend on bank credit to finance their working capital requirements, they cut down on investment and production which then results in a reduction in labor, wages and consumption.

These results indicate the potential of bank-firm credit relationships to act as 'financial accelerator' Bernanke, Gertler, and Gilchrist (1999). A financial shock in this model, even in

FIGURE 1: IMPACT OF A CREDIT SHOCK



NOTE: Numbers on the horizontal axis are quarters since the shock. Numbers on the vertical axis show percentage deviation from steady state.

the absence of bank-firm lending relation (that is, when $\gamma^L = \rho^s = 0$), leads to a reduction in economic activity and a fall in macroeconomic aggregates. These effects, however, become amplified when presence of bank-firm lending relationships are taken into account. This underscores the fact that a model that ignores these credit relationships misses inetersting macroeconomic dynamics and underestimates the impact and amplification of financial shocks. This has real

consequences. In a model that does consider presence of bank-firm lending relationships, the drop in output, investment and bank credit can be twice as large as a model without bank-firm credit relationships would predict.

5 Conclusion

This paper presented a framework to examine effects of financial shocks in a model of lending relationships. Using deep habits framework, I built a model that features lending relationships between banks and firms. A financial shock, in the form of a shock to substitution between vareities of loans, leads to significant economic downturn and a reduction in economic aggregates. To sum up, this paper offers a model to study and explore implications of a credit shock in a model in which lending relationships between banks and firms matter.

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