Credit Market and Macroeconomic Volatility*

Caterina Mendicino†
Stockholm School of Economics
JOB MARKET PAPER

January 26, 2006

Abstract

This paper investigate how the degree of credit market development is related to business cycle fluctuations in industrialized countries.

I show that a business cycle model with collateral constraints generate a negative relation between the volatility of the cyclical component of output and the size of the credit market. I dentify the reallocation of capital as the key element in shaping out this relation. According to the model, more credit to the private sector makes output less sensitive to productivity shocks. Thus, the amplification role of credit frictions in the propagation of productivity shocks to output is greater in economies with higher degrees of credit rationing. I confront the prediction of the model with a panel of OECD countries over the last 20 years. Empirical evidence confirms that countries with a more developed credit market experience smoother fluctuations. Moreover, a greater size of the credit market dampens the propagation of productivity shocks to output and investment.

Keywords:*collateral constraint, reallocation of capital, asset prices*

JEL codes:E21-E22- E44- G20

*I am indebted to Kosuke Aoki, Giancarlo Corsetti, Martin Floden, Lars Ljungqvist for useful feedbacks on this project. I am also grateful to Jesper Linde, Guido Rey, Ulf Söderström, partecipants to the economic workshop at Stockholm School of Economics, the seminar at the Swedish Central Bank, the macroworkshop at the European University Institute and the research seminar at the ECB, the 11th Society of Computational Economics annual conference (Washington, 05) the X Workshop of Dynamic Macroeconomics (Vigo, 05) and the MMF annual meeting (Crete, 05) for helpful discussions. This paper was partly written while I visited the European Central Bank whose hospitality I gratefully acknowledge.

†Stockholm School of Economics, Department of Economics, BOX 6501, 113 83 Stockholm, Sweden. e-mail:caterina.mendicino@hhs.se

1 Introduction

During the past two decades financial systems have experienced deep structural changes as a result of regulatory reforms and technological innovations. The main goal was to improve efficiency within the financial system, but the macroeconomic implications could go beyond the main motivation. The deregulation process contributed to a considerable increase in bank loans extended to the private sector. A simultaneous decline in output volatility for most of the OECD countries in the last 20 years has been firmly established[1]. Changes in the underlying characteristics of the economy and thus in the mechanism through which exogenous shocks spread through and propagate in the economy could be the main reason for such a decline. Several studies give a primary role to the conduct of monetary policy[2]. Other studies, show that the decrease in inflation and output volatility is given by changes in the variance of exogenous shocks[3]. A few studies claim that instead the decline in output variability depends on other characteristics of the economy[4]. What is the contribution of credit market development to the increased macroeconomic stability in industrialized countries?

In the literature there is no rigorous evidence on the relation between the size of the credit market and output volatility in OECD countries Campbell and Hercowitz (2004) show that in the US, financial reforms of the early 1980's coincided with a decline in volatility of output, consumption and hours worked. The empirical evidence on macroeconomic volatility, shows that countries with more developed financial systems have smoother fluctuations[5]. However, these studies rely on cross-country analysis based on samples that include a large number of developing countries. Does the same relationship hold for industrialized countries?

[1] See e.g. Blanchard and Simon (2000), McConnell and Perez Quiroz (2001) and Stock and Watson (2003)

[2] See e.g. Clarida, Gali and Gertler (2000), Cogley and Sargent (2001, 2003), Boivin and Giannoni (2002), Canova (2004).

[3] Sims (2001), Sims and Zha (2001).

[4] Hanson (2001), Campbell and Hercowitz (2004).

[5] See Beck et al (2000), Denizer, Iyigun,Owen (2002) and Da Silva (2002).

Figures 1-2 show respectively the size of the credit market – measured by the credit to the private sector as a share of gdp and the volatility of output over the time period 1983-2004 – measured as the standard deviation of the log detrended real output – for a sample of 22 OECD countries. Both figures show significant differences among OECD countries. Some evidence that a smoother fluctuations are associated to higher levels of credit over gdp is found. Table 1.a shows that the ratio of credit to gdp, both contemporaneous and at the beginning of the period, is negatively correlated to the standard deviation of output, consumption and investment. Table 1.b shows the mean equality tests for the volatility of output, consumption, investment and investment in residential properties across treatment (size of the credit market below median size in the sample) and control (size of the credit market above median size in the sample) groups of countries, observed over 5-years between 1983-2004. The results suggest that countries with a smaller size of the credit market had on average higher volatility of output and investments.

In this paper I analyse how the size of the credit market is related to business cycle fluctuations in industrialized countries.

The paper builds on Kiyotaki and Moore (1997) and subsequent work where credit frictions propagates and amplifies shocks[6]. Following Kiyotaki and Moore's work an important strand of the business cycle literature has used collateral constraints as an amplification mechanism of shocks[7]. However, little attention has been devoted to the impact of credit market development on economic activity and business cycles. 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. Campbell and Hercowitz (2004) study how credit market development affected the volatility in hours, output and household debt in the US. Their model is based on the household sector, and the interaction between access to the credit market and labour supply is of

[6] See Bernanke and Gertler (1989) among others Kiyotaki and Moore (1997).

[7] See among others Iacoviello (2005), Iacoviello and Minetti (2005), Vlieghe G.W. (2003), Campbell and Hercowitz (2004), Kocherlakota (2000).

great importance in showing that a lower collateral requirement implies lower volatility. Using a different set-up in which the debt limit is not determined by the market price of land or capital, but by the expected lifetime profitability of the firm, Quadrini and Jerman (2005) show that financial development enables firms to take on more debt, making the economy more vulnerable to shocks. But, at the same time it improves the access to alternative sources of funding allowing for greater flexibility in investments. Thus, the business cycle results depend on which of the two mechanisms prevails. Aghion et al. (2005) develop a two-period growth model to show that tighter credit constraints affecting the composition of investment lead to both higher aggregate volatility and lower mean growth for a given total investment rate.

In this paper I revisit the link between credit market and macroeconomic fluctuations. To this purpose, I develop a full-fledged two-sector business cycle 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 and 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. Kiyotaki and Moore assume that 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 model both groups of agents have a concave utility function and are identical, except that they have different subjective discount factors. The setup turns out to be similar to the one used by Cordoba and Ripoll (2004). However, I also introduce aggregate uncertainty. Thus, differently from the other specifications of the model previously adopted in the literature, asset prices are not perfectly foreseen by agents. I also allow for the existence of liquidation costs in modelling the collateral constraint in order to investigate the behavior of economies that differ in terms of access to credit financing. Last, allowing for capital reproducibility, I develop a model with one capital good and two sectors, consumption and investment goods' production.

Differently from the few other models about finance and business cycle volatility, I focus on the behavior of capital reallocation as the main propagation channel. While papers about credit frictions analyze mainly the effect of frictions on investment in new capital, assuming a production of investment goods, I also study the reallocation of existing capital. In fact, I show that not only the allocation of new capital between industries with different marginal productivity but also the reallocation of productive assets – both across different industries and within industries across different firms – is larger in economies with a higher degree of credit rationing. In the model, I identify the existence of credit rationing as the main source of dispersion in the marginal productivity of capital. Since capital reallocation turns out to be the main mechanism of amplification of shocks, economies with a more developed credit market experience smoother fluctuations[8].

Cordoba and Ripoll (2004) show that adopting standard assumptions about preferences and technologies makes Kiyotaki and Moore's model unable to generate persistence and amplification of shocks. Thus, their results question the quantitative relevance of credit friction as a transmission mechanism. In this paper I show that the magnitude of the amplification of shocks is related to the degree of credit rationing. Cordoba and Ripoll's findings hold only for economies with the lowest possible degree of credit rationing allowed by the model. However, the magnitude of amplification is greater for countries with a smaller size of the credit market.

[8] According to the Schumpeterian view aggregate shocks generate an inter-firm reallocation of resources. This evidence is well established for job flows. Recent empirical papers show the relevance of the process of reallocation of physical capital over the business cycle [Maksimovic and Phillips (2001) - Andreade, Mitchell and Staffordf (2001) - Schoar (2002) - Jovanovic and Rousseau (2002) - Eistfeld and Rampini (2005)] However, there is no empirical evidence neither about capital reallocation and credit market development nor about capital reallocation and macroeconomic volatility.

In order to evaluate the performance of the model, I calibrate the size the level of credit as a share of gdp and the process for the productivity shock as in the data and I test to which extent the model economy can generate artificial data on output with the same standard deviation as in the data. I use quarterly data on OECD economies ranging from 1983 to 2004. For each country in the sample I calibrate the the size of the credit market according to the level of credit to the private sector as a share of gdp at the beginning of the period (83:1) and the standard deviation of the productivity shock equal to the standard deviation of the cyclical component of the solow residual. The model succees in reproducing output volatility for Germany, Spain, Ireland and Italy and generates quite close results for Sweden.

Last, I test the main predictions of the model using a panel of 22 OECD countries over the period 1983-2004. I ask whether a lower level of credit market development increases the volatility of output (amplification effect). I show that, as in the theoretical model, the size of the credit market is negatively related to output variability. Moreover, a greater size of the credit market dampens the propagation of productivity shocks to output and investment.

The paper proceeds as follows. Section 2 presents the model. Section 3 discusses the solution method and the calibration. Section 4 discusses the steady state implications of different degrees of credit rationing. Section 5 presents the dynamics of the model and Section 6 the relation between the size of the credit market and business cycle volatility. Section 7 confronts the results of the model with a panel of OECD countries. Section 8 concludes.

2 The Model

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) is reproducible and depreciate at a rate δ. 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 Entrepreneurs* (denoted by 1) and n_2 *Impatient Entrepreneurs* (denoted by 2). In order to impose the existence of flows of credit in this economy I assume that the ex-ante heterogeneity is based on different subjective discount factor.

Agents of type i, $i = 1, 2$, maximize their expected lifetime utility as given by:

$$\max_{\{c_{it}, k_{it}, b_{it}\}} E_t \sum_{t=0}^{\infty} \beta_i^t U\left(c_{it}\right)$$

with $\beta_1 > \beta_2$ s.t. a *budget constraint*

$$c_{it} + q_t(k_{it} - (1-\delta)\, k_{it-1}) = F_{it} + \frac{b_{it}}{R_t} - b_{it-1}$$

technology

$$F_{it} = y_{it} + q_t h_{it}$$

$$y_{it} = Z_t \left(k_{it-1}^c\right)^{\alpha_i^y} \qquad h_{it} = Z_t \left(k_{it-1}^h\right)^{\alpha_i^h}$$

and a *borrowing constraint*

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

Differently from Kiyotaki and Moore (1997) I assume that agents have access to the same concave production technology[9]. In fact, while in Kiyotaki and Moore (1997) the two groups of agents also represent two different sectors of the economy, I instead assume technology to be the same for both groups of agents ($\alpha_1 = \alpha_2$). Moreover, I also allow for reproducible capital and I assume that each agent is able to produce both consumption and investment goods[10].

[9] See Cordoba and Ripoll (2004) for a discussion on how different assumptions about the production technology affect the impact of technology shocks in this economy.

[10] In this way I avoid to create a rental market for capital and I make the model directly comparable to Kiyotaki and Moore (1997) and Cordoba and Ripoll (2004).

For simplicity I assume that both productions are identical[11].

However, I still follow Kiyotaki and Moore (1997) in assuming 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 agent 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 agents cannot precommit to produce. Moreover, they are 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, he will get his asset. However, following Iacoviello (2005), I assume the lenders can repossess the borrower's assets only after paying a proportional transaction cost $[(1-\gamma)E_t q_{t+1} k_{it}]$. Thus, agents cannot borrow more than a fraction γ of next period expected value of the asset

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

where $\gamma < 1$ and $(1-\gamma)$ is the cost that lenders have to pay in order to repossess the asset but at the same time represents the degree of credit rationing of the economy. Thus, as in Aghion, Baccheta and Banerjee (2003) and Campbell and Hercowitz (2004) limiting the borrowing to a fraction of the expected liquidation value of the capital takes into account different degrees of credit market development: an high γ represents a developed financial sector while a low γ characterizes an underdeveloped system.

2.1 Agent's optimal choices

Step1: Optimal allocation of Capital

I break up the agents' problem in two step. First, given this period's capital, each agent allocates the existing capital to produce either consumption or investment goods by solving

[11] Assuming decreasing returns in the production of investment goods is similar to the common assumption of convex adjustment costs for investments.

$$\max_{k_{it-1}^c} Z_t \left\{ \left(k_{it-1}^c\right)^\alpha + q_t \left(k_{it-1} - k_{it-1}^c\right)^\alpha \right\}$$

This leads to the first order condition

$$\left(k_{it-1}^c\right)^{\alpha-1} = q_t \left(k_{it-1} - k_{it-1}^c\right)^{\alpha-1}$$

It is possible to express the amount of capital allocated to each production as a fraction ot the total capital owned by each agent

$$k_{it-1}^c = \theta k_{it-1}$$

where $\theta(q, Z) = \frac{q_t^{\frac{1}{\alpha-1}}}{Z_t^{\frac{1}{\alpha-1}} + q_t^{\frac{1}{\alpha-1}}}$.Thus, the total production by each individual can be written as

$$F_{it} = k_{it-1}^\alpha Z_t \left[\theta^\alpha + q_t \left(1-\theta\right)^\alpha\right]$$

Step 2: Utility Maximization

Now it is possible to simplify the maximization problem to get

$$\max_{\{c_{it}, k_{it}, b_{it}\}} E_t \sum_{t=0}^{\infty} \beta_i^t U\left(c_{it}\right)$$

s.t. the *budget constraint*

$$c_{it} + q_t(k_{it} - (1-\delta)\, k_{it-1}) = k_{it-1}^\alpha \left[Z_t \theta^\alpha + q_t \left(1-\theta\right)^\alpha\right] + \frac{b_{it}}{R_t} - b_{it-1}$$

and the *borrowing constraint*

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

Agents' optimal choices are then characterized by

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

and

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

where $F_{k_{i,t+1}}$ is the marginal product of capital.

The first equation relates the marginal benefit of borrowing to its marginal cost, while the second equation shows that the opportunity cost of holding one unit of capital, $\left[q_t - \beta_i E_t \frac{U_{c_{i,t+1}}}{U_{c_{i,t}}} q_{t+1} (1-\delta)\right]$, is bigger than or equal to the expected discounted marginal product of capital.

It is possible to show that impatient agents borrow up to the maximum in a neighborhood of the deterministic steady state. If fact, if we consider the euler equation of the impatient household in steady state

$$\mu_2 = (\beta_1 - \beta_2) U_{c_2} > 0$$

where μ_{2t} is the lagrange multiplier associated to the borrowing constraint. Thus, if the economy fluctuates around the deterministic steady state, the borrowing constraint holds with equality,

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

and

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

where $W_{2,t} = F_{2,t} + q_t (1-\delta) k_{2,t-1} - b_{2,t-1}$, is the impatient agent's wealth at the beginning of the period 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.

Thus, in a neighborhood of the steady state 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

$$\frac{U_{c_{i,t}}}{R_t} - \mu_{2,t} = \beta_i E_t U_{c_{i,t+1}}$$

Moreover, 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

$$q_t - \beta_2 E_t \frac{U_{c_{2,t+1}}}{U_{c_{2,t}}} q_{t+1} (1-\delta) = \beta_2 E_t \frac{U_{c_{2,t+1}}}{U_{c_{2,t}}} \left(F_{k_{2,t+1}}\right) + \gamma E_t q_{t+1} \frac{\mu_{2,t}}{U_{c_{2,t}}}$$

On the contrary, patient households are creditors in a neighborhood of the steady state. Thus, the lender's capital decision is determined at the point in which the opportunity cost of holding capital equals its marginal product

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

3 Model Solution

3.1 Benchmark Parameters' Values

I calibrate 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%. Impatient households' discount factor equals 0.95. Lawrance (1991) estimates discount factors for poor households in the range (0.95, 0.98), while according to Carroll and Samwick (1997) the empirical distribution of discount factors lies in the interval (0.91, 0.99). I assume the following utility function:

$$U(c_{it}) = \frac{c_{it}^{1-\theta}}{1-\theta}$$

and set θ equal 3.3. The productivity parameter α is 0.36 as in the tradition of the real business cycle literature[12]. The baseline choice for the fraction of borrowing constrained population is set to 50%. Last, I calibrate the technology shocks according to standard values in the real business cycle literature[13]. The parameters representing the degree of credit rationing is in the range [0,1]. Table 2 summarizes the parameter values. Figure 4 shows that by using these parameter values and varying γ between zero and unity, it is possible to reproduce the same ratio of private credit to gdp as in the data.

3.2 Dynamics

The agents' optimal choices of bonds and capital together with the equilibrium conditions, represent a non-linear dynamic stochastic system of equations.

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

[13] For the technology shock see, Cooley & Prescott (1995, chapter 1 in Cooley's book), or Prescott 1986.

Since the equations are assumed to be well behaved functions, the solution of the system is found by adopting standard local approximation techniques. 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)[14].

4 Credit Market's Size and the Deterministic Steady State

Now, I analyse how the degree of credit rationing affects the deterministic steady state of the model. Since total output is maximized if the marginal productivity of the two groups is identical (first best allocation), I examine how the allocation of capital between the two groups varies with γ. Impatient households are credit constrained in steady state so their capital holding is less than capital held by patients agents. Using the equations representing the households' optimal choice of capital evaluated at the steady state it is possible to show that as long as

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

$\gamma < \frac{1}{\beta_1}$ (assumption 3):

$$\frac{K_1}{K_2} = \left[\frac{\beta_1}{\beta_2}\frac{1-\beta_2(1-\delta)-\gamma(\beta_1-\beta_2)}{1-\beta_1(1-\delta)}\right]^{\frac{1}{1-\alpha}} > 1$$

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. Compared to the first best allocation, the allocation under credit constraints reduces the level of capital held by the borrowers. In fact, it implies a difference in the marginal productivity of the two groups as long as $\gamma < \frac{1}{\beta_1} = 1.0101$. Figure 5.a shows how the steady state productivity gap in total production between the two groups of agents varies with respect to γ. In presence of credit frictions is not possible to reach the efficient equilibrium, but an higher γ reduces the output loss. In fact, a lower degree of credit rationing allowing for a more efficient allocation of capital between the two groups, implies a smaller productivity gap, thus, lower losses in terms of total production. As figure 5.b shows, the higher γ the greater the amount of capital assigned to the production of consumption goods, despite of a lower share of total capital allocated to this sector. At the same time, decreases the difference in capital assigned to the production of both consumption and investment goods by the two groups of agents. However, the difference in the amount of capital assigned to the two sectors is always bigger for the production of consumption goods.

Figure 6a-6b show how the steady state values of the model's variables change with respect to the degree of credit market development, γ. At the individual's level with an higher γ there is a more efficient allocation of capital between the two groups. An increased access to the credit market implies a credit expansion and thus a rise in the level of investment by borrowers. With more capital allocated to the most productive group of agents, there is an increase in the production share of constrained agents and consequently in total production.

So, also the amount of total capital and consumption are higher. Up to a certain value of γ, borrowers' consumption also increases. This could be due to both a credit channel effect and a wealth effect. Agents benefit of both a larger access to debt financing and an increasing value of their assets.

As expected, for high values of γ borrowers' steady state consumption decreases as γ approaches unity. In an environment with relaxed credit restrictions impatient agents prefer to consume more today than in the future reducing in this way the steady state level of consumption.

It is important to stress the increasing path in the steady state level of asset prices. The lenders' optimal choice of capital gives

$$q = \frac{\beta_1}{1-\beta_1} F_{k_1}$$

Thus, in steady state the asset prices depend on the marginal productivity of capital.

5 Benchmark Model Dynamics

I now consider the response of the model economy to a productivity shock. I assume that the economy is at the steady state level at time zero and then is hit by an unexpected 1% increase in aggregate productivity. The results are reported in Figures 8a-8d. When aggregate productivity exogenously increases, agents reallocate optimally the existing capital between the two sectors. In order for the agents to smooth the effect of the shock through investment, more capital is allocated to the production of investment goods. Thus, the change of use of the existing productive capital amplifies the effect of a positive technology shock on the aggregate production of investment goods. On the contrary the impact of the shock on the production of consumption goods is reduced (first impact less than 1%). Since the shock is temporary, agents save part of the extra resources to smooth consumption. Constrained agents smooth the effects of the shock by buying more capital. This implies an increase in the price of the productive asset. The increase in asset prices coupled with the increase in investments generate a credit boom.

Figure 8b-8c shows the dynamics of production in more detail. The effect of the shock on aggregate production is amplified both in the first and second period and it is highly persistent. However, the impact is much stronger on the production of investment goods. The reason why this production reacts much more to the shock is given by the physical reallocation of capital towards this sector. In fact following the shock, the share of existing capital allocated to the production of consumption goods decreases (Figure 8c bottom left box). The change of location of capital is the mechanism that can amplify or reduce the first impact of the shock itself. Since in the first period, agents decide to reallocate their own capital optimally in the same way, independently of the ownership both productions behave identically[15]. In the second period, however, the productions specific to the constrained agents are more strongly affected by the shock and show a significant degree of amplification[16]. On the contrary, the amplification in lenders' productions is scarce[17]. Also in the second period, the allocation of capital between the two sectors affects the behavior of production. But, what further amplifies the impact of the shock, is the fact that the capital held by constrained agents increases substantially. Constrained agents smooth the effects of the shock by buying more capital. The rise in current investment expenditures propagates the positive the effect of the shock on borrowers' production over time. Since the marginal productivity of capital is higher for borrowers, this generate a persistent effect on aggregate production as well. In fact, when the capital used by the most productive agents increases - as well as the share of production $(F_{2,t}/F_t)$ of this group of agents - the effect of the shock is amplified even more. While in the first period the only source of amplification is given by the reallocation of capital in terms of use (to the most relevant sector)[18] in the second period both physical and ownership reallocation take place[19].

[15] Amplification of 0.34% in total production, 0.21% in investment goods production and a reduction in the production of consumption goods of -0.06%.

[16] Amplification of 0.86% in total production, 0.78% in investment goods production and 0.42% in the production of consumption goods.

[17] Amplification of 0.07% in total production, 0.03% in investment goods production. The effect on consumption goods production is reduced by 0.31%.

[18] As in the individual case, amplification of 0.34% in total production, 0.21% in investment goods production and a reduction in the production of consumption goods of -0.06%.

[19] Amplification of 0.45% in total production, 0.36% in investment goods production and 0.0081% in the production of consumption goods.

The demand for productive assets by constrained agents turns out to be higher than their own production of investment goods. In order for the capital market to clear, lenders have to reduce their demand for capital and thus the user cost of holding capital has to increase as shown in Figure 8d. The rise in asset prices, coupled with the increase in investments implies a credit boom[20]. In order for the patient agents to be willing to increase their offer of funds, the interest rate increases. However, constrained agents benefit from the direct impact of the technology shock and also from an indirect impact through asset prices.

6 Credit Market's Size and Business Cycle

6.1 Benchmark Model: Quantitative Results

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[21]. Thus, as in Aghion, Baccheta and Banerjee (2003) and Campbell and Hercowitz (2004), the way credit market development is modelled is through relaxing credit restrictions. At the same time, γ represents different sizes of the credit market. Thus, I study how the reaction to productivity shocks is affected by the size of the credit market. Differently from previous literature, allowing for the reallocation of existing capital between sectors, I can show that the reaction to shocks varies already in the first period. Figure 9a-9b show the first impact of the shock on production – i.e. the intensity of reaction for any given γ. A higher γ magnifies the reaction of consumption good production while weakens the response of the production of investment goods. The reaction of the two sectors is explained by the dynamics of the allocation of capital between the two groups. As shown by Figure 9.a (top panel), the magnitude of the reallocation of capital is lower in economies with a more

[20]
$$\hat{b}_{t+1} = \hat{q}_{t+1} + \hat{k}_{t+1}$$

[21] Note that (1-γ) is the cost of liquidation.

developed credit market. In the model, a greater access to credit is associated with a smaller difference in productivity, thus with a smaller amplification of shocks. When less capital flows to the production of investment goods, the response of this sector decreases further more. Since the decrease in the intensity of reaction of this sector is bigger than the amplification of the shock in the production of consumption goods – notice that the response of this sector never reach 1% – a greater size of the credit market dampens the propagation of productivity shocks to output.

As already pointed out by Cordoba and Ripoll (2004), the elasticity of total output to technology shocks can be written as

$$\epsilon_{Fz} = \epsilon_{Fk_2}\epsilon_{k_2z} = \frac{F_{k_2} - F_{k_1}A}{F_{k_2}}\alpha\frac{y_2}{y}\epsilon_{k_2z}$$

where $A = \left[-\frac{1-\beta_1(1-\delta)}{\beta_1}\frac{\beta_2}{1-\beta_2-\gamma(\beta_1-\beta_2)}\right]^{\frac{1}{\alpha-1}}$. The first term is the productivity gap between constrained and unconstrained agents, α represent the share of collateral in production while $\frac{y_2}{y}$ is the production share of constrained agents and ϵ_{k_2z} is the redistribution of capital. When we look at the first impact of the shock, the only variable affecting the response of output is the change in the productivity gap. As expected, the productivity gap decreases with γ.

The response of total production shows that the magnitude of the amplification of shocks is higher the higher the degree of credit rationing. When γ equals unity we find that the existence of collateral constraints generates small output amplifications in the first period. This last result is in accordance with Cordoba and Ripoll (2004) findings. They show that most of my modelling choice (assumptions 1, 2, 4) make the model with credit constraints unable to generate persistence and amplification of shocks. It is possible to reach an amplification of maximum 0.4% using an ad hoc calibration of the model's parameters – large share of capital in the production function (0.5), an elasticity of intertemporal substitution particularly small (0.037) and an high level of impatience (0.89) – that would enhance the amplification power of collateral constraints[22].

[22] Table 3.a shows that the magnitude of the first-impact amplification varies with the size

Figure 9.c shows that the relation between the size of the credit market and the second impact of the shock on output and investment is non-linear. As shown in steady state, the fraction of total output produced by constrained agents increases with γ due to the fact that more capital is held by the constrained population. However, for the same reason, the productivity gap decreases with γ. The second impact on output depends on this two opposite forces. Thus, regardless the shape of capital reaction to technology shocks, the relationship between γ and the second impact of z_t on y_t has an inverted U shape. That is of course more pronounced if $\epsilon_{k_2 z}$ is not monotonic.

6.2 Credit Market Size and Output Volatility: a Computational Experiment

Now I examine the standard deviation of total output and both consumption and investment goods productions generated by the model in economies with different sizes of the credit market. See Figure 10. Each point represents the standard deviations given a particular value for γ. I simulate the model for 1000 value of γ in the range [0,1]. The length of the simulated series is of 21 years while the number of simulated series for the calculation of moments is 5000 for any given γ. The productivity shock follows an AR(1) process $\ln(Z_t) = \rho_Z \ln(Z_{t-1}) + \varepsilon_{Zt}, \quad \varepsilon_{Zt} \backsim^{iid} N(0, \sigma_\epsilon)$. I calibrate the standard deviation of the productivity process equal to the average standard deviation of the cyclical component of the solow residual for the all sample of countries during the period 1983:1-2004:4. Thus, I set the standard deviation of the productivity equal to the average value (σ_z =0.9875), $\rho_z = \{0\}$ and I generate artificial series for asset prices, output, investment and consumption goods, for any given size of the credit market in accordance with the data[23]. As a result, the size of

of the credit market in the model. In economies with γ between [0.4-0.85] –to match the level of private credit over gdp for most of the countries in the sample of countries shown in figure 1– the amplification in the first period is between $[0.318\%, 0.027\%]$ for total output and $[0.62, 0.04]$ for investment. Thus, in an economy with $\gamma = \{0.4, 0.85\}$ output react by respectively 0.29% and 0.143% more than in economy with $\gamma = 1$. Amplification in the second period varies between $[0.4\%, 0.25\%]$.

[23] I allow for γ to vary between 0.1 and 1 in order to match the size of the credit market of the sample.

the credit market is significantly negatively related to output and investment variability. On the contrary, the volatility of consumption goods' production shows an increasing path. Thus, according to the model, both the amplification and the persistent effect of productivity shocks on output is lower for a greater size of the credit market[24].

Figure 11.a and 11.b show the standard deviation of output both in the actual data and simulated series over respectively 21 and 4 years. Table 3.c shows the mean equality test for the volatility of output, investment and consumption in the simulated series. In accordance with the result of the test on actual data, the standard deviation of output and investment is on average bigger for countries with a size of the credit market below the median value.

Thus, the model would predict lower amplification of shocks in economies like US and UK compared to other countries like Italy or Sweden that show a lower share of credit over gdp. In order to evaluate the performance of the model, I calibrate the size the level of credit as a share of gdp and the process for the productivity shock as in the data and I test to which extent the model economy can generate artificial data on output with the same standard deviation as in the data. I use quarterly data on OECD economies ranging from 1983 to 2004. Figure 12 show the behavior of the size of the credit market during the last 20 years for the countries in the sample considered. For each of these countries I calibrate the the size of the credit market according to the level of credit to the private sector as a share of gdp at the beginning of the period (83:1) and the standard deviation of the productivity shock equal to the standard deviation of the cyclical component of the solow residual. Table 4 shows the results for 7 OECD economies with that substantially differ in terms of size of the credit market. I consider 4 EMU countries – Germany, Spain, Ireland and Italy – Sweden, UK and US. The model succeed in reproducing output volatility for

[24] Using the ratio of standard deviation of output to shock as a measure of amplification I compare two economies with different size of credit market (See Table 3.b). I refer to a share of credit to the private sector over gdp equal to $\{1.11, 3.84\}$. As a result, output is 13.16% more volatile in economies characterized by the lowest size of the credit market and. Further more, investment's volatility is 70% higher when credit as a share of gdp equals 1.11.

Germany, Spain, Ireland and Italy and generates quite close results for Sweden.

7 Empirical Analysis

I analyse the relationship between credit market development and the size of business cycle fluctuations in the data. I use a cross-country approach, following the existing literature on the determinants of business cycles (see among others, Karras and Song (1996), Beck et al. (2000), Denizer et al. (2002), Ferreira da Silva (2002) and Buch et al (2005)). The dataset includes time-series quarterly data ranging from 1983 to 2004 for 22 OECD economies[25].

The theoretical model developed above assert that economies with a more developed credit market experience lower macroeconomic volatility. Both correlations (see Table 4.a) and mean equality tests (see Table 4.b) show that smoother fluctuations are associated to higher levels of credit over gdp. In order to test for causality, I present more systematic evidence on the relation between credit market development and business cycle volatility. I test the predictions of the theoretical model using the following simple empirical framework:

$$\sigma^Y_{i,t} = \mu_i + \lambda_t + \beta_1 Credit_{i,t} + \beta_2 X^{control}_{i,t} + u_{i,t}$$

where the time index refers to non-overlapping five-year periods, $\sigma^Y_{i,t}$ is the standard deviation of the business cycle component of gdp in real terms for country i, μ_i is a country specific effect, λ_t is a time specific effect, and $u_{i,t}$ is the variability in output not explained by the regressors. The measure of credit development – $Credit_{i,t}$ – and additional control variables – $X^{control}_{i,t}$– are described below. I use a beginning of the period measure of credit market development to focus on how the established level of credit over gdp affects volatility in the following period. All the other variables refer to non-overlapping five-year periods. Thus, the data set contains a panel of 22 countries and 4 time periods.

[25] All the data used are obtained from OECD's database but the data on private credit come from the IFS.

For each period I observe the level of credit development at the beginning of the period (first quarter of the first year of the 5 years) and the subsequent fluctuations. *Credit* is the value of credit extended to the private sector by banks and other financial intermediaries as a share of gdp. This is a standard variable used as a proxy for financial development in the finance and growth literature[26]. I also include in the regression other variables often considered determinants of business cycle fluctuations: the variability of solow residuals, short term interest rate, prices and terms of trade. As standard in the panel literature on the sources of business cycle the attempt is to control for macroeconomic shocks that would cause volatility in gdp. The volatility of the cyclical component of the solow residuals is often used as a proxy for technology shocks. As in Backus et al.(1992), Karras and Song (1996) and Ferreira da Silva (2002) I define it as the change in the log of real gdp minus (1-α) times the change in the log employment[27]. I include the standard deviation of the short-term interest rate to control for monetary policy shocks. Following Buch et al. (2005) I also take into account an indicator of volatility of the supply side measured as the standard deviation of the terms of trade. I also control for a measure of price flexibility as the standard deviation of the detrended CPI. Since I am interested in the volatility of the cyclical component of gdp, solow residuals, and interest rate, alternatively the first differencing and the Hodrick-Prescott filter are used to remove the estimated trend of the series. (In this tables only HP)

Simple bivariate regressions presented in table 5 confirm that, despite the inclusion of country and/or period fixed effects, indicate that credit market development is negatively and significantly related to output volatility. Although the fixed effect specification reduces the concern about potential omitted variables, I introduce in the regression a set of variables that may help to explain volatility. The negative relation holds also when I control for different sources of business cycle volatility (Table 6). About the other variables the results are in accordance with previous literature. Output volatility is strongly related

[26] See King and Levin (1993) and Levine, Loyaza and Beck (2000) among others.
[27] is the capital share of output. Following those authors I set it equal to 0.36.

to the volatility of the solow residual, of the interest rate and the terms of trade volatility. The coefficient related to the consumer prices variability has a negative sign although not significant. Columns 3 and 5 include interaction terms between credit market development and the standard deviation of solow residuals. According to the theoretical model presented above, the impact of a productivity shock should depend on the degree of credit market development. As a result of the estimations, a greater size of the credit market dampens the propagation of solow residual volatility. To correct for potential eI also use a set of instrumental variables to correct for potential endogeneity between the size of the credit market and output volatility. I use as instruments for the size of the credit market the lagged level of credit to the private sector as a share of gdp and "creditor rights" [La Porta et al. (98), La Porta et al (05)]. This last one is an index aggregating creditor rights where the rights of secured lenders are defined in laws and regulations.It ranges from 0 (weak creditor rights) to 4 (strong creditor rights) and is constructed as at January for every year from 1978 to 2003. In order to increase the variability in the instruments I measure volatility over a 3-year base and use the value at the beginning of the period. Table 6.b shows that the relation between credit market development and output volatility is unchanged. Sargan Test of overidentifying restrictions shows that the instruments used are valid (not correlated with the error term) and correctly excluded from the regression.

Next, I investigate how credit market development affects the variability of Investment and consumption. As table 7 shows, the greater the size of the credit market the lower the volatility of investment. The variability of both solow residual and interest rate increases investment volatility. Moreover, the effect of solow residual's volatility is dampened by a greater size of the credit market. The results for consumption volatility reveal that the size of the credit market is negatively related to the standard deviation of consumption as well (table 8). But, once I control for solow residuals and interest rate variability the relation turns not significant. However, the interaction term between credit market and solow residuals is positive and strongly significant. Contrary to the other measures of business cycle volatility, the impact of solow residual volatility is magnified by a higher level of credit market development.

These empirical results have twofold implications. From one side indicate that a better developed credit market can help decreasing the impact of productivity shocks on output and investment. But, on the other hand, they also indicate the amplification role of the credit market in the propagation of these kind of shocks to consumption. Both implications are in line with the predictions of the theoretical model.

8 Concluding Remarks

In this paper I analyze the relation between the size of the credit market and business cycle volatility.

Previous empirical papers using large sample of countries, most of which developing countries, show evidence on the negative relation between credit market development and business cycle volatility. In this paper I revisit the relation between the size of the credit market – used in the literature as a proxy for the degree of development of the credit market – and output, consumption and investment volatility over the business cycle. I focus on OECD countries. Some evidence on the fact that countries with a greater size of the credit market experience smoother fluctuation also among industrialized countries is shown. Further more I also show that a greater size of the credit market reduces the impact of productivity shocks on the cyclical component of output and investment.

Looking for an explanation to this empirical fact relying on a business cycle model with credit frictions, I show that a simple business cycle model with collateral constraints can generate the same kind of relation as in the data. I develop a two-sectors business cycle model to investigate the contribution of credit market development to the decrease in macroeconomic volatility. The model is built on Kiyotaki and Moore (1997). I introduce aggregate uncertainty and capital reproducibility in the model. In order to investigate the behavior of economies that differ in terms of access to credit financing, I also allow for the existence of liquidation costs in modelling the collateral constraint. I identify the the reallocation of existing capital as the key mechanism in shaping out this relation.

In a standard one sector model the propagation of shocks is implied by the redistribution of capital that flows from lenders with lower marginal productivity to borrowers with higher productivity. This effect predict an inverted U shape relation between the size of the credit market and output volatility. In the two sector model, the transmission of shocks is amplified not only by the redistribution of capital but also by the reallocation of capital in terms of use. This second effect generate greater amplification and persistence of shocks for any given size of the credit market. However, the contribution of the reallocation of existing capital is stronger in economies with a smaller size of the credit market and diminish with the size of the credit market. Thus, the reallocation of capital between sectors shapes out the relation between macroeconomic volatility and the size of the credit market.

9 References

1. Aghion, P., Abhijit B. and T. Piketty, (1999), Dualism and MacroeconomicActivity, Quarterly Journal of Economics 114, 1359-1397.

2. Aghion, P., Philippe B. and A. Banerjee, (2003), Financial Development and the Instability of Open Economies, Journal of Monetary Economics, 1077-1106.

3. Aghion, P., G.M. Angeletos, A. Banerjee and K. Manova, (2005), Volatility and Growth: Credit Constraints and Productivity-Enhancing Investment, mimeo.

4. Aiyagari, S.R, (1994),Macroeconomics with Frictions, Federal Reserve Bank of Minnesota Quarterly Review, vol.18,n.3.

5. Aizenman, J., (1997), Capital markets integration, volatility and persistence. Journal of Macroeconomics19, 217–236.

6. Aizenman, J., and A. Powell, (1997), Volatility and Financial Intermediation. NBER Working Paper 6320.

7. Andrade, G., Mitchell M., and Erik Stafford, (2001), New Evidence and Perspective on Mergers. Journal of Economic Perspectives, 15, 103-120.

8. Arias, A. Hansen G.D. and L.E. Ohanian, (2004), Why have Business Cycle Fluctuation Become less Volatile?, mimeo.

9. Aoki, K., Proudman J. and J. Vlieghe, (2001), Houses as Collateral: Has the Link between House Prices and Consumption Changed?, mimeo, Bank of England.

10. Bandiera, O.,Gerard C., (1998), Honoan P.,and F.Schiantarelli, Does Financial Reform Raise or Reduce Savings?, mimeo.

11. Baxter, M., (1996), Are Consumer Durables Important for Business Cycles?, Review of Economics and Statistics 78, 147-155.

12. Beck, T., Levine, R. and Loayza, N., (1999), Finance and the sources of growth. World Bank Policy Research Working Paper no. 2057.

13. Bekaert, G. Campbell R. H. and C. Lundblad, (2004), Growth Volatility and Financial Liberalization, nber wp. 10560.

14. Bencivenga, V. R., and B. D. Smith, (1993), "Some Consequences of Credit Rationingin an Endogenous Growth Model." Journal of Economic Dynamics and Control 17 (January-March 1993), 97- 122.

15. Benhabib, J, and A. Rustichini, (1991), Vintage capital, investment and growth, Journal of Economic Theory 55, 323-339.

16. Benhabib, J., Perli R. and P. Sakellaris, (2005), Persistence of Business Cycles in Multisecors RBC Models, mimeo.

17. Bernanke, B. S., (1984), Permanent Income, Liquidity, and Expenditure on Automobiles: Evidence From Panel Data, Quarterly Journal of Economics, 99 (3), 587-614.

18. Bernanke, B. S., and Mark Gertler, (1989), Agency Costs, Net Worth and Business Fluctuations, American Economic Review, 79, March, 14-31.

19. Bernanke, B., Gertler, M., Gilchrist, S., (1998), The financial accelerator in a quantitative business cycle framework. NBER Working Paper 6455.

20. Blanchard, O.J. and J. Simon, (2000), The Long and Large Decline in U.S. Output Volatility, Brookings Papers on Economic Activity, 1, 135-147.

21. Boivin, J. and M. Giannoni, (2002), Has Monetary Policy Become Less Powerful?, Columbia Business School, mimeo.

22. Campbell, J. R. and Z. Hercowitz, (2004), The Role of Collateralized Household Debt in Macroeconomic Stabilization, nber wp 11330.

23. Canova, F., (2004), Monetary Policy and the evolution of the Us economy: 1948-2002, mimeo.

24. Canova, F. and L. Gambetti, (2004), Structural Changes in the US Economy: Bad Luck or Bad Policy, mimeo.

25. Carroll, C. D. and A. A. Samwick, (1997), The nature of precautionary wealth. Journal of Mon-etary Economics 40, 41-71.

26. Young, C.E., Ramey,V. A. and R. A. Starr, (1995), Liquidity constraints and intertemporal consumer optimization: Theory and evidence from durable goods," Journal of Money, Credit and Banking 27, 272-287.

27. Clarida, R., Gali J. and M Gertler, (2000), Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory, The Quarterly Journal of Economics, 147-180.

28. Cogley, T. and T.J. Sargent, (2001), Evolving Post-World War II U.S. Inflation Dynamics", NBER Macroeconomic Annual, 16.

29. Cogley, T. and T.J. Sargent, (2003), Drifts and Volatilities: Monetary Policies and Outcomes in the Post WWII U.S., New York University, mimeo.

30. Cooley, T. and E. Prescott, Economic Growth and Business Cycles, (1995), in T.Cooley ed., Frontiers of Business Cycle Research (Princeton: Princeton University Press, 1995), 1-38.

31. Cooley, T. F. and V. Quadrini, (1998), Financial markets and firm dynamics. Mimeo, Universitat Pompeu Fabra.

32. Cordoba, J.C and M.Ripoll, (2004), Credit Cycles Redux, forthcoming, International Economic Review.

33. Davis, N. and J. Heathcote, (2005), Housing and the Business Cycle, International Economic review, 751-784.

34. Denizer, C. , Murat Iyigun and A.Owen, (2002), Finance and Macroeconomic Volatility, Contributions to Macroeconomics, Vol. 2: No. 1, Article 7.

35. Driscoll, M., (1991), Deregulation, Credit Rationing, Financial Fragility and Economic Performance, OECD wp 977.

36. Eistfeld, A. and A.A.Rampini, (2005), Capital reallocation and Liquidity, forthcoming, Journal of Monetary Economics.

37. Eistfeld, A. and A.A.Rampini, (2005), New or Used? Investment with Credit Constraints, mimeo.

38. Englund, P., (1996), Loan-to-Value Ratios in Sweden, Scandinavian Housing & Planning Research 13.

39. Fernández-Villaverde, J. and D. Krueger, (2002), Consumption and Saving over the Life-Cycle: How Important are Consumer Durables?, in Proceedings of the North American Summer Meetings of the Econometric Society:Macroeconomic Theory, 2002.

40. Freeman, S. and F. E. Kydland (2000). Monetary aggregates and output,. American Economic Review 90(5), 1125-1145.

41. Gertler, M. (1988), Financial Structure and Aggregate Economic Activity: an Overview,Journal of Money, Credit and Banking, vol.20.

42. Gomme, P., F. Kydland, and P. Rupert, (2001), Home Production Meets Time to Build, Journal of Political Economy 109, 1115-1131.

43. Greenwood, J. and Z. Hercowitz, (1999), The Allocation of Capital and Time over the Business Cycle, Journal of Political Economy 99, 1188-1214.

44. Greenwood, J. , Hercowitz, Z. and P. Krusell, (2000), The Role of Investment-Specific Technological Change in the Business Cycle, European Economic Review 44, 91-115

45. Greenwood, J., R. Rogerson, and R. Wright, (1995), Household Production in Real Business Cycle Theory, in T. Cooley ed., Frontiers of Business Cycle Research (Princeton: Princeton University Press), 157-174.

46. Hanson, M. (2001), Varying Monetary Policy Regimes: a Vector Autoregressive Investigation, Wesleyan University, mimeo.

47. Hodrick, R. J., and E. C. Prescott, (1997), Postwar U.S. Business Cycles: An Empirical Investigation, Journal of Money, Credit and Banking 29, 1-16.

48. Hubbard, R.G., (1997), Capital-Market Imperfections and Investment. NBER Working Paper 5966.

49. Hull L., (2003), Financial Deregulation and Household Indebtedness, DP 2003/01, Reserve Bank of New Zealand.

50. Iacoviello, M., (2005), House Prices, Borrowing Constraints and Monetary Policy in the Business Cycle, American Economic Review, 739-764.

51. Iacoviello, M. and R. Minetti, (2005),International Business Cycles with Domestic and Foreign Lenders , forthcoming Journal of Monetary Economics.

52. Jappelli, T., and M. Pagano (1989), "Aggregate consumption and capital market imperfections: an international comparison", American Economic Review, December, 79, 5, 1088-1105.

53. Jappelli, T., and M. Pagano, (1998), The Determinants of Saving: Lessons from Italy, CSEF working paper.

54. Jovanovic, B., and P. L. Rousseau, (2002), The Q-Theory of Mergers, American Economic Review Papers and Proceedings 91(2), 336-41.

55. Karras, G., and F. Song, (1996), Sources of business-cycle volatility: an exploratory study on a sample of OECD countries, Journal of Macroeconomics 18, 621–637.

56. Kask, J., (2003), Household Debt and Finacial Stability, Kroon&Economy n 4.

57. King, R, and R. Levine, (1993), Finance and Growth: Schumpeter Might Be Right, Quarterly Journal of Economics 108, 717-737.

58. Kiyotaki, N., (1998), Credit and Business Cycles, The Japanese Economic Review,vol.49, n.1.

59. Kyiotaki, N. and J. Moore, (1997), Credit Cycles, Journal of Political Economy, 211-248.

60. Klein, P., (2000),Using the Generalized Schur Form to Solve a Multivariate Linear Rational Expectations Model, Journal of Economic Dynamics and Control 24, 1405-1423.

61. Kocherlakota, N.R., (2000), Creating Business Cycles Through Credit Constraints, Federal Reserve Bank of Minneapolis Quartely Review, vol 24, n.3.

62. Larrain, B., (2003), Financial Development, Borriwing Constraints and the Volatility of Industrial Production, mimeo.

63. Levine, R., (1997), Law, Finance, and Economic Growth. University of Virginia, mimeo.

64. Levine, R. (1997), Financial Development and Economic Growth: Views and Agenda, Journal of Economic Literature 35, 688-726.

65. Levine, R., Thorsten B., and A. Demirguc-Kunt, (2001), A New Database on the Structureand Development of the Financial Sector, World Bank Economic Review.

66. Levine, R., Loyaza, N. and T. Beck (2000), Financial Intermediation and-Growth: Causality and Causes, Journal of Monetary Economics 46, 31-77.

67. Long, J. and C. Plosser, (1983), Real Business Cycles, Journal of Political Economy, 91, 39-69.

68. Ma, C.H. and Smith, B. D., (1996), Credit market imperfections and economic development: theory and evidence. Journal of Development Economics, 48, 351-387

69. Maksimovic, V. and G. Phillips, (1998), Asset Efficiency and Reallocation Decisions of Bankrupt Firms, Journal of Finance 53, 1619-1643.

70. McConnell, M. and Perez Quiroz, G., (2000), Output fluctuations in the US: what haschanged since the early 1980s?, American Economic Review, 90, 1464-1476.

71. McKinnon, R., (1973), Money and Capital in Economic Development. Brookings Institution, Washington,DC.

72. Mercer Oliver Wyman, (2003), Study on the Financial Integration of European Mortgage Markets.

73. Miles D., (1992), Housing Markets, Consumption and Financial Liberalization in the Major Economies, European Economic Review, 36, 1093-1127 .

74. Minsky, H., (1986), Stabilizing an Unstable Economy. Yale University Press, New Haven.

75. Minshkin, F., (2000), Financial Stability and the Macroeconomy, WP 9, Central Bank of Iceland.

76. Ortalo-Magné, F. and S. Rady, (2001), Housing Market Dynamics: On the Contribution of Income Shocks and Credit Constraints, CEPR Working Paper 3015.

77. Pagano, M., (1993), Financial markets and growth: an overview. European Economic Review, 37, 613-622

78. Poterba, J., (2000), Stock Market Wealth and Consumption, Journal of Economic Perspectives, 14, Spring, 99-118.

79. Quadrini V. and U. Jerman (2005), Financial Development and Macroeconomic Stability, mimeo.

80. Rajan, R., (1994), Why bank credit policies fluctuate: a theory and some evidence. Quarterly Journal ofEconomics 109, 399–441

81. Ramey, G., and V. Ramey (1995), Cross-Country Evidence on the Link BetweenVolatility and Growth, American Economic Review 85, 1138-51.

82. Ramey V.A. and M.D. Shapiro, (1998a), Capital Churning, mimeo.

83. Ramey, V. A., and M. D. Shapiro, (1998b), Costly Capital Reallocation and the Effects of Government Spending, Carnegie-Rochester Conference Series on Public Policy 48, 145-94.

84. Rampini, A. A., (2003), Entrepreneurial Activity, Risk, and the Business Cycle, Working Paper.

85. Sims, C., (2001), Comment to Evolving post WWII US inflation dynamics, NBER Macroeconomic Annual, 16.

86. Sims, C.A. and T. Zha, (2004), Were there Regime Switches in US Monetary Policy,Federal Reserve Bank of Atlanta, working paper 2004 -14.

87. Stock, J., and M. Watson, (1998), Business cycle fluctuations in US macroeconomic time series, NBER Working Paper 6528.

88. Stock, J. and M. Watson, (2003), Understanding Changes in Business Cycle Dynamics, Harvard University, mimeo.

89. Suarez, J., and O. Sussman, (1997), Endogenous cycles in a Stiglitz–Weiss economy, Journal of Economic Theory 76, 47–71.

90. Uhlig, H., (1995), A toolkit for analyzing nonlinear dynamic stochastic models easily, Institute for Empirical Macroeconomics DP 101.

91. Vlieghe G.W., (2003), Imperfect Credit Markets and the Transmission of Macroeconomic Shocks: A Simple Framework, mimeo lse.

92. Watson, M., (1994), Business-cycle durations and postwar stabilization of the US economy, American Economic Review 84, 24–46.

93. Weinberg, J., (1995), Cycles in lending standards, Federal Reserve Bank of Richmond Economic Quarterly 81, 1–18

94. Wited,T., (1992), Debt, Liquidity Constraint, and Corporate Investment: Evidence from Panel Data, Journal of Finance, XLVII, 4.

Table 1.a: Correlation Matrix - data

	σ(y)	σ(I)	σ(c)	*credit*	$credit_{t-1}$
σ(y)	1				
σ(I)	0.7145	1			
σ(c)	0.6773	0.6026	1		
credit	-0.3244	-0.2992	-0.2353	1	
$credit_{t-1}$	-0.4339	-0.3843	-0.2807	0.9908	1

σ(y),σ(I), σ(c), standard deviation of respectively detrended log real output, investment and consumption. *credit* stands for credit to the private sector as a share of gdp, is the ratio at the beginning of the period (1983:1). Data on 22 OECD countries. Source: OECD.

Table 1.b: Mean Equality Test - data

5-years	σ(y)	σ(c)	σ(I)	σ(Ih)
credit $<$ *median* *vs* *credit* $>$ *median*	**.4485** (.13485)	.00291 (.0021)	**.0208** (.0069)	**.0208** (.0069)

σ(y),σ(I), σ(Ih),σ(c), standard deviation of respectively detrended log real output, investment, investment in residential properties and consumption. *credit* stands for credit to the private sector as a share of gdp, ratio at the beginning of the period (1983:1), 5 percent significant coefficients in bold. Data on 22 OECD countries. Source: OECD.

tab 6.b Credit and Output Volatility, IV, 2SLS

$credit_t$	**-.1832959**	-*.1328753*	
	(.0674018)	(.0683903)	
σ(sol)		**.1599957**	**.5206834**
		(.0806794)	(.1981169)
σ(R)		**.1711271**	.1426517
		(.086914)	(.0912565)
cr*sol			**-.161091**
			(.0804824)
c	**1.742073**	**1.197494**	**.9640533**
	(1889492)	(.2610167)	(.1984586)
Sargan	0.4838	0.7142	0.9456
Countries	22	22	22
obs	154	154	154
Period	1983-04	1983-04	1983-04

Instruments for the Size of the Credit Market:
- Lagged level of Credit to the Private Sector as a Share of Gdp.
- Creditor Rights [La Porta et al. (98), La Porta et al (05)]

Table 2: Parameter Values

preferences		**shock process**	
discount rate	$\beta_1 = 0.99$	autocorrelation	$\rho_z = 0/0.95$
	$\beta_2 = 0.95$	variance	$\sigma_z = 0.0056$
	$\theta = 3.3$		
technology			
	$\alpha = 0.36$	**borrowing limit**	$\gamma \in [0, 1]$
depreciation rate	$\delta = 0.03$	**population**	$n = 0.5$

Table 3.a: amplification effect first and second impact of shocks

Reproducible Capital

		$\gamma = 1$	$\gamma\epsilon[0,1]$	$\gamma\epsilon[0.4, 0.85]$
total production	first impact	0.027	$[0.362, 0.027]$	$[0.318, 0.17]$
	second impact	0.37	$[0.40, 0.26]$	
investment goods	first impact	0.04	$[0.75, 0.04]$	$[0.62, 0.03]$
	second impact	0.56	$[-0.394, 0.72]$	
consumption goods	first impact	-0.01	$[-0.2, -0.01]$	$[-0.18, -0.01]$
	second impact	-0.19	$[-0.045, -0.19]$	

Intensity of reaction to a 1% shock in productivity with autocorrelation =0.95. Amplification in the firstand second impact on output, consumption and investment goods. Percent unit.

Table 3.b: amplification effect – simulations

Reproducible Capital $\gamma\epsilon[0.4 - 0.85]$, $\sigma(\epsilon) = 0.56$

	ρ_z= 0.95 ,$\sigma(z) = 1.79$	ρ_z= 0 , $\sigma(z) = \sigma(\epsilon)$
$\sigma(Y)/\sigma(z)$	$[0.5356 - 0.4940]$	$[1.3453 - 1.1998]$
$\sigma(I)/\sigma(z)$	$[0.6603 - 0.5549]$	$[1.7481 - 1.4054]$
$\sigma(C)/\sigma(z)$	$[0.3305 - 0.3567]$	$[0.6924 - 0.8206]$

$\sigma(y)/\sigma(z)$ is the ratio between the standard deviation of output, consumption and investment goods in the simulated series generated trough the model and the standard deviation of the shock. Lenght of the simulated series 20 years, number of simulated series for the calculation of moments 1000.

Table 3.c: Mean Equality Test simulations

5-years	σ(y)	σ(c)	σ(I)
credit < *median* *vs* *credit* > *median*	**.12636** (.00818)	**−.08957** (.00748)	**.13338** (.00835)

σ(y),σ(I), σ(c),standard deviation of respectively detrended log real output, investment, and consumption. *credit* stands for credit to the private sector as a share of gdp, ratio at the beginning of the period (1983:1), 5 percent significant coefficients in bold.

Table 4: Output Volatility: Actual Data vs Simulated Series

DATA				Simulation
	credit / γ	$\sigma(solow)$	$\sigma(output)$	$\sigma^{sim}(output)$
DEU	2.7829213 0.800875	0.9175	**1.161915**	1.1200 (.0864) [1.0336 − 1.2065]
ESP	1.4483340 [0.541954]	0.8115	**1.153786**	1.0845 (0.0934) [0.9911 − 1.1779]
UK	2.2465514 [0.711735]	0.5374	1.112685	0.6539 (0.0521) [0.6018 − 0.7061]
IRE	1.5295126 [0.5618406]	1.4025	**1.79738**	1.7618 (0.1395) [1.6223 − 1.9014]
IT	2.2676677 [0.715556]	0.6174	**0.842011**	0.8036 (0.0651) [0.7385 − 0.8687]
SWE	2.2717095 [0.716292]	0.8350	1.295511	1.0768 (0.0887) [0.9896 − 1.1639]
US	3.3126851 [0.875168]	0.5513	0.969275	0.6676 (0.0568) [0.6048 − 0.7209]

Table 5: Credit and Output Volatility.

	Pooled Regression	Country Fixed Effect	Time Fixed Effect	Fixed Effect
credit	**-0.46003** (0.02284)	**-0.76518** (0.23833)	**-0.44495** (0.06185)	**-1.20046** (0.40714)
c	**2.23392** (0.13769)	**2.87908** (0.56633)	**2.20203** (0.13076)	**3.95013** (0.91433)
R^2	0.188302	0.388818	0.405306	0.446425
Countries	22	22	22	22
obs	88	88	88	88
Period	1983-04	1983-04	1983-04	1983-04

Dependent Variable, σ(y), standard deviation detrended log real output. Panel regressions based on5-year non-overlapping averages. White-type robust standard errors in parenthesis, 5 and 10 per cent significant coefficients respectively in bold and italics

Table 6: Credit and Output Volatility. Fixed Effects

credit	**-1.20046**	**-0.66897**		**-0.77225**	
	(0.40714)	(0.32778)		(0.25953)	
σ(solow)		**0.571645**	**0.731025**	**0.558278**	**0.757494**
		(0.147120)	(0.135090)	(0.142069)	(0.161547)
σ(interest rate)		*0.10605*	**0.15790**	*0.08656*	**0.14546**
		(0.06158)	(0.02536)	(0.04668)	(0.01584)
σ(terms of trade)				**6.74460**	**6.84469**
				(2.22843)	(2.31439)
σ(price)				-0.54431	-0.44162
				(0.39367)	(0.42719)
credit*solow			**-0.0765309**		**-0.0973101**
			(0.0177231)		(0.0305728)
c	**3.95013**	**2.10109**	**0.53787**	**2.25847**	**0.44981**
	(0.91433)	(0.93910)	(0.13736)	(0.74498)	(0.11740)
R^2	0.446425	0.686156	0.677566	0.697561	0.686830
Countries	22	22	22	20	20
obs	88	88	88	80	80
Period	1983-04	1983-04	1983-04	1983-04	1983-04

Dependent Variable, σ(y), standard deviation detrended log real output. Panel regressions based on 5-year non-overlapping averages. Country and time-fixed effects included. White-type robust standard errors in parenthesis, 5 and 10 per cent significant coefficients respectively in bold and italics

Table 7: Credit and Investment Volatility

credit	**-0.19461**	**-0.13391**	
	(0.02448)	(0.02559)	
σ(solow)		**0.147491**	**0.257916**
		(0.060136)	(0.117498)
σ(interest rate)		**0.04784**	**0.06278**
		(0.02186)	(0.01689)
credit*solow			*-0.0501575*
			(0.0275573)
c	**0.94148**	**0.60024**	**0.28338**
	(0.05474)	(0.06798)	(0.07951)
R^2	0.256682	0.382261	0.346563
Countries	..18	..18	..18
obs	..72	..72	..72
Period	..1983-04	..1983-04	..1983-04

Dependent Variable, σ(investment) standard deviation of investment. Panel regressions based on 5-year non-overlapping averages. White-type robust standard errors in parenthesis, 5 and 10 per centsignificant coefficients respectively in bold and italics

Table 8: Credit and Consumption Volatility

credit	**-0.14152**	-0.07338	
	(0.08049)	(0.05638)	
σ(solow)		**0.057096**	0.034932
		(0.028307)	(0.021784)
σ(interest rate)		*0.01220*	**0.02457**
		(0.00611)	(0.00928)
credit*solow			**0.0176638**
			(0.0054706)
c	0.43238	0.21544	**0.02288**
	(0.17414)	(0.13739)	(0.00468)
R^2	0.582360	0.624378	0.623435
Countries	20	20	20
obs	80	80	80
Period	1983-04	1983-04	1983-04

Dependent Variable, σ(consumption), standard deviation detrended log real consumption. Panel regressions based on 5-year non-overlapping averages. White-type robust standard errors in parenthesis, 5 and 10 per cent significant coefficients respectively in bold and italics

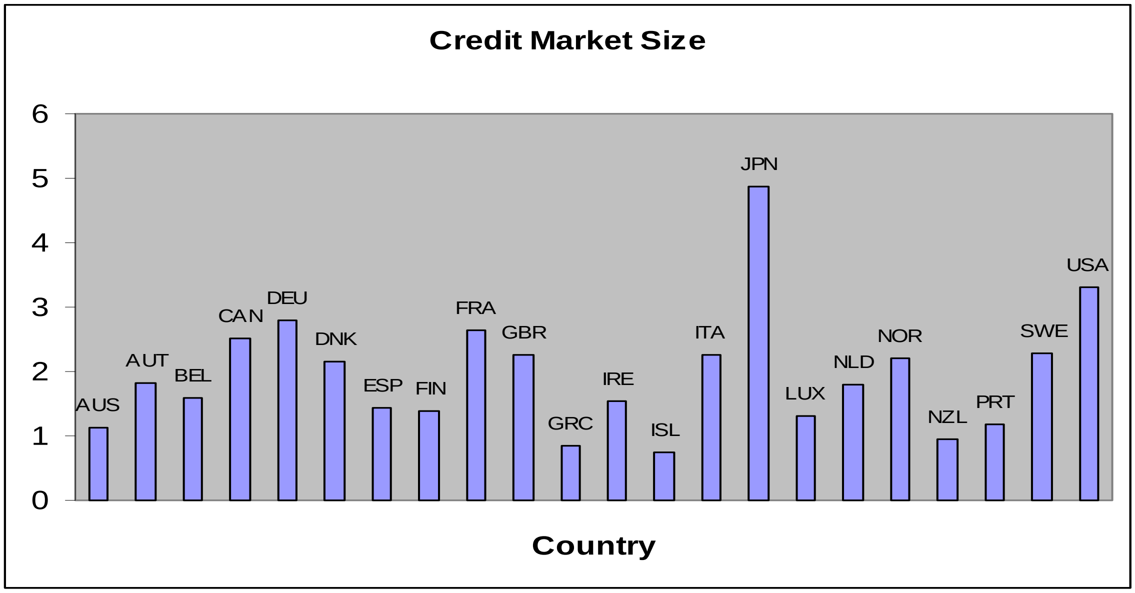


Figure 1: size of the credit market measured by the credit to the private sector as a share of gdp over the time period 1983-2004.

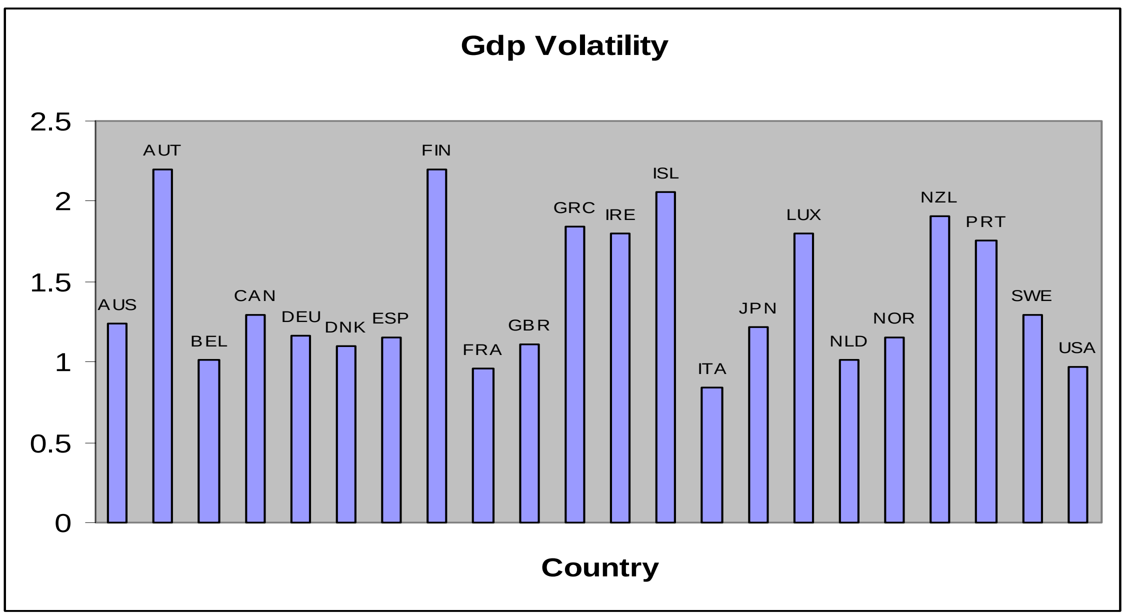


Figure 2 volatility of output measured as the standard deviation of the log detrended real output over the time period 1983-2004.

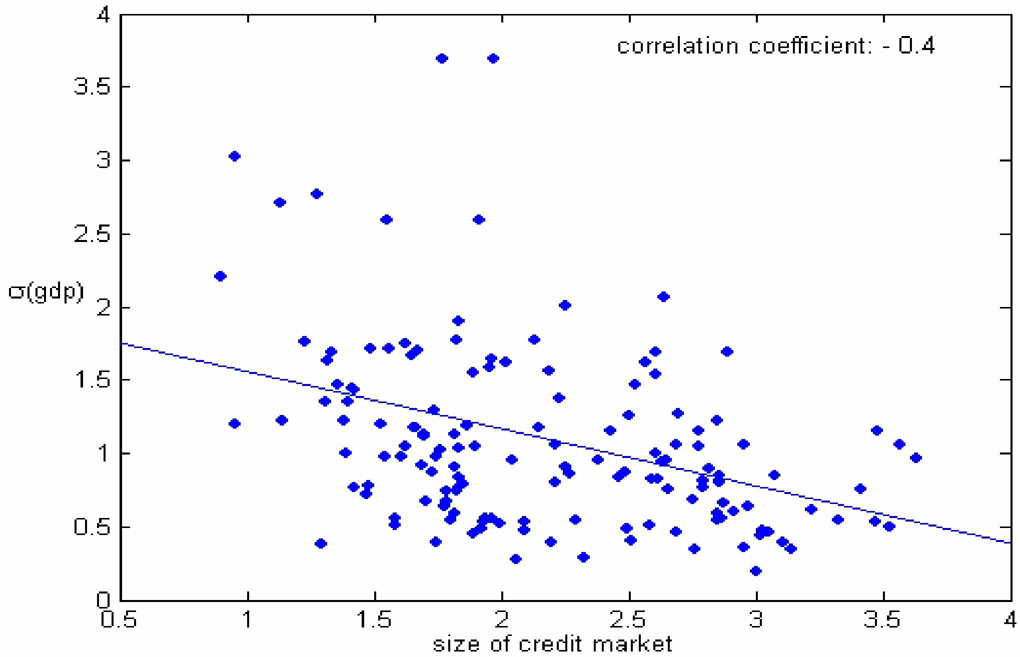


Figure 3 plots the measure of credit market development against the measure of business cycle volatility. Output's standard deviations as well as the average of private credit as a share of Gdp are calculated on quarterly data for 5 non-overlapping years.

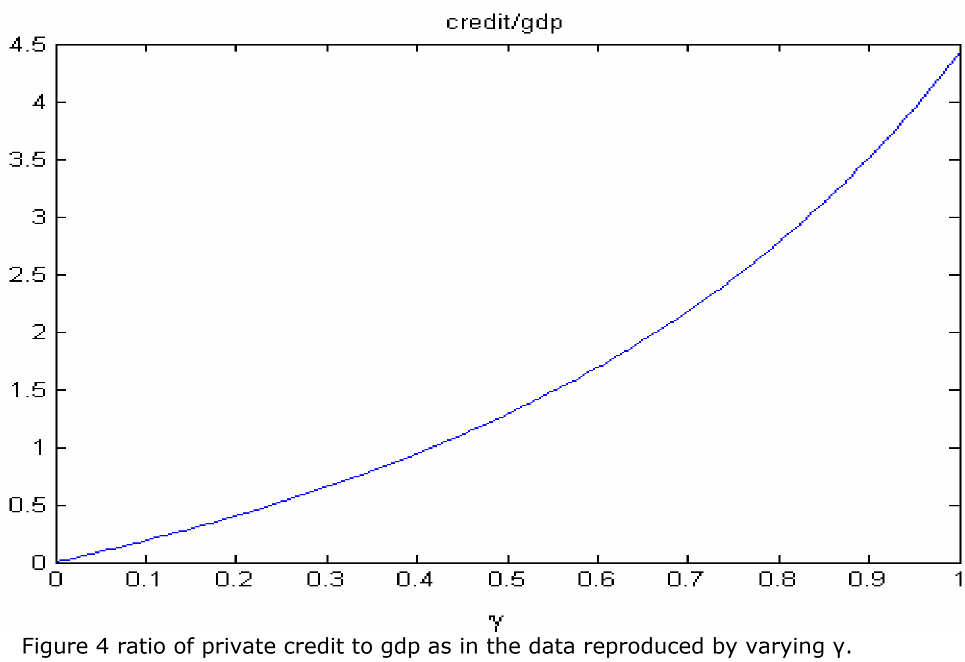


Figure 4 ratio of private credit to gdp as in the data reproduced by varying γ.

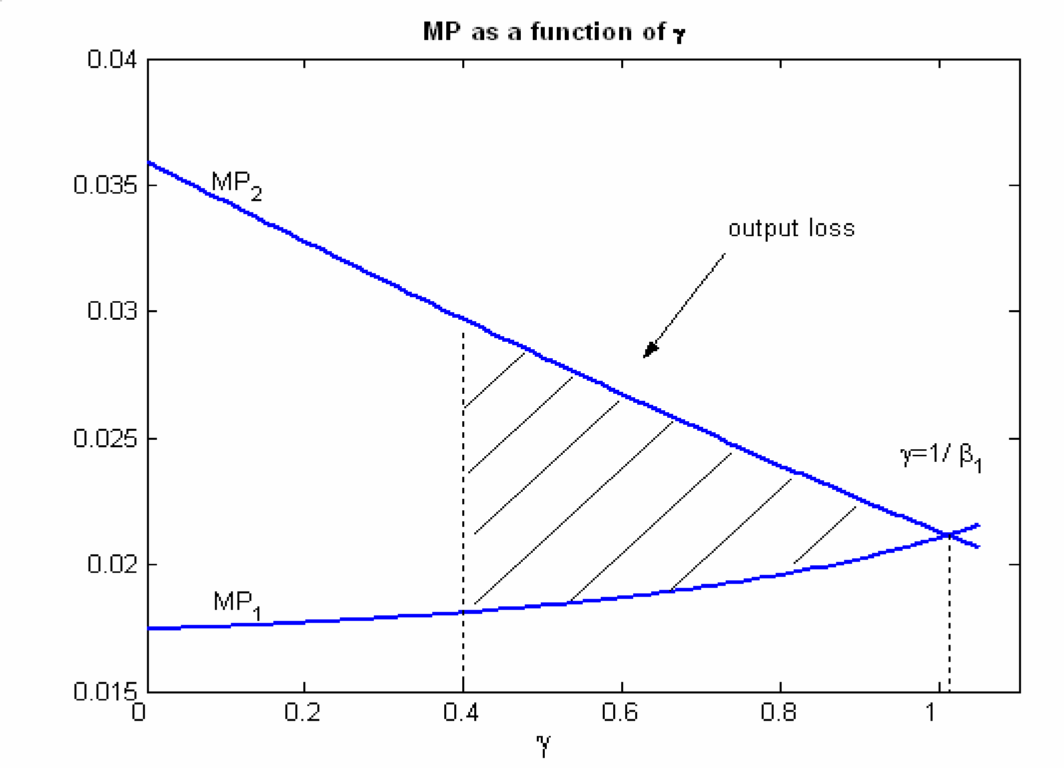


Figure 5a shows how the steady state productivity gap in total production between the two groups of agents varies with respect to γ.

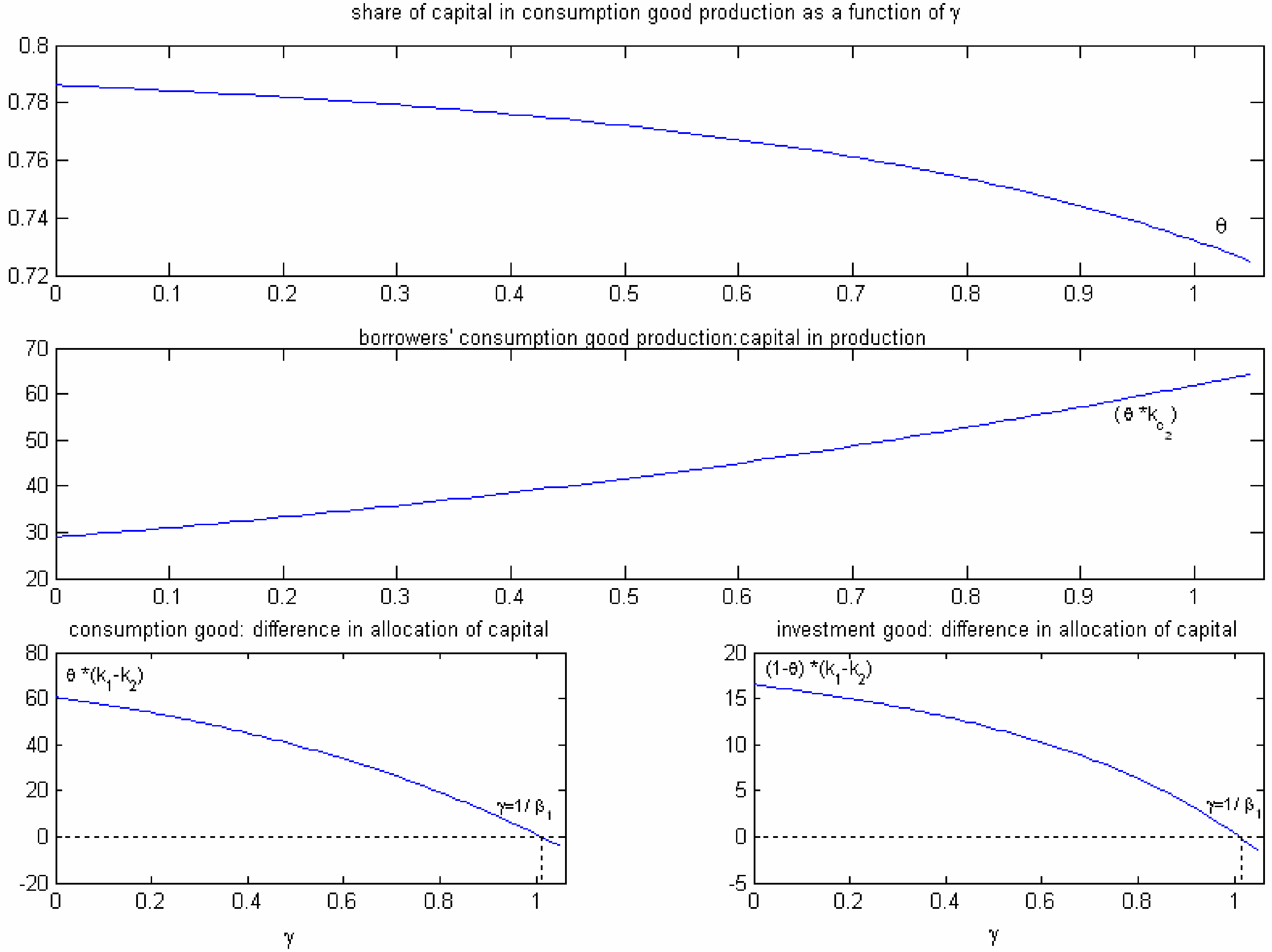


Figure 5.b capital assigned to the production of both consumption and investment goods by the two groups of agents.

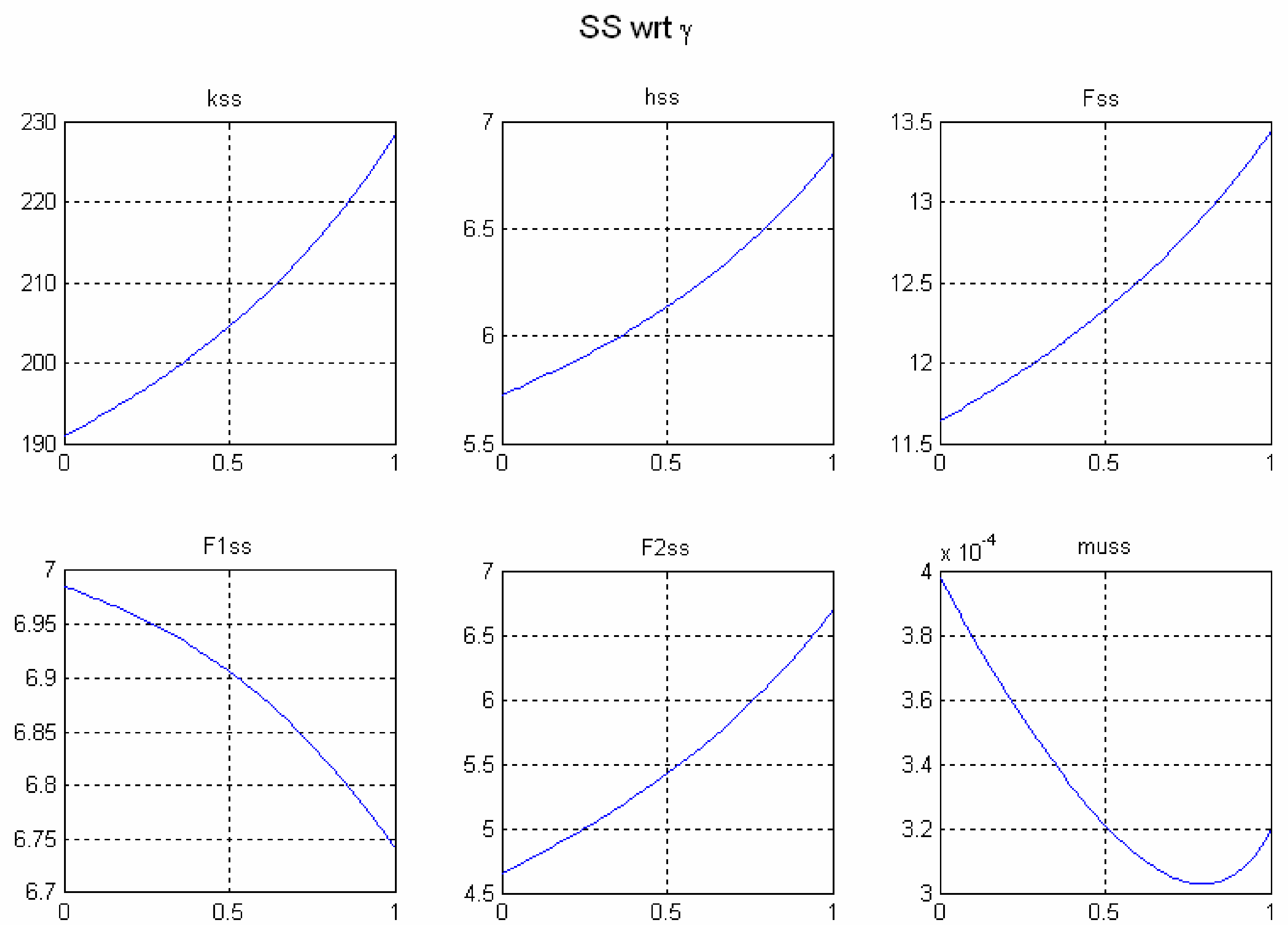


Figure 6a show how the steady state values of the model's variables change with respect to the degree of credit market development.

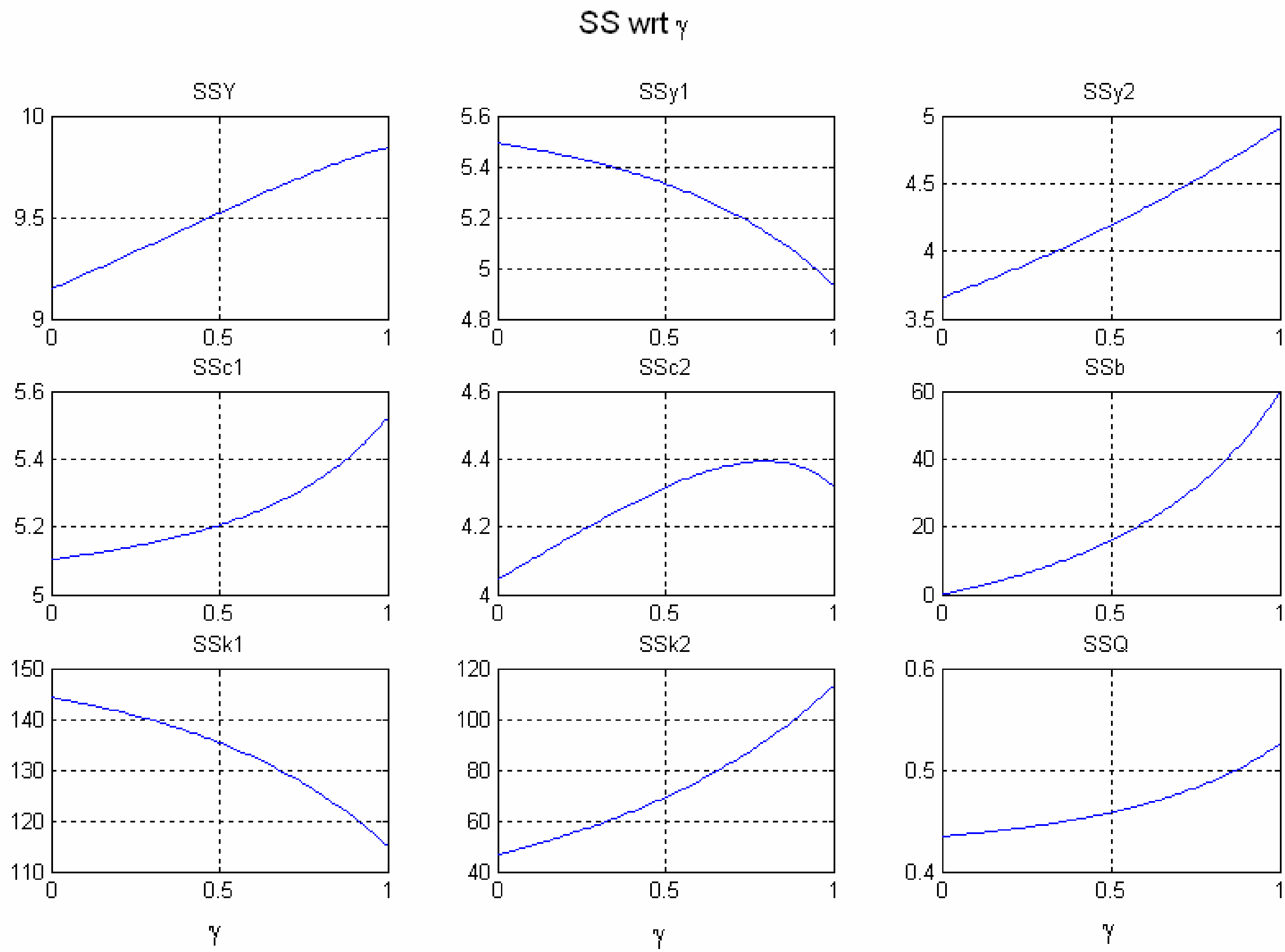


Figure 6b show how the steady state values of the model's variables change with respect to the degree of credit market development.

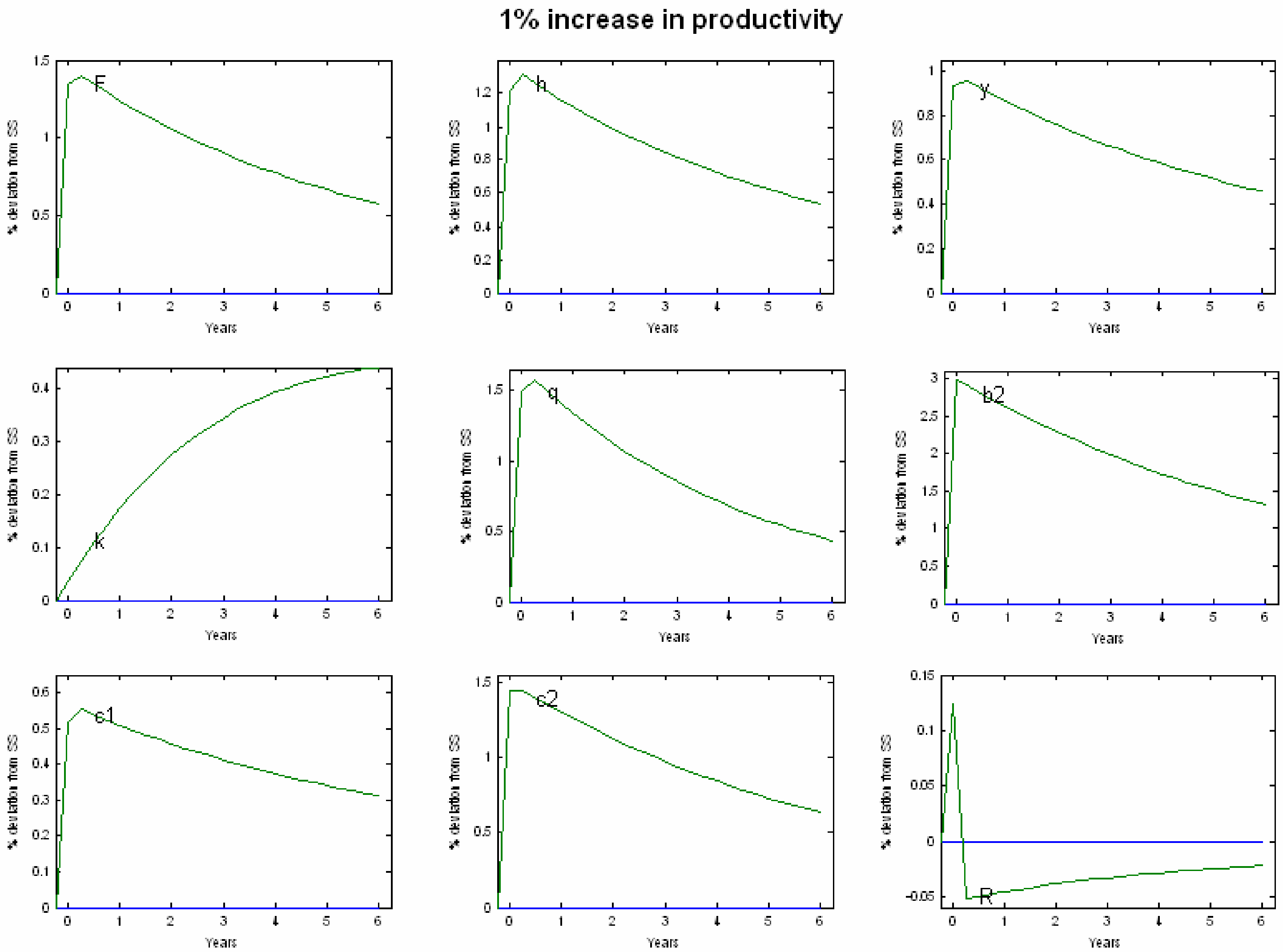


Figure 8.a responses of the model economy to an unexpected 1% increase in aggregate productivity.The units on the vertical axes are percentage deviations from the steady state, while on the horizontal axes are years.

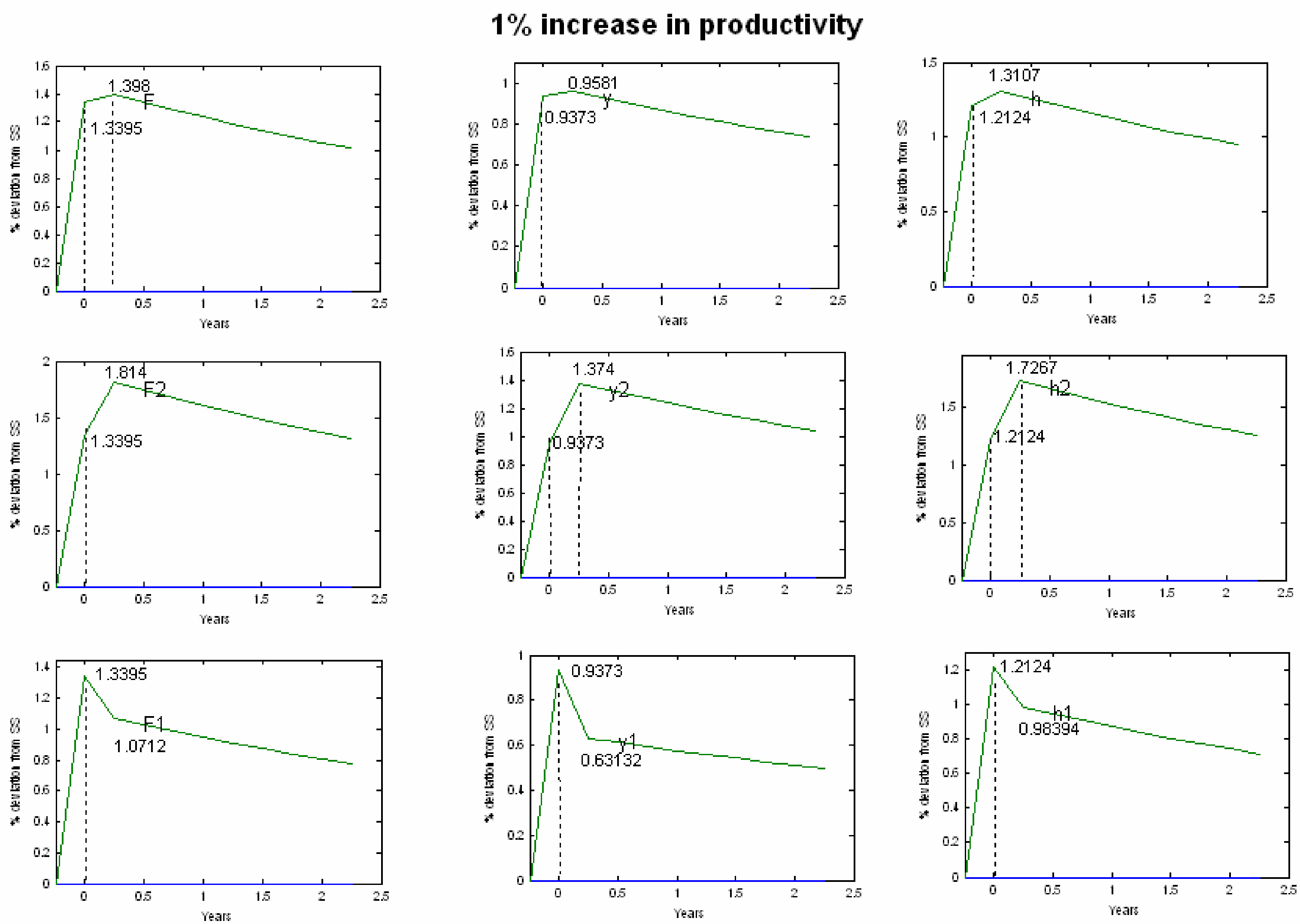


Figure 8b responses of the model economy to an unexpected 1% increase in aggregate productivity. The units on the vertical axes are percentage deviations from the steady state, while on the horizontal axes are years.

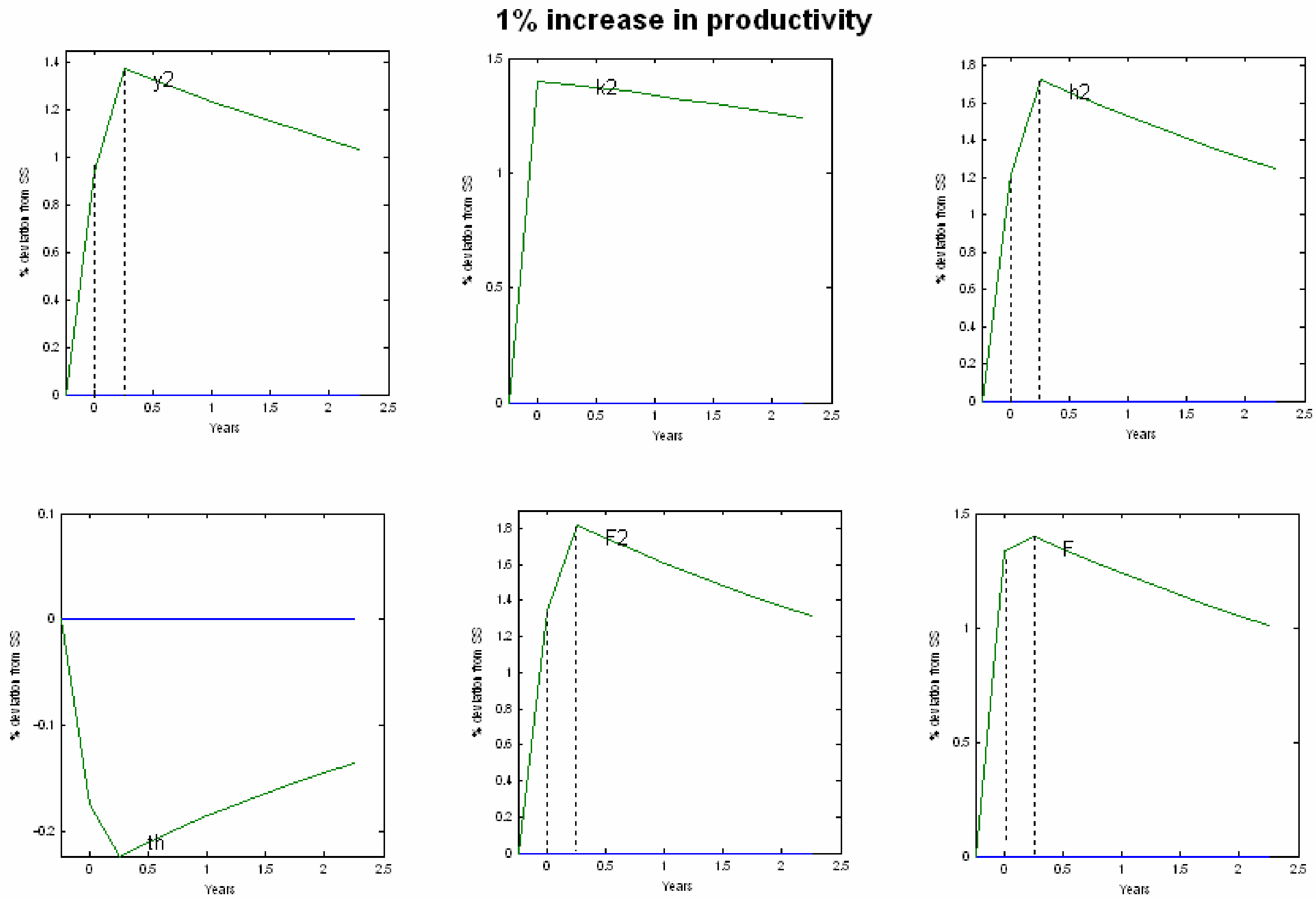


Figure 8c responses of the model economy to an unexpected 1% increase in aggregate productivity. The units on the vertical axes are percentage deviations from the steady state, while on the horizontal axes are years.

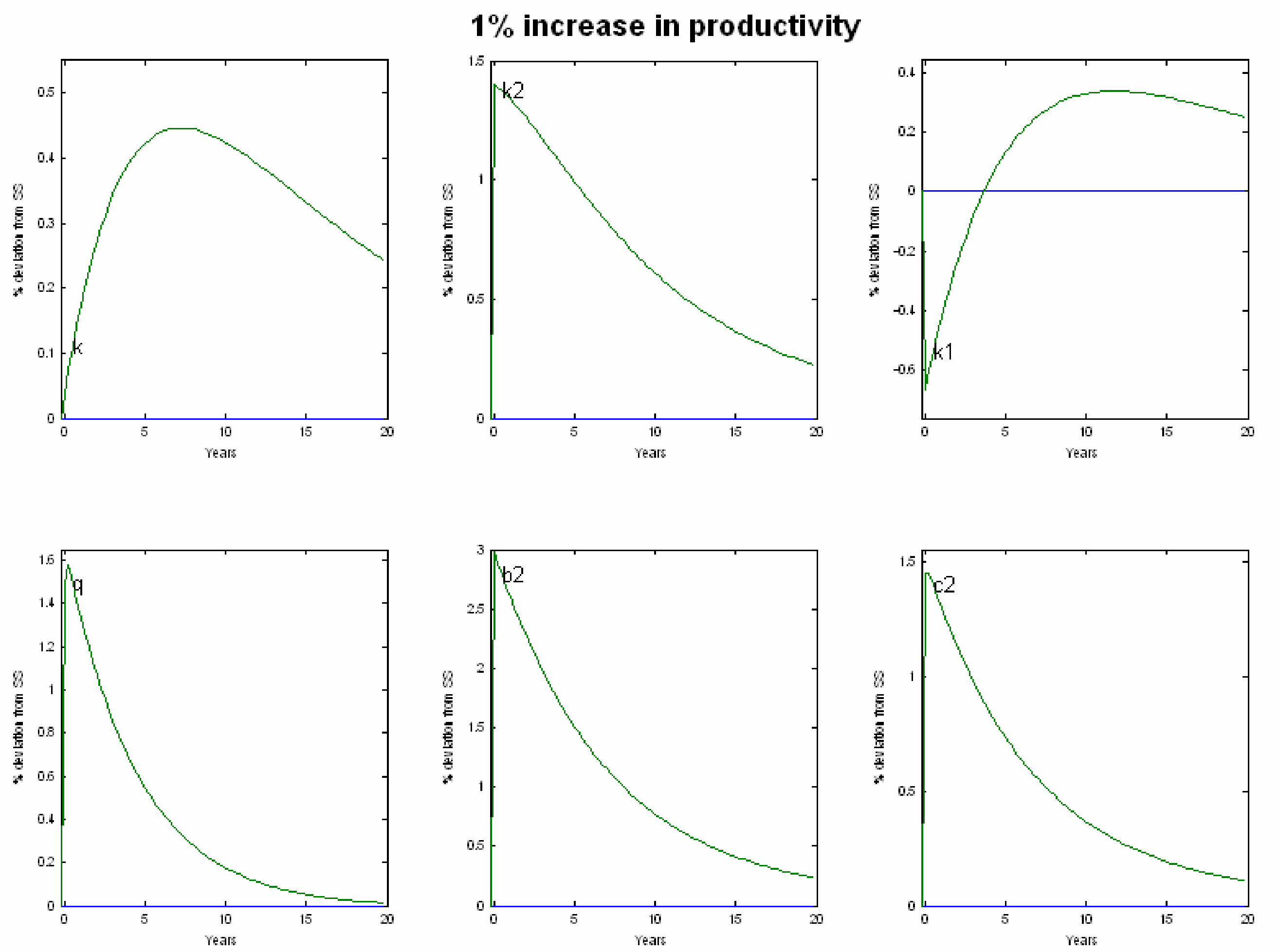
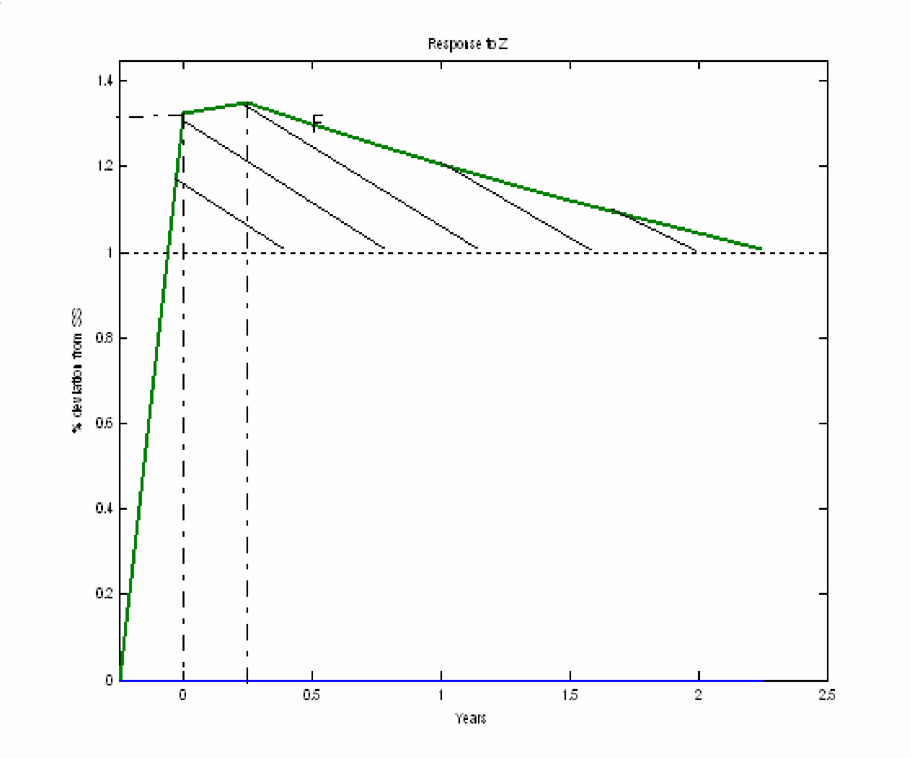


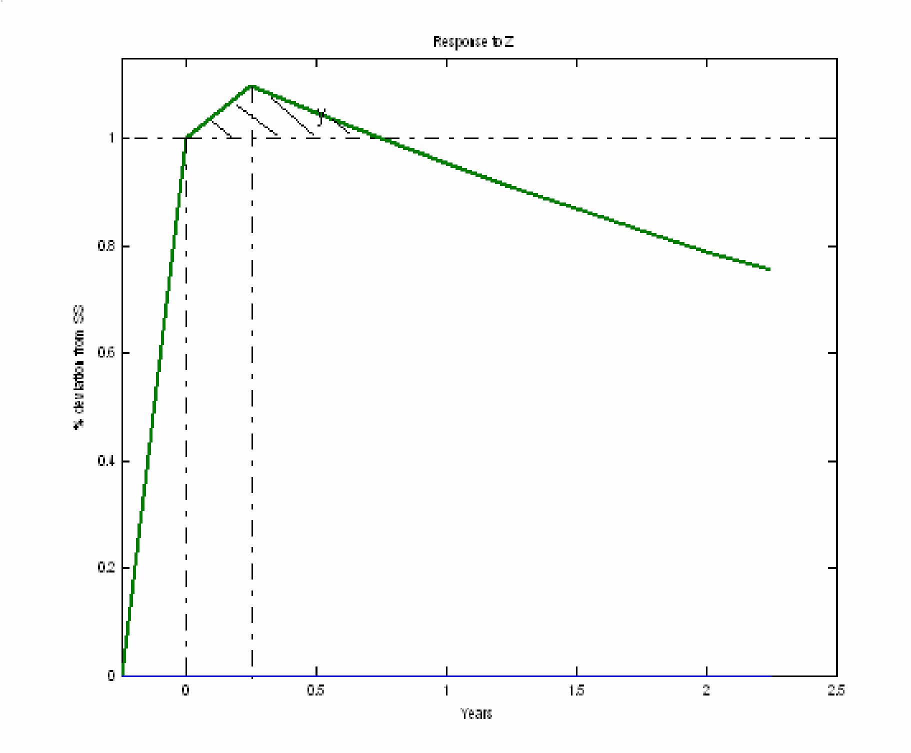
Figure 8d responses of the model economy to an unexpected 1% increase in aggregate productivity. The units on the vertical axes are percentage deviations from the steady state, while on the horizontal axes are years.

One-sector vs Two-sector model

Two- sector



One-sector



$$F_t = Z_t k^{\alpha}_{t-1} (\theta^{\alpha} + q_t (1-\theta)^{\alpha})$$

$$Y_t = Z_t k_{t-1}^{\alpha}$$

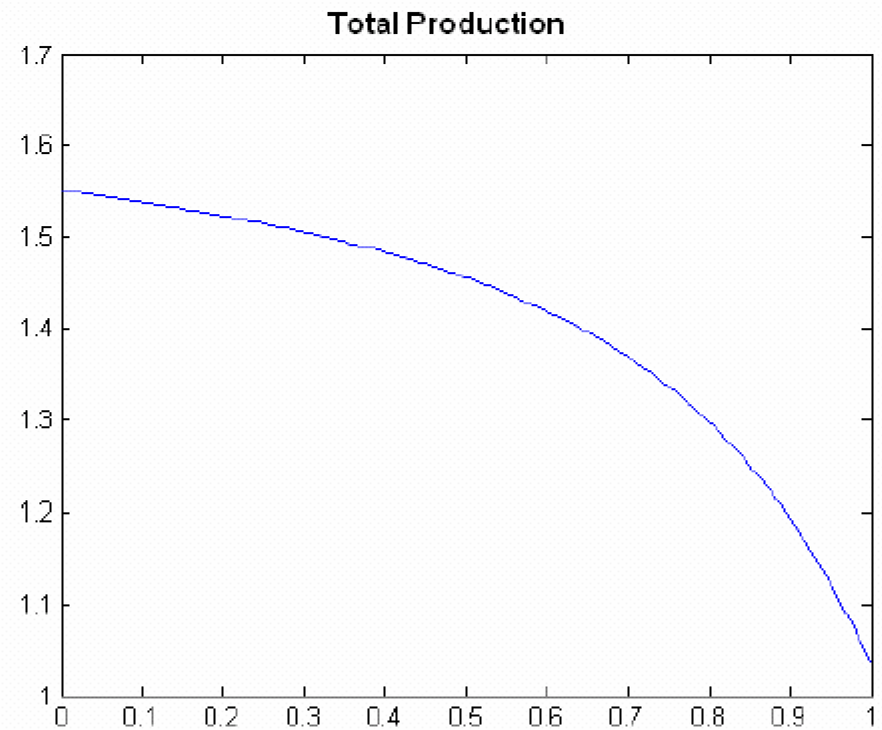


Figure 9. a: first impact of a productivity shock on total output for any given size of the credit market

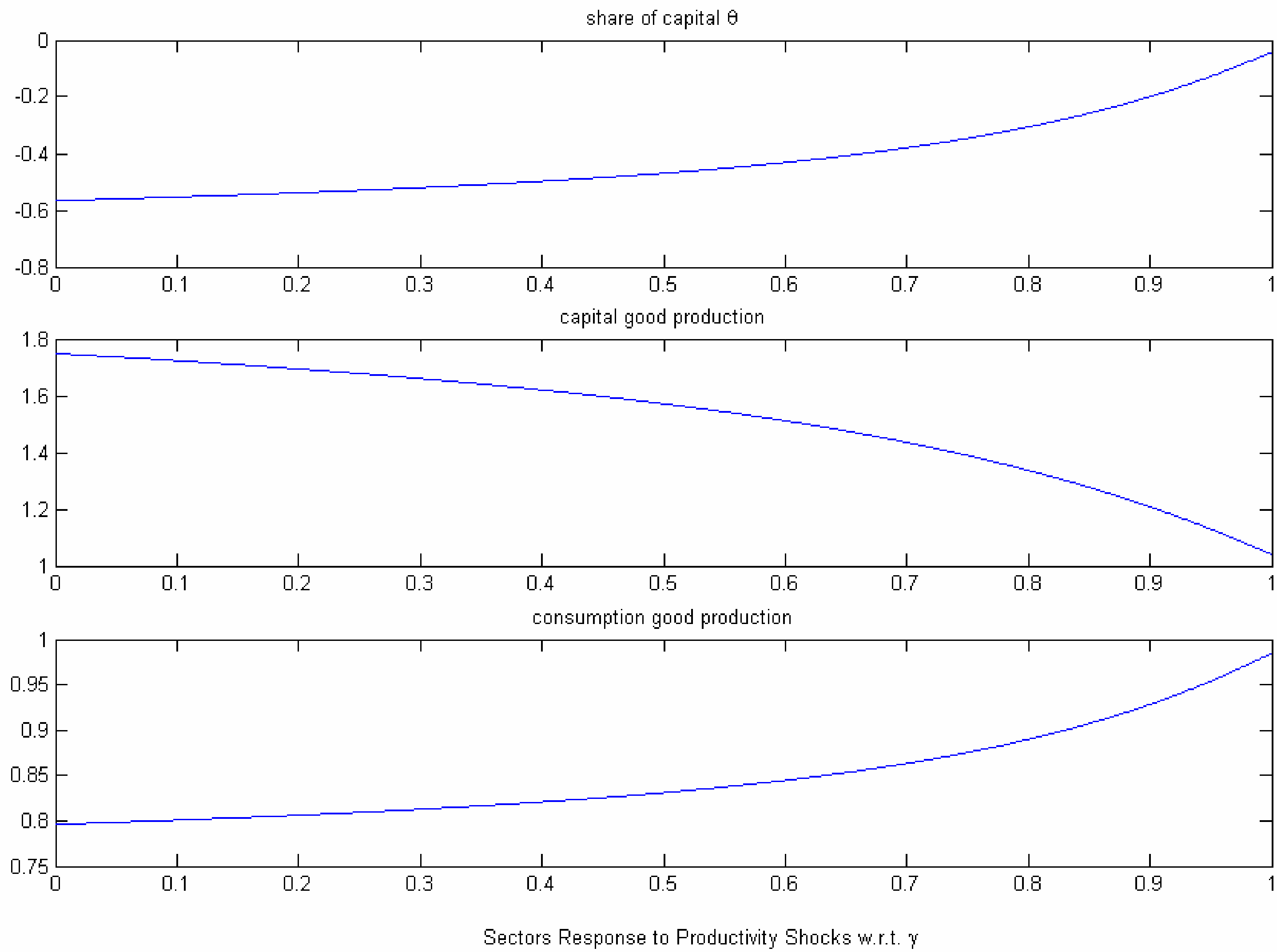
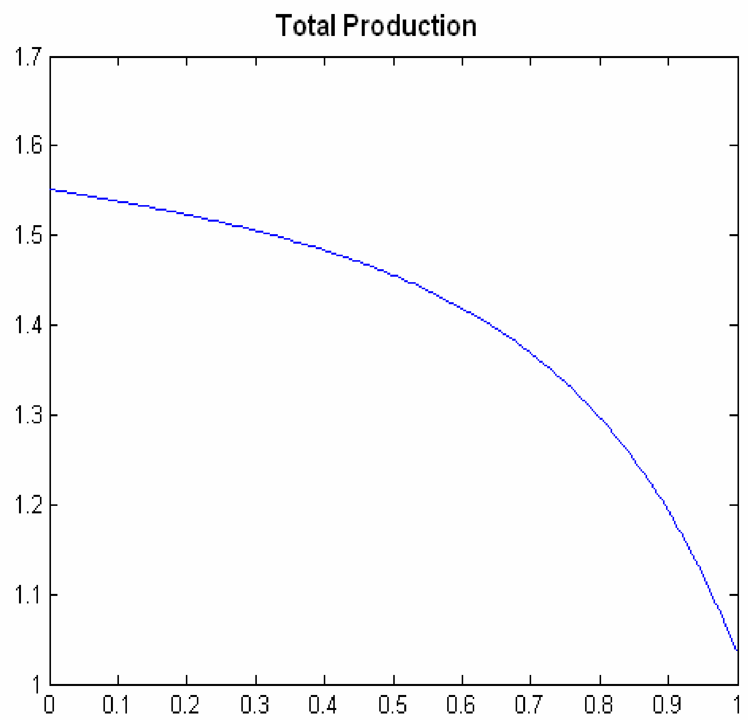
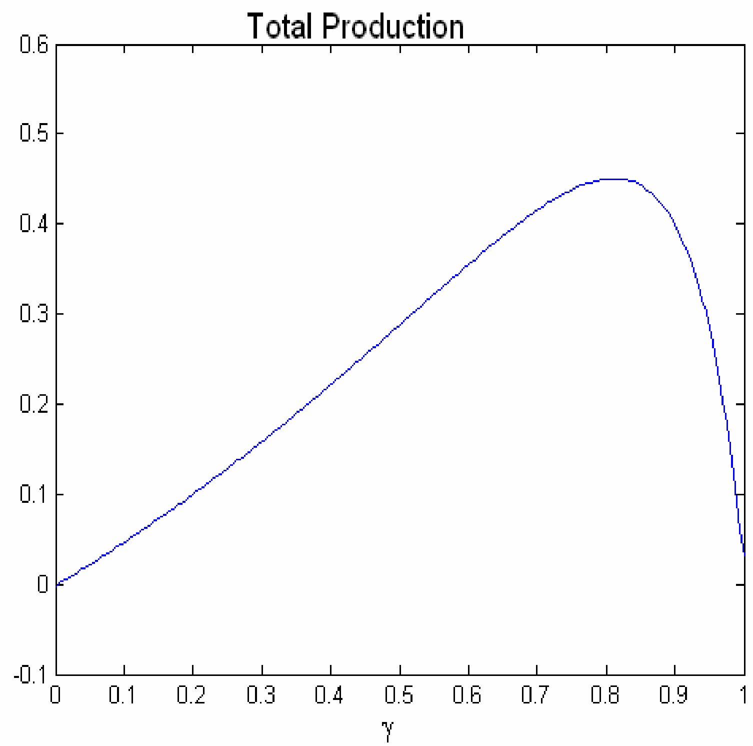


Figure 9a first impact of the shock on production -- i.e. the intensity of reaction for any given γ

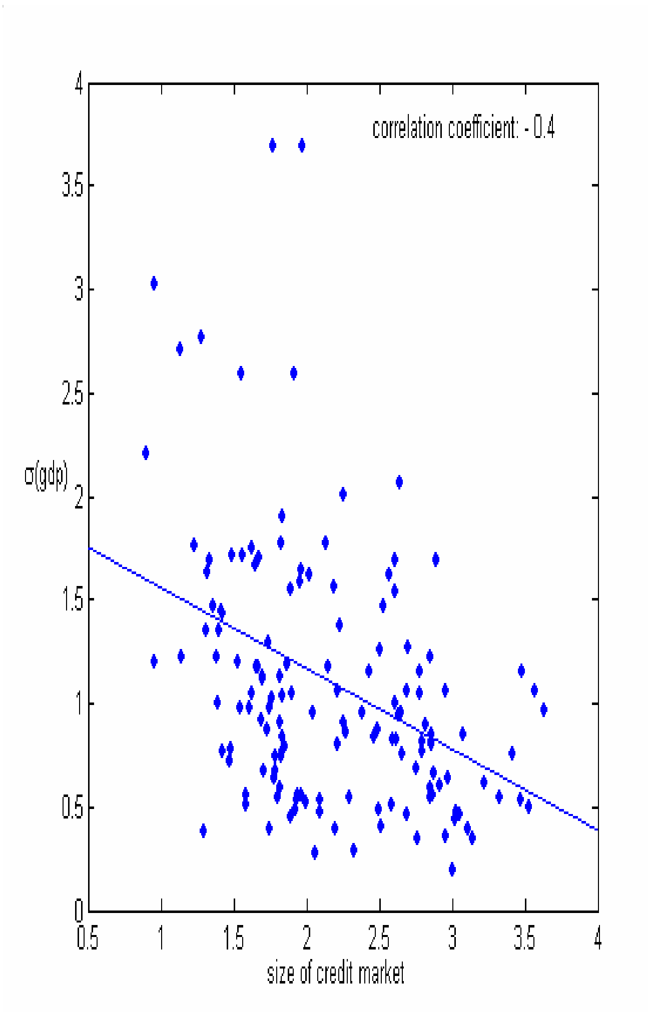
Two- sector

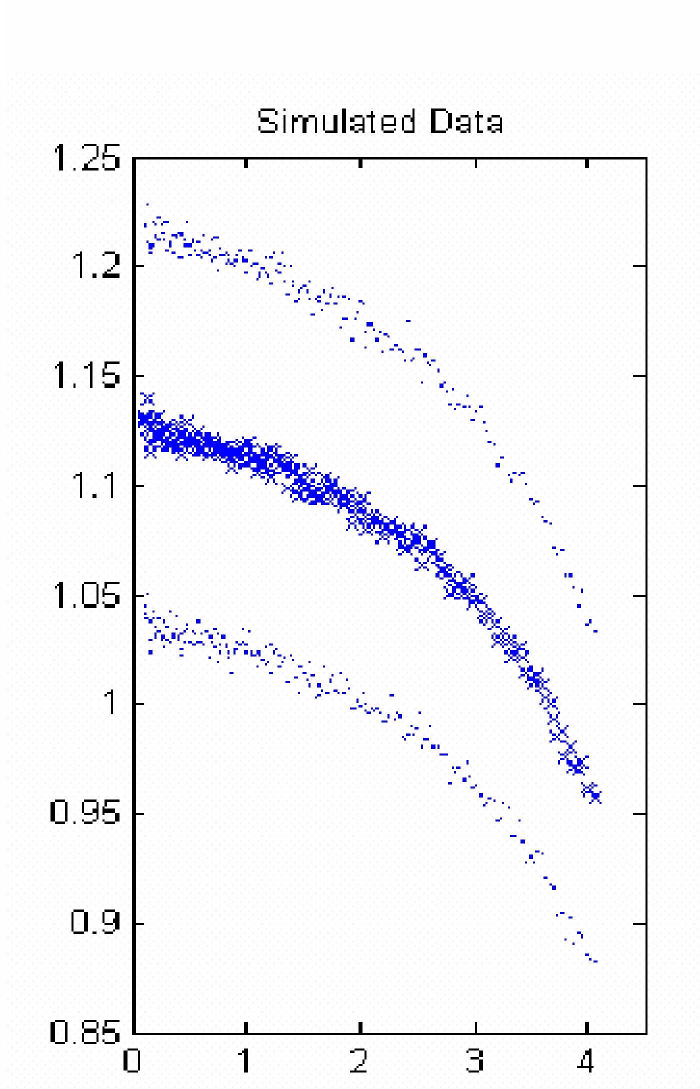


One-sector



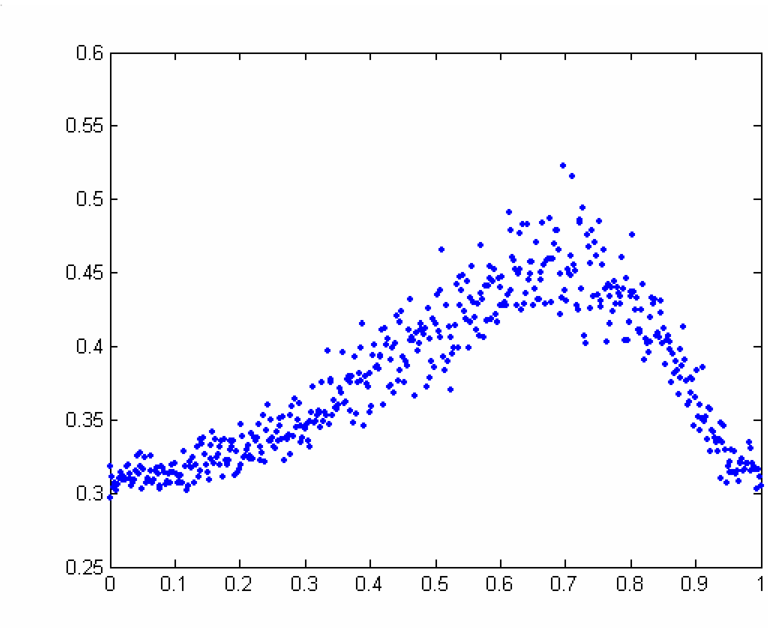
Actual vs Simulated Data





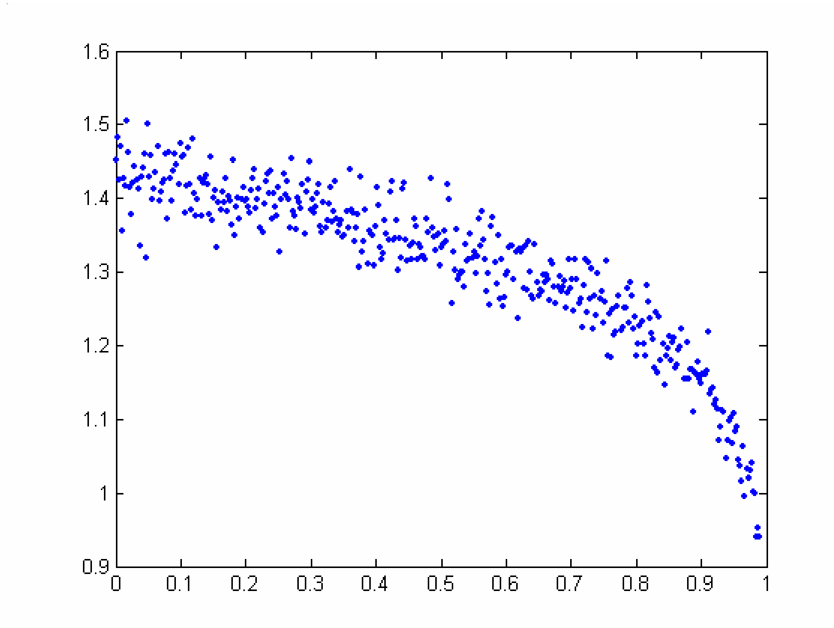
One-sector vs Two-sector Model

One-sector



$$Y_t = Z_t k_{t-1}^{\alpha}$$

Two-sector



$$F_t = Z_t k_{t-1} \left(\theta^{\alpha} + q_t (1-\theta)^{\alpha}\right)$$

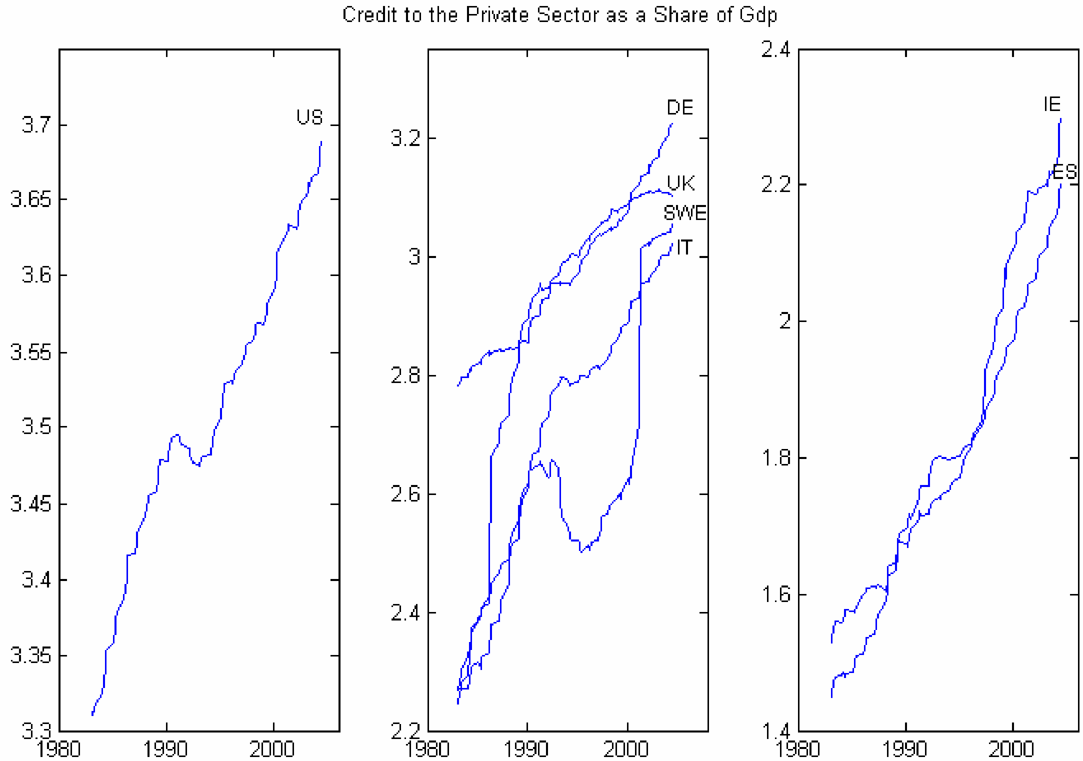


Figure12 behavior of the size of the credit market during the last 20 years