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Caterina Mendicino

Credit Market Development, Economic Performance and Business Cycle Volatility*

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Abstract

This paper studies the role of credit market development in an economy with credit frictions. I examine how the provision of credit in connection with collateral assets affects both economic performance and business cycle volatility.

First, I analyse the macroeconomic implications of an improvement in the financial market that allows for a higher degree of access to the credit market. Then, I study how different levels of credit market development affect the vulnerability of the economy to major adverse shocks.This paper sheds light on the trade off between efficiency and stability over the business cycle.

In the framework of an economy in which credit constraints arise because borrowers cannot force lenders to repay, I show that, as expected, facilitating collateralized debt financing implies an increase in efficiency in terms of production. Moreover, I also show how the rise in collateral/asset prices is a direct consequence of credit market development. Last, but most intriguing I demonstrate that the higher output volatility over the business cycle is associated with an higher degree of access to the credit market .

JEL Classification:E21,E30,E32,E44,E51,G12,G21,G33

Key Words: Credit Market Development, Credit Frictions, Heterogeneous Agents, Business Cycle.

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1 Introduction

During the past two decades financial systems have experienced deep structural changes as a result of regulatory reforms and technological innovations. Financial market reforms have taken place both in developing and developed countries. Particularly among OECD countries, United States, United Kingdom and the Nordic Countries implemented government reforms directed to credit market deregulation.

The main goal was to improve efficiency within the financial system, but the macroeconomic implications could go beyond the main motivation. The deregulation process discouraged household savings and contributed to a considerable increase in bank loans extended to the private sector[1]. The ratio of private outstanding credit over total disposable income therefore reached very high levels in the last years[2]. See figure in appendix. The high level of credit to the private sector and particularly household indebtedness, both in absolute terms and relative to their income, has attracted the attention of policy makers and raised concerns about the macroeconomic implications.

This paper investigates the role played by the provision of credit in connection with collateral assets and the macroeconomic implications of credit market development. Moreover, it analyses how credit market deepening affects the response of aggregate variables to negative shocks over the business cycle.

Regardless of whether private sector debt is sustainable, the large stock of borrowing could increase the sensitivity of the private sector to fluctuations in income, capital prices (housing, buildings, machinery) and the interest rate. A greater level of indebtedness may reduce the ability to smooth temporary negative shocks due to the burden of debt. In fact, during periods of stable economic conditions an easier access to loans -for instance due to relaxed ceiling on loan to value ratio.- could improve economic performance but, on the other hand, an excessive debt accumulation in preceding periods might become burdening for the borrowers if market conditions reverse.

This paper is related to the large literature about financial frictions and business cycle. Most of the theoretical research focuses on credit frictions as a

[1]See among others Gelosos and Werner (1999) for the case of Mexico, Leslie Hull (2003) for New Zealand, Boone, Laurence, Nathalie Girouard and Isabelle Wanner (2001)and Claus, Iris and Grant Scobie (2001) for an international comparison.

[2]Guy Debelle, Household Debt and the Macroeconomy, BIS Quartely Review, March 2004.

transmission mechanism that propagates and amplifies shocks. Bernanke and Gertler (1989), Calstrom and Fuerst (1997), Bernanke, Gertler and Gilchrist (1999) among others, study the relevance of financial factors on firm's investment decisions, emphasizing the role of agency-costs and limited enforceability. Kiyotaki and Moore (1997) and Kiyotaki (1998) show that if debt needs to be fully secured by collateral, small shocks can have large and persistent effects on economic activity.

Kiyotaki and Moore's work has been very influential and a big strand of literature has used collateral constraints as an amplification mechanism of shocks. However, in models with collateral constraints little attention has been devoted to the impact of credit market development on economic activity and the business cycle.

An exception is Aghion, Baccheta and Banerjee (2003) who study credit development as a source of instability in a small open economy. They show that small open economies at an intermediate level of financial development are more vulnerable to shocks. They also analyze the effects of capital account openness in economies with different degrees of credit market development.

Unlike Aghion,Baccheta and Banerjee (2003) I focus on a closed economy model in which both lenders and borrowers sectors are modelled. I use a collateral constraint based on real assets and thus I give a primary role to the asset prices. Moreover, I focus on different types of shocks. In fact, I investigate not only the effects of an aggregate technology shock but also the consequences of a shock to the loans' supply. Most importanty I focus my attention on the impact of permanent shocks to the loan to value ratio.

I use a model built on Kiyotaki and Moore (1997). In order to generate a motive for the existence of credit flows, two types of agents are assumed. Both of them produce and consume the same good using a physical asset. They differ in terms of discount factors. As a consequence impatient agents are borrowers. Credit constraints arise because lenders cannot force borrowers to repay. Thus, physical assets such as land, buildings and machinery, are used not only as factors of production but also as collateral for loans.

The setup differs from Kiyotaki and Moore (1997) in that I use more standard assumptions about preferences and technologies. First, in their paper the two groups of agents are risk neutral. Moreover, they represent two different sectors of the economy - borrowers are "farmers" and lenders are "gatherers"- and thus, apart from using different discount factors, they also differ in their production technology. In the present setup both groups of agents have a concave utility function and are identical, only difference is the subjective discount factor. The setup turns out to be similar to the one used by Cordoba and Ripoll(2004). However, I also introduce aggregate uncertainty in the model. Thus, differently from all the other specifications of the model previously adopted in the literature, asset prices are not perfectly foresighted by agents. Last, but most important I also allow for the existence of liquidation costs in modelling the collateral constraint. Consequently, I can investigate the macroeconomic consequences of structural changes implying an eased access to credit financing.

I show that facilitating collateralized debt financing implies an increase in efficiency in terms of production but also a rise in collateral/asset prices. In fact, an increased access to the credit market implies a credit expansion and thus a rise in the level of investment in asset by borrowers. This leads to a more efficient allocation of capital between the two groups and consequently increases efficiency in production. As a result in the new steady state the level of output, and thus total consumption, would be higher.

Moreover, I show that the higher the degree of access to the credit market the higher the output volatility over the business cycle. And the higher leveraged are agents, the lower their ability to smooth negative shocks.

The paper is organized as follows. Section 2 presents the model. Section 3 analyses the relation between improvement in credit market technology and macroeconomic performance. Section 4 shows how different degrees of credit market development affect business cycle volatility. Section 5 draws some tentative conclusions.

2 The Model

2.1 Economic Environment

Consider a stochastic discrete time economy populated by two types of households that trade two kinds of goods: a durable asset and a non durable commodity. The durable asset (k) does not depreciate and has a fixed supply normalized to one. The commodity good (c) is produced with the durable asset and cannot be stored.

At time t there are two competitive markets in the economy: the asset market in which the one unit of durable asset can be exchanged for q_t units of consumption good, and the credit market.

I assume a continuum of ex-ante heterogeneous households of unit mass: n_1 *Patient Households* (denoted by 1) and n_2 *Impatient Households* (denoted by 2). In order to impose the existence of flows of credit in this economy I assume ex-ante heterogeneity based on different subjective discount factor.

Assumption 1 : $\beta_2 < \beta_1 < 1$

This assumption ensures that in equilibrium patient households lend and impatient households borrow .

Both agents produce the commodity good using the same technology

$$y_{it} = Z_t k_{it-1}^{\alpha}$$

where Z_t represent an aggregate technology shock. It follows an AR(1) process

$$\ln(Z_t) = \rho_Z \ln(Z_{t-1}) + \varepsilon_{Zt}, \quad \varepsilon_{Zt} \backsim^{iid} N(0, \sigma_{\varepsilon_Z}), 0 < \rho_Z < 1$$

Assumption 2 : $\alpha_1 = \alpha_2 < 1$

Following Kiyotaki and Moore (1997) I assume that the technology is specific to each producer and only the household that started the production has the skills necessary to conclude the production. This means that if the household i decides to not put his effort in the production between t and t+1 there would be no outcome of production at t+1, and there would only be the asset k_{it} at t+1. The household cannot precommit to produce. Moreover, he is free to walk away from the production and the debt contracts between t and t+1. This results in a default problem that makes creditors to protect themselves by collateralizing the household's asset. The creditor knows that in case the household runs away from production and debt obligations, they will get his asset. Thus, the debt repayment, b_{it+1}, of the borrower is limited to a fraction of next period expected value of the asset:

$$b_{it} \leq \gamma E_t \left[q_{t+1} k_{it} \right]$$

Assumption 3: $\gamma < 1$

Limiting the borrowing to a fraction of the expected liquidation value of the capital takes into account different degrees of development of the credit market technology. A high γ represents a developed financial sector while a low γ characterizes an underdeveloped system.

Households face the following problem:

$$\max_{\{c_{it},k_{it},b_{it}\}} E_0 \sum_{t=0}^{\infty} (\beta_i)^t U(c_{it}) \qquad i=1,2$$

$$s.t.$$

$$c_{it} + q_t(k_{it} - k_{it-1}) = y_{it} + \tfrac{b_{it}}{R_t} - b_{it-1}$$

$$y_{it} = Z_t k_{it-1}^{\alpha}$$

$$b_{it} \leq \gamma E_t \left[q_{t+1} k_{it}\right]$$

Where k_{it} is a durable asset, c_{it} a consumption good, and b_{it} the debt level.

2.2 Competitive Equilibrium

Definition 1 *A market equilibrium is given by a sequence of prices* $\{q_t, R_t\}$ *and allocations* $\{c_{it}, k_{it}, b_{it}\}_{t=0}^{\infty}$ *for i=1,2 such that:*

- *given* $\{q_t, R_t\}$ *each agent chooses* $\{c_{it}, k_{it}, b_{it}\}_{t=0}^{\infty}$ *to maximize the expected life time utility subject to the production function, the borrowing constraint and the flow of funds constraint*
- *the markets for capital, consumption good and debt clear:* $\sum_{i=1}^{2} n_i k_{it} = K = 1$, $\sum_{i=1}^{2} n_i c_{it} = \sum_{i=1}^{2} n_i y_{it}$ *and* $\sum_{i=1}^{2} n_i b_{it} = 0$.

Agents' optimal choices of bonds and capital are characterized by:

$$\frac{U_{c_{i,t}}}{R_t} \geq \beta_i E_t U_{c_{i,t+1}}$$

and

$$q_t - \beta_i E_t \frac{U_{c_{i,t+1}}}{U_{c_{i,t}}} q_{t+1} \geq \beta_i E_t \frac{U_{c_{i,t+1}}}{U_{c_{i,t}}} \left(F_{k_i,t+1}\right)$$

where $F_{k_i,t} = \alpha Z_t k_{it-1}^{\alpha-1}$ is the marginal product of capital.

The first equation relates the marginal benefit of borrowing to its marginal cost. For constrained agents the marginal benefit is always bigger than the marginal cost of borrowing. If I define $\mu_{i,t} \geq 0$ as the multiplier associated with the borrowing constraint the euler equation becomes:

$$\frac{U_{c_{i,t}}}{R_t} - \mu_{i,t} = \beta_i E_t U_{c_{i,t+1}}$$

The second equation states that the opportunity cost of holding one unit of capital, $\left[q_t - \beta_i E_t \frac{U_{c_i,t+1}}{U_{c_i,t}} q_{t+1}\right]$, is bigger or equal to the expected discounted marginal product of capital. For constrained agents the marginal benefit of holding one unit of capital is given not only by its marginal product but also by the marginal benefit of being allowed to borrow more:

$$q_t - \beta_2 E_t \frac{U_{c_{2,t+1}}}{U_{c_{2,t}}} q_{t+1} = \beta_2 E_t \frac{U_{c_{2,t+1}}}{U_{c_{2,t}}} (F_{k_2,t+1}) + \gamma E_t q_{t+1} \frac{\mu_t}{U_{c_{2,t}}}$$

In a neighborhood of the steady state, Impatient Households borrow up to the maximum. Consequently, they face an always binding borrowing constraint. Thus

$$b_{2,t} = \gamma E_t \left[q_{t+1} k_{2t}\right]$$

and

$$k_{2t} = \frac{W_{2,t} - c_{2,t}}{\left[q_t - \gamma E_t \frac{q_{t+1}}{R_t}\right]}$$

where $W_{2,t} = y_{2,t} + q_t k_{2,t} - b_{2,t-1}$, is the impatient agent's wealth[3] at the beginning of time t and $d_t = \left[q_t - \gamma E_t \frac{q_{t+1}}{R_t}\right]$, represents the difference between the price of capital and the amount he can borrow against a unit of capital, i.e. the downpayment required to buy a unit of capital. Patient households are creditors in a neighborhood of the steady state. The creditor's capital decision is determined at the point in which the opportunity cost of holding capital equals its marginal product:

$$q_t - \beta_1 E_t \frac{U_{c_{1,t+1}}}{U_{c_{1,t}}} q_{t+1} = \beta_1 E_t \frac{U_{c_{1,t+1}}}{U_{c_{1,t}}} (F_{k_1,t+1})$$

3 Model Solution

3.1 Deterministic Steady State

In the absence of credit constraints the efficient allocation of capital between the two groups would be given by:

$$M_{1,t} = M_{2,t}$$

Thus, given the aggregate condition on capital

$$n_1 k_1 + n_2 k_2 = K_1 + K_2 = 1$$

[3] That is his output and the value of the land held the perious period net of debt repayment.

then

$$K_2^{eff} = \frac{n_2}{n_1+n_2} = n_2 \qquad and \qquad K_1^{eff} = 1 - n_2$$

This means that if the two groups are equally large, each group gets the same amount of capital in steady state[4].

Proposition 2 *The steady state interest rate is determined by the discount factor of the patient agent.*

Proof. Given the euler equation of the patient households:

$$\frac{U_{c_{1,t}}}{R_t} = \beta_1 E_t U_{c_{1,t+1}}$$

in a deterministic steady state:

$$R = \frac{1}{\beta_1}$$

■

Proposition 3 *In steady state the group of impatient households is credit constrained*

Proof. Consider the euler equation of the impatient household:

$$\frac{u_{c_{2,t}}}{R_t} - \mu_{2,t} = \beta_2 E_t u_{c_{2,t+1}}$$

In steady state it implies:

$$\mu_2 = \left(\frac{1}{R} - \beta_2\right) u_{c_2} = (\beta_1 - \beta_2)\, u_{c_2}$$

As long as Assumption 1 holds, the lagrange multiplier associated with borrowing constraint for the impatient household is strictly positive. Thus, impatient household are credit constrained in steady state. ■

Proposition 4 *In a credit constrained steady state, impatient households are credit constrained and their capital holding is $K_2 < K_2^{eff} = K_1^{eff}$.*

[4] If $n_1 = n_2 = 0.5$ then $K_2^{eff} = 0.5 \qquad and \qquad K_1^{eff} = 0.5$

Proof. Using the equations representing the households' optimal choice of capital evaluated at the steady state it is possible to show that: $F_{k_1} < F_{k_2}$.

$$\frac{F_{k_2}}{F_{k_1}} = \frac{\beta_1 \left[1 - \beta_2 - \gamma(\beta_1 - \beta_2)\right]}{(1 - \beta_1)\, \beta_2} > 1$$

Where $F_{k_i} = \alpha \left(\frac{K_i}{n_i}\right)^{\alpha - 1}$. In fact the equation above is always bigger than 1 as long as $\gamma < \frac{1}{\beta_1}$. And due to Assumption 3 this is always the case. ■

Proposition 5 *The steady state allocation of capital depends on the subjective discount factors, the fraction of the two groups of agents and the degree of credit market development. Calculations in the appendix show that*

$$K_2 = \frac{1}{\left\{1 + \frac{n_1}{n_2}\left[\frac{\beta_2(1-\beta_1)}{\beta_1[1-\beta_2-\gamma(\beta_1-\beta_2)]}\right]^{\frac{1}{\alpha-1}}\right\}}$$

Compared to the first best allocation, the allocation under credit constraints reduces the level of capital held by the borrowers and implies a difference in the marginal productivity of the two groups. See Figure 1.

Proposition 6 *In steady state the asset prices depend on the marginal productivity of capital*

Proof. From the households' optimal choice of capital

$$q = \frac{\beta_1}{1 - \beta_1} F_{k_1} = \frac{\beta_2}{1 - \beta_2 - \gamma(\beta_1 - \beta_2)} F_{k_2}$$

■

3.2 Dynamics

The equilibrium conditions above represent a non-linear dynamic stochastic system of equations. Since the equations represent well behaved functions, it is possible to adopt standard local approximation techniques to find the solution. All the methods commonly used for this kind of systems rely on log-linear approximations around the steady state to get a solvable stochastic system of difference equations.

By finding a solution I mean to write all variables as linear functions of a vector of state variables, both endogenous state x_{t-1} and exogenous state $z_t$variables, i.e. I are looking for the *recursive equilibrium law of motion:*

$$x_t = Px_{t-1} + Qz_t$$

$$y_t = Rx_{t-1} + Sz_t$$

where y_t is the vector of endogenous (or jump) variables.

In order to solve for the recursive law of motion I need to find the matrices P, Q, R, S so that the equilibrium described by these rules is stable. I solve this system via the method of undetermined coefficients (McCallum (1983),King,Plosser and Rebelo (1987), Campbell (1994), Uhlig (1995) among others)[5]

3.3 Calibration

I set the model parameters, calibrating the model at quarterly frequencies. I set patient households' discount factor equal to 0.99, such that the average annual rate of return is about 4%. I calibrate impatient's households' discount factors according to Lawrance (1991) and Samwick (1998) that estimate discount factors, respectively, for poor and young households in the range (0.97, 0.98). The share of capital in the production α is 0.36 as in the tradition of the real business cycle literature[6]. Following the literature on collateral constraint, technology shocksare assumed to have zero persistence. I also assume no persistence in the preference shocks while the *Loan to Value Ratio* shock is assumed to be permanet. The baseline choice for the loan to value ratio, γ, is 40% and the fraction of borrowing constrainted population is set to 50%.

Basic Calibration

preferences			**borrowing limit**		
discount rate	β_1	0.99	weight on capital	γ	0.4
	β_2	0.97			
technology			**shock process**		
capital share	α	0.3	autocorrelation	ρ_z	0
				ρ_γ	1
population	n	0.5		ρ_ξ	0

Tab.1

[5] See Harald Uhlig "A Toolkit for Analyzing Nonlinear Dynamic Stochastic Models Easily" for the description of the solution method.

[6] See Cooley and Prescott (1995) or Prescott (1986).

4 Credit Market Development and Long Run Performance

4.1 Steady State Analysis

I now investigate the implication of credit market development - i.e. an increased access to credit market. Limiting the borrowing to a fraction of the expected liquidation value of the capital takes into account different degrees of development of the banking technology in liquidating the collateral. A high γ represents a developed credit sector while a low γ characterizes an underdeveloped system. Note that (1-γ) is the cost of liquidation. Thus, the way credit market development is modelled is through relaxing credit restrictions.

The parameter γ, representing the loan to value ratio, affects the steady state allocation of capital, the determination of the level of borrowing and the asset price.

Proposition 7 *A permanent increase in γ rises the level of capital held in the new steady state by borrowers*

Proof. The derivative of K_2 with respect to γ is strictly positive ■

Proposition 8 *A permanent increase in γ rises the steady state asset price level*

Proof. As long as $\alpha < 1$ the marginal productivity for lenders is increasing in K_2. Thus, in the new steady state asset price is settled to an higher level. ■

Figure 2 shows how γ affects the marginal productivity and thus efficiency in production. *Ceteris paribus* a higher γ reduces the difference between borrowers' and lenders' marginal productivity. Even if it is not possible to reach the efficient equilibrium ($M_{1,t} = M_{2,t}$) it is possible to reduce the efficiency loss by setting γ closer to 1.

Changes in steady state values due to credit market development are shown in Figure 3 and 4. An increased access to the credit market implies a credit expansion and thus a rise in the level of investment by borrowers. As expected this leads to a more efficient allocation of capital between the two groups and consequently to an increase in production. As a result in the new steady state the level of output, and thus total consumption, is higher. The price of the collateral/asset is also higher.

Up to a certain value of γ, borrowers' consumption also increases. This could be due to both a credit channel effect and an asset wealth effect. Agents benefit of a larger access to debt financing and of an increasing value of their assets. But easing the liquidity constraints faced by households leads to a rise not only in the household indebtedness level but also in the ratio of household liabilities to production. Indebtedness increases more than production. Moreover, borrowers' wealth decreases while total wealth increases.

What is the welfare cost of a lower level of credit market development? I measure the welfare cost as a percentage increase in consumption that a household would need to be as well off under the lower degree of access to the credit market, as in an higher one. Using the steady state value of consumption at different levels of credit market development, I calculate the percentage increase such that:

$$\sum_{t=0}^{\infty} (\beta_i)^t U\left(c_{iSS}^{\gamma=0.7}\right) = \sum_{t=0}^{\infty} (\beta_i)^t U\left((1+x)\, c_{iSS}^{\gamma=\nu}\right)$$

with $c_{iSS}^{\gamma=0.7}$ and $c_{iSS}^{\gamma=\nu}$ being the steady state consumption levels of individual i=1,2 at $\gamma = 0.7$ and $\gamma = \nu$ with $\nu = \{0.001, 0.1, 0.2, ...0.6\}$.

A high level of credit market development is represented by $\gamma = 0.7$ since it allows for borrowing up to the 70% of the next period value of the own capital.

I quantify the welfare cost of a less developed credit market first separately for the two groups of agents (borrowers and lenders) then according to the following overall measure of welfare:

$$\sum_{i=1}^{2} n_i \sum_{t=0}^{\infty} (\beta_i)^t U\left(c_{iSS}^{\gamma=0.7}\right) = \sum_{i=1}^{2} n_i \sum_{t=0}^{\infty} (\beta_i)^t U\left((1+x)\, c_{iSS}^{\gamma=\nu}\right)$$

Table 2 shows the welfare cost of a lower degree of credit market development. As expected the lower ν the higher the welfare gains. The measure varies between 0.05% and 6.97% for the borrowers, 1.04% and 3.31% for the lenders. When the credit multiplier is higher both agents are better off. The total welfare cost varies between 0.86% and 3.93%.

4.2 A permanent increase in the degree of credit financing

Now I analyze the effects of a permanent increase in the access to credit financing on asset prices, total output and indebtedness. I study the response of the model's variables to a 10% permanent positive shock to γ stating from γ=0.4. It should be interpreted as any institutional change that increases the access to the credit market.

Being able to borrow more, the impatient agents increase both their consumption and investment level. Thus, their production level increases. The increased level of investment in physical assets raises also their capacity of borrowing next period and the level of indebtedness increases. For the market to clear the other group of agents should be willing to demand less of the asset in fixed supply. The price of the asset, therefore, has to increases.

Figure 5.a-5.b show the transition to the new steady state after a positive permanent shock to γ. The transition to the new deterministic steady state takes some years.

After the first impact, asset prices increase slowly and reach a new level that is 8% higher than the old one. This pattern is due to changes in the interest rate and thus consumption choices. In fact, asset price dynamics are given by the demand for capital[7]:

$$q_t - \beta_1 E_t \frac{U_{c_{1,t+1}}}{U_{c_{1,t}}} q_{t+1} = \beta_1 E_t \frac{U_{c_{1,t+1}}}{U_{c_{1,t}}} \left(F_{k_1,t+1} \right)$$

If the borrowers' demand for assets goes up, then to clear the market the lenders' demand has to decrease. This could be driven by a rise in the user cost of holding assets. $u_t = \left[q_t - \beta_1 E_t \frac{U_{c_{1,t+1}}}{U_{c_{1,t}}} q_{t+1} \right]$.

Iterating forward

$$q_t = E_t \sum_{j=0}^{\infty} \Lambda_{t,t+j} \left(F_{k_1,t+1} \right)$$

[7] Alternatively:

$$q_t - \beta'' E_t \frac{u_{c_{2,t+1}}}{u_{c_{2,t}}} q_{t+1} = \beta'' E_t \frac{u_{c_{2,t+1}}}{u_{c_{2,t}}} \left(M_{2,t+1} \right) + \gamma E_t q_{t+1} \frac{\mu_t}{u_{c_{2,t}}}$$

thus the asset price level depends not only on the marginal productuvity of borrowers but also on the liquidity constraints.

where $\Lambda_{t,t+j} = (\beta_1)^j \frac{u_{c_{1,t+j}}}{u_{c_{1,t}}}$ depends on consumption choices and thus is linked to the interest rate.[8]

5 Credit Market Development and Business Cycle

In this section I consider the response of the model economy to negative shocks. In order to analyze the role of credit market development as a source of instability over the business cycle I compare the responses of economies with different degrees of access to the credit market.

I assume that the economy is at the steady state level at time zero and then is hit by unexpected shocks under different degrees of access to the credit market. I consider an unexpected one-time ($\rho = 0$) decrease in aggregate productivity of 1%.

See Figure 6. The units on the vertical axes are percentage deviations from the steady state, while on the horizontal axes are years, with the shock taking place in the third quarter.

An aggregate negative technology shock affects the production negatively, and thus also earnings of both groups of agents.

Highly leveraged agents smooth the effects of the negative shock on consumption by buying less capital. Cutting back their investment expenditures, borrowers are unable to borrow more. As a consequence the shock has a persistent effect on borrowers' production, and thus, because of credit constraints, on investment expenditures. The shock in period t affects borrowers' demand for capital in future periods.

In order for the market to clear lenders have to reduce their demand for capital and this requires their user cost of holding capital to fall. The fall in asset prices affects further negatively the borrowing capacities of impatient agents implying a deeper cut in their investments.

From the log-linearized version of the collateral price dynamics equation I see that this price is directly affected by marginal productivity of the collateral asset and by differences in marginal productivity:

[8]Linear preferences for the lenders would imply that the dynamics of the price of the durable asset depend only on the expected marginal productivity; viceversa, a linear technology would make fluctuations independent of marginal productivity. Moreover in the later case, the steady state level would be unchanged.

$$\hat{q}_t = \frac{M_{1ss}}{q_{ss}} \sum_{j=0}^{\infty} (\beta_1)^{j+1} \left[\hat{M}_{1t+j+1}\right] + \left(1 + \frac{M_{1ss}}{q_{ss}}\right) \sum_{j=0}^{\infty} (\beta_1)^{j+1} \left[U_{c_{1,t+j+1}} - U_{c_{1,t+j}}\right]$$

The collateral price is directly affected by the negative technology shock through the marginal productivity but also by the asset dynamics.

$$\hat{M}_{1t+1} = \hat{z}_{t+1} - (1-\alpha)\,\hat{k}_{1t}$$

As a consequence of both reduced investments and lower asset prices, borrowers also experience a credit crunch. since

$$\hat{b}_{t+1} = \hat{q}_{t+1} + \hat{k}_{t+1}$$

Thus, the economy suffers the direct impact of the negative technology shock and also the indirect impact of a reduction in asset price. Moreover, the overall impact is stronger the higher is γ. With a higher γ most of the variables react by more or show a stronger persistence. Figure 8.a shows the total output response to a 1% negative technology shock in economies with different degrees of credit market development. The higher γ the more persistent the effects of the shock. Table 3 shows the standard deviation of total output for three different values of γ. Output volatility increases with the degree of access to the credit market regardless of the persistence of the shock. Standard deviations are calculated over 12 quarters. The shock hits the economy in the second quarter. The standard deviation of output is about 10.7% higher in an economy in which agents can borrow up to the 80% of the next period value of their asset, compared to an economy in which the loan to value ratio is 30%.

The higher level of liabilities, both in absolute terms and relative to the income, in a system characterized by a more developed credit market, makes agents more vulnerable to declines in asset values. A negative shock reduces their ability to access credit due to the higher debt level and falling asset prices. Thus, increased indebtedness makes agents more susceptible to liquidity problems.

Regardless of whether private sector debt is sustainable, high levels of indebtedness increase the sensitivity of the private sector to fluctuations in asset prices and wealth. The same results hold if I consider an individual preference shock that affects loans supply and interest rates. I consider a 1% shock to lenders' preferences[9]. A positive preference shock that hits only lenders, makes them willing to consume more and thus reduces the supply of bonds.

This implies a reduction in the demand for capital from borrowers and thus a fall in asset prices. Lenders are indifferent between buying bonds or capital, so in order for demanding more capital its user cost should decline. The effect of limited liquidity also reduces investment in capital and thus production for the borrowers. On the other hand the increase in production by lenders is not enough to raise total production.

The overall effect on total production if presented in figure 8.b. As before an higher persistence of the effect of the shock is present on an economy with a more developed credit system. Table 3 shows the standard deviation of total output over 12 quarters. The higher the steady state indebtedness level, the stronger the negative effect of the shock on production and capital decisions.

6 Conclusion

This paper studies how the provision of credit in connection with collateral assets affects both economic performance and the business cycle volatility. I provide a simple framework for analyzing the role of credit market development in an economy with imperfect credit markets.

I assume that agents face credit constraints, with the constraints being tighter at a lower level of credit market development. This model economy is used to discuss the interaction between aggregate output dynamics, collateral/asset prices and wealth distribution. The paper sheds light on the trade off between efficiency and stability.

I show that an increased access to the credit market implies a credit expansion and thus a rise in the level of investment expenditure by borrowers. This leads to a more efficient allocation of capital between the two groups of agents

[9] A loan supply shock is modelled as a shock to lenders' preferences (ξ_{1t}):

$$E_0 \sum_{t=0}^{\infty} (\beta_1)^t U(c_{1t})\xi_{1t}$$

where

$$\ln(\xi_{1t}) = \rho_Z \ln(\xi_{1t-1}) + \varepsilon_{\xi t}, \quad \varepsilon_{\xi t} \backsim^{iid} N(0, \sigma_{\varepsilon\xi}), 0 < \rho_\xi < 1$$

and consequently increases total production and wealth.

At the same time asset prices also increase. Being able to borrow more, the impatient agents increase both their consumption and investment expenditures. For the market to clear the other group of agents should be willing to demand less of the asset in fix supply. Thus, their opportunity cost of holding the asset must increase.

A second contribution of this paper is to analyze the link between credit market development and business cycle volatility. I show that more developed credit markets are more vulnerable to negative shocks. In fact, the higher level of liabilities, both in absolute terms and relative to the income, make agents more vulnerable to declines in asset values. After a negative shock their ability to access credit is more difficult due to the higher debt level and falling asset prices. Thus, highly leveraged agents are more susceptible to liquidity problems.

The trade off between efficiency and stability implies that policies directed to credit market development should take into account the impact on business cycle volatility. Based on the first results, policy makers should promote credit market development as a source of improvement in economic performance. On the other hand, regardless of credit sustainability and financial crises, they should also pay attention to the impact of the credit market characteristic on short-run instability.

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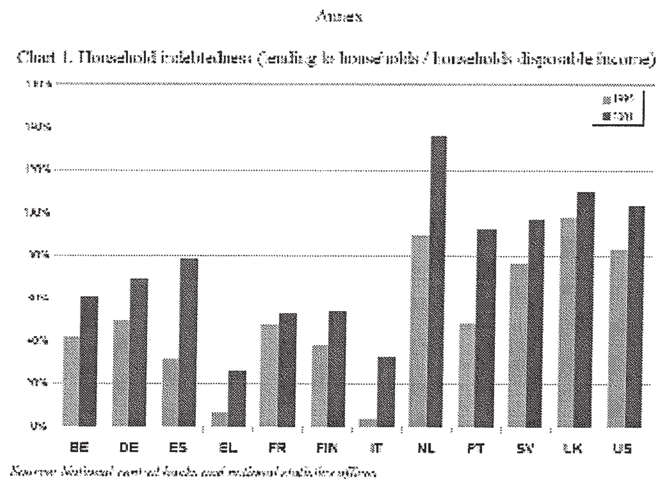
8 Appendix

Household Indebtedness:



Welfare:

Welfare Gains from γ to γ'= 0.7

γ	$\gamma = .001$	$\gamma = .1$	$\gamma = .2$	$\gamma = .3$	$\gamma = .4$	$\gamma = .5$	$\gamma = .6$
borrowers	.0697	0.0551	.0409	.0277	.0160	.0065	.0005
lenders	.0331	.0316	.0296	.0268	.0230	.0177	.0104
total	.0393	.0357	.0316	.0270	.0217	.0157	.0086

table 2

Business Cycle

1% Aggrevate Negative Technology Shock

persistence		$\rho = 0$			$\rho = 0.5$	
credit mkt	$\gamma = 0.8$	$\gamma = 0.5$	$\gamma = 0.3$	$\gamma = 0.8$	$\gamma = 0.5$	$\gamma = 0.3$
	0.7472	0.7343	0.7254	0.9226	0.8879	0.8577

1% Aggrevate Negative Loan Supply Shock

persistence		$\rho = 0$			$\rho = 0.5$	
credit mkt	$\gamma = 0.8$	$\gamma = 0.5$	$\gamma = 0.3$	$\gamma = 0.8$	$\gamma = 0.5$	$\gamma = 0.3$
	1.1499	0.5885	0.2149	1.1037	0.4858	0.1798

$Table 3$

8.1 Equilibrium Conditions

The system of non-linear equations is given by 4 first order conditions

$$\frac{U_{c_{1,t}}}{R_t} = \beta_1 E_t U_{c_{1,t+1}} \tag{E.1}$$

$$\frac{U_{c_{2,t}}}{R_t} - \mu_{2,t} = \beta_2 E_t U_{c_{2,t+1}} \tag{E.2}$$

$$q_t - \beta_1 E_t \frac{U_{c_{1,t+1}}}{U_{c_{1,t}}} q_{t+1} = \beta_1 E_t \frac{U_{c_{1,t+1}}}{U_{c_{1,t}}} F_{k_1,t+1} \tag{E.3}$$

$$q_t - \beta_2 E_t \frac{U_{c_{2,t+1}}}{U_{c_{2,t}}} q_{t+1} = \beta_2 E_t \frac{U_{c_{2,t+1}}}{U_{c_{2,t}}} F_{k_2,t+1} + \gamma E_t q_{t+1} \frac{\mu_{2t}}{U_{c_{2,t}}} \tag{E.4}$$

4 aggregate conditions

$$n_1 k_{1t} + n_2 k_{2t} = K_{1t} + K_{2t} = 1 \tag{E.5}$$

$$y_t = n_1 y_{1t} + n_2 y_{2t} \tag{E.6}$$

$$n_1 b_{1t} + n_2 b_{2t} = 0 \tag{E.7}$$

1 budget constraint[10]

$$c_{2t} + q_t(k_{2t} - k_{2t-1}) = y_{2t} + \frac{b_{2t}}{R_t} - b_{2t-1} \tag{E.8}$$

1 borrowing constraint

$$b_{2,t} = \gamma E_t \left[q_{t+1} k_{2t} \right] \tag{E.9}$$

the resource constraint

$$y_t = n_1 c_{1t} + n_2 c_{2t} \tag{E.10}$$

the two technologies:

$$y_{1t} = Z_t k_{1t-1}^{\alpha} \qquad y_{2t} = Z_t k_{2t-1}^{\alpha} \tag{E.11}$$

12 equations and 12 unknowns: $\{\mu_{2t}, q_t, R_t, y_t\}$ and $\{c_{it}, k_{it}, b_{it}, y_{it}\}_{t=0}^{\infty}$ for i=1,2.

[10] Using the Walras' Law we can drop at each t one of the two budget constraints.

8.2 Steady State

From E.1 I find the steady state interest rate:

$$\frac{1}{R} = \beta_1 \tag{ss.1}$$

from E.2 the lagrange multiplier:

$$\mu_2 = (\beta_1 - \beta_2)\, u_{c_2} \tag{ss.2}$$

Using E.3 and E.4:

$$q = \frac{\beta_1}{1-\beta_1} F_{k_1} = \frac{\beta_2}{1-\beta_2-\gamma(\beta_1-\beta_2)} F_{k_2} \tag{ss.3}$$

and substituting for K_1 using the aggregate condition on capital: $K_1 = 1 - K_2$ I find the steady state allocation of capital to the group of borrowers: K_2

$$\frac{\beta_1}{1-\beta_1}\left(\frac{1-K_2}{n_1}\right)^{\alpha-1} = \frac{\beta_2}{1-\beta_2-\gamma(\beta_1-\beta_2)}\left(\frac{K_2}{n_2}\right)^{\alpha-1}$$

Thus:

$$K_2 = \frac{1}{\left\{1 + \frac{n_1}{n_2}\left[\frac{\beta_2(1-\beta_1)}{\beta_1[1-\beta_2-\gamma(\beta_1-\beta_2)]}\right]^{\frac{1}{\alpha-1}}\right\}}$$

In case the two group of agents have different technologies, substituting for K_1 the equation become nonlinear in K_2 and not solvable analytically,thus, a *nonlinear rootfinding problem* arises.

In the *nonlinear rootfinding problem*, a function f mapping $\mathbb{R}^n$ to $\mathbb{R}^n$ is given and one must compute an n-vector x, called a *root* of f, that satisfies $f(x) = 0$. In our problem the $f(x)$ is represented by ss.

In this case I implement a numerical algorithms for solving the system quickly and accurately.

Then using E.3:

$$q = \frac{\beta_1}{1-\beta_1} F_{k_1} \tag{ss.4}$$

where $F_{k_1} = \left(\frac{1-K_2}{n_1}\right)^{\alpha-1}$.

Thus I find the steady state borrowing level:

$$b_2 = \gamma\,[q k_2] = -b_1 \tag{ss.5}$$

and the total production:

$$y = n_1 y_1 + n_2 y_2 \tag{ss.6}$$

where

$$y_1 = k_1^{\alpha} \quad y_2 = k_2^{\alpha} \tag{ss.7}$$

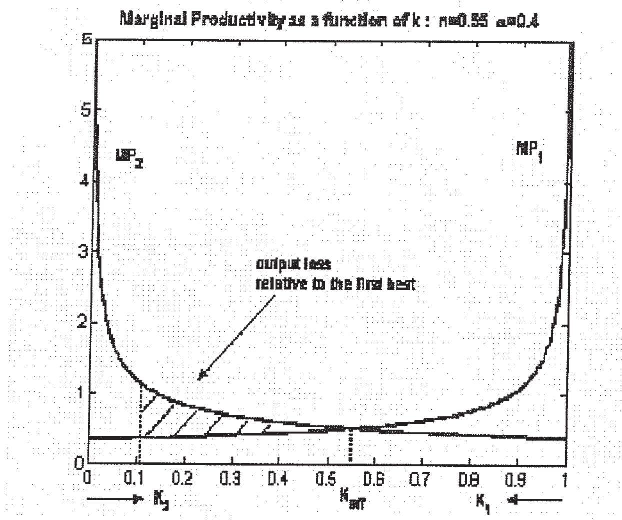
From E.8 I find the consumption of the borrowers

$$c_2 = y_2 - b_2 \left(1 - \frac{1}{R}\right) \tag{ss.8}$$

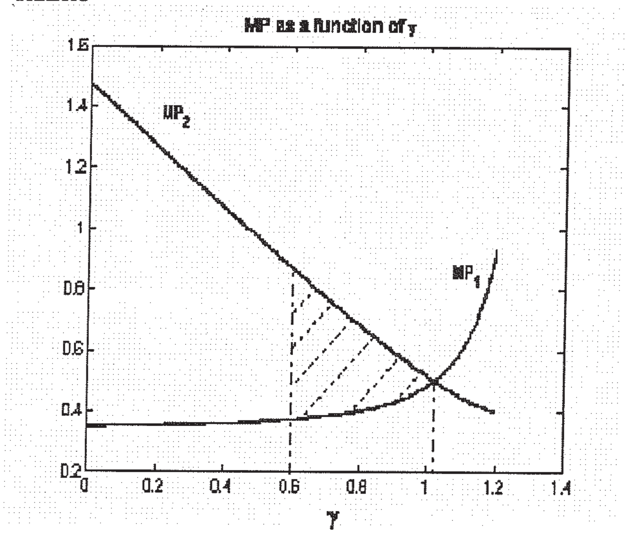
and from the resource constraint the consumption of the group of lenders

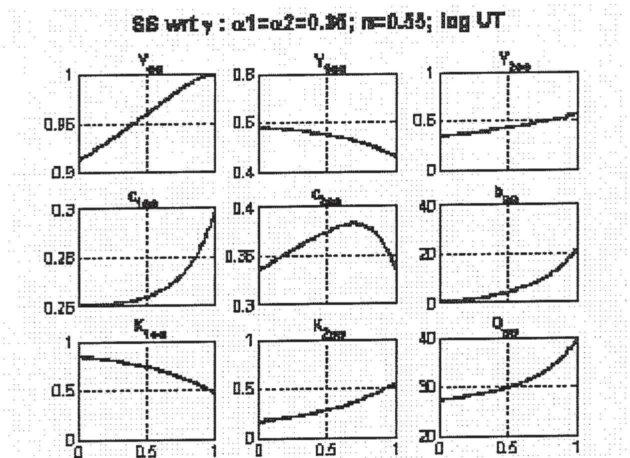
$$n_1 c_1 = y - n_2 c_2 \tag{ss.9}$$

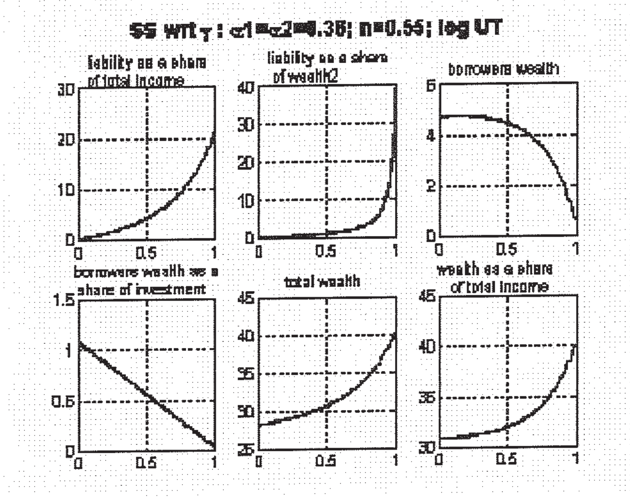
GRAPH 1



GRAPH 2




SS wrt γ : α1=α2=0.36; n=0.55; log UT


SS wrt γ : α1=α2=0.36; n=0.55; log UT
liability as a share of total income
liability as a share of wealth2
borrowers wealth
borrowers wealth as a share of investment
total wealth
wealth as a share of total income

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