MONETARY POLICY AND CREDIT MARKET IMPERFECTION

Luong Tuan Anh
Princeton University, USA

1. INTRODUCTION

Credit market imperfection has been an issue in almost every country. It might arise from asymmetric information: banks perceive incorrectly the risk exposure of firms, hence can not fully provide credit to them. The severeness might however vary across countries. Its damages are various: preventing human capital investment (Lambertini 2001; Tesfatsion and Orazem 1997; Shea 1997), increasing inequality through distribution effect (Reto and Oechslin 2003; Iradian 2005), leading to high unemployment (Acemoglu 2000; Wasmer and Weil 2000) or preventing firms from switching to more productive and capital-intensive technology (Horii, Ohdoi and Yanamoto 2005).

Surprisingly, the literature of credit market imperfection does not examine quantitatively the effect of this imperfection on the number of firms in the economy. Asymmetric information might lead to quantitative constraint in credit market (Stiglitz and Weiss 1981; Jaffe and Russel 1976). This credit constraint will reduce the number of firms, therefore affects output. Our paper aims to close this gap via the price of asset. It extends the Corsetti and Pesenti (2005) framework. In particular, there will be a representative consumer, a continuum of firms, a bank and a policy maker. The firms will need to acquire one unit of land (assets) as fixed investment before being able to produce. This requirement implies that these firms will need to borrow from the bank. It is showed that when credit market is not needed (i.e. no loan request) or when it is perfect (i.e. loan requests are satisfied entirely) monetary policy should respond fully to productivity growth. However, when credit market is needed but imperfect monetary policy responds to this growth only to the extent of this imperfection. It is also showed that this imperfection is unsustainable, leaving the need for government interventions to fix it.

The rest of the paper as follows. The second section will present the model, how the representative consumer, the bank and the firms react to productivity shocks. It then shows us how the government should intervene, and examines whether the imperfection needs to be fixed. The last section concludes.

2.THE MODEL

In our model, land appears as assets. At the first place (period 0), each consumer possesses one unit of land. He (she) can use his land by 2 ways: either to hold it which brings him some utility (for instance, think about land providing him shelters or playing grounds), or sell to the firms. Land is assumed to be divisible, so a portion of it can be sold. There is a continuum of firms, normalized by 1. The competition is imperfect. Each firm provides one variety a la Dixit-Stiglitz. Each firm needs to buy one unit of land as a fixed cost. As opposed to hiring labor, the firms need to borrow from the bank to buy this unit of land (i.e. each firm, in order to produce, buys one of land at the beginning of the period, hires some labor, produces and then pays the wage bill at the end of the period). Although loans yield the same interest as bonds, it is assumed that they are not substitutes: the firms can only borrow from the bank, not from the **consumer**.

The credit imperfection arises from information asymmetry. The bank perceives imperfectly the risk of the firms that need credit. This is usually the case in developing countries, where the financial market is not well developed, where banks don't have enough information to evaluate the projects presented by the firms. As a consequence, some firms (perceived as low risk) can get the loans they need, while others (perceived as high risk ones) can not.

In our set up, the monetary stance (the government's control) will be the consumption expenditure. Money has two components: the monetary stance and the credit granted to the firms. The former does not pay any interest while the latter does. The policy maker can only control the first component, but not the second due to credit market imperfection.

3. THE CONSUMER

Because of the frictions created in our set up (fixed cost, credit imperfection) the number of firms that produce will not be always be one. We call that N_t ($0 \le N_t \le 1$). The problem of choosing the optimal basket of goods is then:

$\max_{\{C_t(j)\}} \left(\int_0^{N_t} C_t^{1-\frac{1}{q}}(j)dj \right)^{\frac{q}{q-1}}$ subject to the spending constraint: $\int_0^{N_t} p_t(j)C_t(j)dj = E$ where E is the spending on consumption goods.

Solving this problem gives us the following solution:

$$C_t(j) = \left(\frac{p_t(j)}{P_t} \right)^{-q} C_t \qquad (1)$$

where

$$C_t = \left(\frac{1}{N_t} \int_0^{N_t} C_t^{1-\frac{1}{q}}(j)dj \right)^{\frac{q}{q-1}} \quad \text{the consumption index} \qquad (2)$$

and $$P_t = \left(\frac{1}{N_t} \int_0^{N_t} p_t^{1-q}(j)dj \right)^{\frac{1}{1-q}} \quad \text{the price index.} \qquad (3)$$

We will see that in equilibrium all firms behave the same way (i.e. setting the same price and producing the same level of output). In this case the consumption expenditure is $E = \int_0^{N_t} p_t(j)C_t(j)dj = N_t P_t C_t$

The utility of a representative consumer is assumed to have the following form: $u(C_t, l_t, x_t) = \ln C_t - hl_t + c\,x_t$ where l_t is his labor and x_t is the fraction he decides to keep. The budget constraint is:

$$N_t P_t C_t + B_t + (1-x_{t-1})Q_t = (1+i_{t-1})B_{t-1} + w_t l_t + (1-x_t)Q_t + N_t \Pi_t \qquad (4)$$

The spending for consumption $N_t P_t C_t$ and bonds B_t plus the price $(1-x_{t-1})Q_t$ to buy back the fraction of land he sold a period earlier must be equal to the interest on bonds $(1+i_{t-1})B_{t-1}$, the labor income $w_t l_t$, the land income $(1-x_t)Q_t$ and the profit of the firms redistributed to the representative agent $N_t \Pi_t$. To make the problem symmetric, the firms will sell the unit of land they acquired a period earlier to the consumers after their project finish at the end of the current period. This won't make the problem less general as all transactions are done at the market price, yet we don't need to keep track on the land holding of the representative consumer as he always has one unit of land at the beginning of each period.

The representative consumer has to maximize his expected utility

$$\max_{\{C_i,l_i,x_i\}_{i=t}^{\infty}} E_t \sum_{i=t}^{\infty} b^{i-t} u(C_i, l_i, x_i) \text{ subject to the budget constraint} \qquad (4)$$

The first-order conditions are given by:

$$\frac{1}{C_t} = l_t N_t P_t \qquad (5)$$

$$h = l_t w_t \qquad (6)$$

$$c = l_t Q_t - b\, E_t\, l_{t+1} Q_{t+1} \qquad (7)$$

$$l_t = b\,(1 + i_{t+1})\, E_t\, l_{t+1} \qquad (8)$$

With l_t the Lagrangian multiplier. The condition (8) assures that the representative consumer will be indifferent about selling or holding bonds.

4. THE BANK

Economic growth (due to a positive productivity shock) will require money expansion. This will drive up the price of land, and put pressure on the credit market. The bank however has a limited ability to provide credits to the firms. The bank will only grant the loan needed Q_t to N_t firms. The budget constraint of the bank is therefore:

$$m_t - m_{t-1} + B_t + (1 + i_{t-1}) N_{t-1} Q_{t-1} = (1 + i_{t-1}) B_{t-1} + N_t Q_t \qquad (9)$$

Where m_t is the monetary stance. As this is controlled by the policy maker, and the credit needed $N_t Q_t$ derived from the next section, all the bank does is to buy (or sell) bonds B_t to (or from) consumers to balance (9). Since consumers are indifferent about holding or selling bonds, this is always feasible.

5. THE FIRM

The production function is assumed to have the form $Y_t = A_t L_t$ where A_t is the productivity and L_t is labor. Credit market imperfection implies that some firms can not get the loan they need. The bigger the loan, the less chance they get the loan. To formalize this, we assume that the probability of getting an amount g of loan is given by:

$$f(g) = \frac{1}{(k-1)g^{k}} \text{ for } g > 1 \text{ and } \mathbf{1<k<2} \qquad (10)$$

Consider a firm j at time t-1. Assuming nominal rigidities, price at time t is set at time t-1. Given the demand $C_t(j) = \left(\frac{p_t(j)}{P_t}\right)^{-q} C_t$ derived in the consumer section, firm j maximizes its profit:

$$\max_{p_t(j)} E_{t-1} q_{t-1,t} \left(p_t(j) - MC_t \right) \left(\frac{p_t(j)}{P_t} \right)^{-q} C_t$$

where $q_{t-1,t}$ is the stochastic discount factor and MC_t is the marginal cost.

The first-order condition is given:

$$(q-1) E_{t-1} q_{t-1,t} \left(\frac{p_t(j)}{P_t} \right)^{-q} C_t = q E_{t-1} q_{t-1,t} \frac{MC_t}{p_t(j)} \left(\frac{p_t(j)}{P_t} \right)^{-q} C_t \qquad (11)$$

Rearrange terms and note that in equilibrium $p_t(j) = P_t$ we get the price level:

$$p_t(j) = \frac{q}{q-1} \frac{E_{t-1} \frac{MC_t}{N_t}}{E_{t-1} \frac{1}{N_t}} \qquad (12)$$

The expected profit for firm j will be:

$$E_t q_{t,t+1} \Pi_{t+1} = E_t q_{t,t+1} \left(p_{t+1}(j) - MC_{t+1} \right) \left(\frac{p_{t+1}(j)}{P_{t+1}} \right)^{-q} C_{t+1}$$

$$= \quad b \frac{N_t P_t C_t}{P_{t+1}} \frac{1}{q-1} E_t \frac{MC_{t+1}}{N_{t+1}}$$

$$= \frac{b}{q} m_t E_t \frac{1}{N_{t+1}} \; (m_t = N_t P_t C_t \text{ and from (12)}) \qquad (13)$$

From (5), (7) and (8) we get $Q_t = \frac{c}{1-b} m_t$ (14)

We see that a loose monetary policy will drive up land price. The cash flow of the firm j is the following: at the beginning of each period, it gets the credit from the bank to buy the required unit of land, then it hires labor, produces and gets profit Π_t. At the end of that period (or equivalently at the beginning of the next period), it has to pay back the loan to the bank but it sells the land it acquired to the consumer. The no-arbitrage condition provides:

$$\Pi_t = E_t q_{t,t+1} \left((1+i_t) Q_t - Q_{t+1} \right) \qquad (15)$$

or

$$Q_t = \Pi_t + E_t q_{t,t+1} Q_{t+1} \qquad (16)$$

Combine (13), (14) and (16) provides the expected number of firms:

$$E_t \frac{1}{N_{t+1}} = cq \qquad (17)$$

We also have:

$$N_t = \Pr(g > Q_t)$$

$$= \int_{Q_t}^{\infty} \frac{1}{(k-1)g^k} dg$$

$$= \frac{1}{Q_t^{k-1}} \tag{18}$$

From (14) we have:

$$N_t = \frac{(1-b)^{k-1}}{c^{k-1} m_t^{k-1}} \tag{19}$$

The number of firms decreases with the monetary stance. Bordo and Jeanne (2002) get the same result: an expanding monetary policy will decrease the real value of the firms' collateral, therefore prevents them from borrowing.

Formula (19) holds when Q_t is bigger than 1, which is true if b is close to 1 and m_t not too small. The amount of credit granted is:

$$N_t Q_t = \frac{1}{Q_t^{k-2}} = \frac{(1-b)^{k-2}}{c^{k-2} m_t^{k-2}} \tag{20}$$

We see that credit increases at a quicker speed than monetary stance if k<1, at a slower rate than monetary stance if 1<k<2 and even decreases if k>2. Therefore it's reasonable to assume that 1<k<2, when credit increases slower than monetary stance. To close the model, we need to derive the demand for labor and consumption:

$$l_t = \frac{N_t C_t}{A_t} = \frac{m_t}{A_t} \frac{q-1}{q} \frac{E_{t-1} m_t^{k-1}}{E_{t-1} \frac{h m_t^k}{A_t}} \tag{21}$$

$$C_t = \frac{m_t}{P_t N_t} = \frac{(q-1)\, c}{h} \frac{m_t^k}{E_{t-1} \frac{m_t^k}{A_t}} \tag{22}$$

6. THE POLICY MAKER

The policy maker is assumed to concern only about output (GDP). His objective is then:

$$\max_{\{m_s\}_{s=t}^{\infty}} E_t \sum_{s=t}^{\infty} b^{s-t} E_t \ln C_s$$

Use the formula $\frac{df(E(g(X))}{dX} = f'(E(g(X))g'(X)$ we have the first-order conditions:

$$\frac{k}{m_t} = \frac{\frac{k m_t^{k-1}}{A_t}}{E_{t-1} \frac{m_t^k}{A_t}} \text{ or } E_{t-1} \frac{m_t^k}{A_t} = \frac{m_t^k}{A_t} \tag{23}$$

The optimal monetary policy is then $m_t = a_{t-1}A_t^{\frac{1}{k}}$: monetary policy responds to the productivity shock A_t to the extent of the credit market imperfection k (remember that k=1 means the market is perfect). The constant a_{t-1} is chosen as a nominal anchor. For instance, if $\bar{p}$ is the desired inflation rate, i.e. $\frac{P_t}{P_{t-1}} = 1+\bar{p}$ then $a_{t-1} = (1+\bar{p})^{t-1}$.

7. IS CREDIT MARKET IMPERFECTION SUSTAINABLE?

If the country accepts an inflation rate different from 0, the coefficient a will rise exponentially, and so does m_t. If the credit market is not too imperfect (k is close to 1) the number of firms will drop at a lower rate (see 19). To see it clearer, we can compute the time it takes before the economy collapses (assume that it occurs when the number of firms that can not get credit is 30%). If each period is 1 year, we have the following table:

	$\bar{p}$ =2%	$\bar{p}$ =5%	$\bar{p}$ =10%
k=1.05	360 years	146 years	75 years
k=1.1	180 years	73 years	37 years
k=1.5	36 years	15 years	7 years

We can see from the table that if the market is not imperfect (k=1.05) and the government can control the inflation rate at 2%, it will take 360 years before the economy collapses. However, if the market is less perfect (k=1.5) and the inflation is quite high at 10%, it only takes 7 years before the economy collapses.

8. CONCLUSION

This paper has shown that monetary policy should respond to the productivity shock to the extent of market imperfection. The imperfection needs to be fixed sooner or later depending on its severeness. Building a structural form of credit market imperfection (as in Gil 2003) will help derive the degree of credit market imperfection. This can be done in future research.

REFERENCES

[1]. Acemoglu, Daron, *Credit market imperfections and persistent unemployment*, NBER Working Papers, (2000).

[2]. Bordo, Michael and Jeanne, Olivier, *Boom-bursts in asset prices, economic instability and monetary policy,* Centre for Economic Policy Research, (2002).

[3]. Corsetti, Giancarlo and Pesenti, Paolo, *The simple geometry of transmission and stabilization in closed and open economies*, Federal Reserve Bank of New York Staff Report, No.209.(2005).

[4]. Dixit, Avinash and Stiglitz, Joseph E., *Monopolistic Competition and Optimum Product Diversity*, American Economic Review, (1977).

[5]. Foellmi, Reto and Oechslin, Manuel, *Who gains from non-collusive Corruption*, Institute for Empirical Research in Economics, (2003).

[6]. Gil, Pedro Mazeda, *A Model of Firm Behaviour with Equity Constraints and Bankruptcy Costs*, Working paper, (2003).

[7]. Horii, Ryo and Ohdoi, Ryoji and Yamamoto, Kazuhiro, *Finance, Technology and Inequality in Economics Development*, Economics Working Paper Archive WPA, (2005).

[8]. Iradian, Garbis, Inequality, *Poverty and Growth: Cross-country Evidence*, IMF working papers, (2005).

[9]. Jaffee, Dwight M. and Russell, Thomas, *Imperfect information, uncertainty and credit rationing*, Quarterly Journal of Economics, 90, 651-666, (1976).

[10]. Lambertini, Luisa, *Technological change and Public Financing of Education*, Boston College Working Papers in Economics, (2001).

[11]. Shea, John, *Does Parents' money matter?,*NBER Working Papers 6026, (1997).

[12]. Stiglitz, Joseph E. and Weiss A, *Credit rationing in markets with imperfect information*, American Economic Review, 71(3), 393-410, (1981).

[13]. Tesfatsion, Leigh and Orazem, Peter, *Macrodynamic implications of Income transfer Policies for Human Capital Investment and School Effort*, Journal of Economic Growth, (1997).

[14]. Wasmer, Etienne and Weil Philippe, *The macroeconomic of Labor and Credit market imperfections*, CEPR Discussion Papers 3334, (2000).