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Credit Market and Macroeconomic Volatility

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Abstract

This paper investigates how the degree of credit market development is related to business cycle fluctuations in industrialized countries. I show that a business cycle model that includes collateral constraints generates a negative relationship between the volatility of the cyclical component of output and the size of the credit market. Furthermore, I identify reallocation of capital as the key factor shaping this relationship. According to the model, increasing the amount of credit extended to the private sector makes output less sensitive to productivity shocks. Thus, the role of credit friction in amplifying the propagation of productivity shocks to output is greater in economies with more credit rationing. I test the predictions of the model on data using a panel of OECD countries over the past 20 years. Empirical evidence confirms that countries with better-developed credit markets experience smoother business cycle fluctuations. Moreover, a larger 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

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1 Introduction

Over the past two decades, financial systems have experienced deep structural changes as a result of regulatory reform and technological innovation. The main goal of these changes was to improve the efficiency of the financial system, but the macroeconomic implications went beyond this. Deregulation contributed to a considerable increase in the amount of bank credit extended to the private sector. A simultaneous decline in output volatility in most OECD countries over the past 20 years has been firmly established[1]. Changes in the underlying characteristics of the economy, and thus in the mechanism by which exogenous shocks spread and propagate in the economy, could be the main reason for such a decline. Several studies assign a primary role to the conduct of monetary policy[2]. Other studies demonstrate that the decrease in inflation and output volatility is traceable to changes in the variance of exogenous shocks[3]. A few studies, however, claim that this decline in output volatility is due to other characteristics of the economy [4]. What is the contribution of credit market development to increased macroeconomic stability in industrialized countries?

The business cycle literature do not provide rigorous evidence of the relationship between the degree of credit market development and output volatility for OECD countries. However, several empirical studies using large samples of countries demonstrate that countries with well-developed credit markets experience smoother output fluctuations[5].

[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), and Canova (2004)

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

[4] Hanson (2001), Campbell and Hercowitz (2004), and Justiniano and Primiceri (2006).

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

Preliminary analysis of OECD data reveals that the same kind of relationship holds for industrialized countries. In fact, if one borrows from the literature the notion that credit market size is a good measure of credit market development, a negative correlation with output volatility is evident. Figures 1 and 2 present credit market size (measured as the credit extended to the private sector by banks and other financial institutions as a share of GPD) and output volatility (measured as the standard deviation of the log detrended real output), 1983-2004, for a sample of 22 OECD countries. Both figures indicate significant differences among OECD countries. There is some evidence that smoother fluctuations are associated with higher levels of credit as a share of GDP. Table 1a shows that the credit-to-GDP ratio, both current and at the beginning of the period, is negatively correlated with the standard deviations of output, consumption, and investment. Table 1b presents the mean equality tests of the volatility of output, consumption, investment, and investment in residential properties across the treatment (credit market size below the sample median) and control (credit market size above the sample median) groups of countries, observed for rolling five-year periods, 1983-2004. The results suggest that countries with smaller credit markets experienced on average higher output and investment volatility.

This paper revisits the link between credit market size and macroeconomic fluctuations, with a special focus on industrialized countries. The first part of the paper develops a business cycle model that focuses on how the degree of credit market development affects the sensitivity of output to productivity shocks, and thus its volatility over the business cycle. To the best of my knowledge, very few papers have analyzed such issues. Examining access to the international credit market, Aghion, Baccheta, and Banerjee (2003) demonstrate that small open economies at an intermediate level of financial development are more vulnerable to shocks. Campbell and Hercowitz (2004) show that the financial reforms of the U.S. mortgage market in the early 1980s coincided with a decline in the volatility of output, consumption, and hours worked. Finally, Aghion, Angeletos, Benerjee, and Manova (2005) examine how credit market development makes growth less sensitive to exogenous shocks. Unlike their papers, here I focus on the development of the domestic credit market to draw more general conclusions concerning industrialized countries from a business cycle perspective. However, I borrow from this literature the notion that collateral requirements can serve as a proxy for credit market development. Tighter collateral constraints that result in smaller credit markets characterize economies with a less-developed credit market.

I develop a full-fledged, two-sector business cycle model based on Kiyotaki and Moore (1997). To generate a reason for the existence of credit flows, two types of agents are assumed, both of whom produce and consume the same type of goods using a physical asset. They differ, however, in terms of discount factors, and consequently, more impatient agents become 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 loan collateral.

Following the lead of Cordoba and Ripoll (2004), my setup differs from that of Kiyotaki and Moore (1997) in that I use more standard assumptions as to preferences and technologies. Kiyotaki and Moore assume that both groups of agents are risk neutral. Moreover, these agents are taken to represent two different sectors of the economy – borrowers being "farmers" and lenders being "gatherers" – that apart from using different discount factors, also differ in their production technology. In my model, both groups of agents have a concave utility function and are generally identical, except that they have different subjective discount factors. Moreover, aggregate uncertainty is introduced into the model, so asset prices are not perfectly predicted by the agents. Unlike previous literature, I allow for the existence of liquidation costs in modeling the collateral constraint, to be able to investigate the behavior of economies that differ in terms of access to credit financing. Finally, to allow for capital reproducibility, I develop a model with one type of capital goods and two sectors – consumption and investment goods production.

The main propagation channel in the model is provided by the reallocation of capital between different sectors of the economy. Existing literature dealing with credit markets has shown that credit frictions are a powerful transmission mechanism that propagates and amplifies shocks. The main focus of this previous literature is on how credit market frictions affect new capital investment, no role being assigned to the reallocation of existing capital. However, a few papers do examine the behavior of capital reallocation from a microeconomic point of view. Among the main results are that capital flows from less productive to more productive firms[6] and that gains derived from reallocation appear larger when productivity differences are greater[7]. Moreover, Rampini and Eisfeldt (2005) have recently demonstrated that in the USA the amount of capital reallocation represents approximately one quarter of total investment, and that depending on how capital reallocation is measured, between 1.4 and 5.5 of the capital stock turns over each year. Furthermore, the reallocation of existing productive assets among firms (sales and acquisitions of property, plant,

[6] Maksimovic and Phillips (2001)
[7] Lang, Stulz, and Walkling (1989) and Servaes(1990)

and equipment) is procyclical[8].

Unlike previous literature, this paper demonstrates that in a model that includes collateral constraints, the reallocation of capital contributes in quantitatively significant terms to amplification. Moreover, such a business cycle model can generate a negative relationship between credit market development and output volatility, as long as the model allows for the reallocation of capital among firms. In fact, only by allowing for the reallocation of capital can credit market development make output less sensitive to productivity shocks.

This finding contributes significantly to the debate concerning the amplification role of collateral constraints. Cordoba and Ripoll (2004) show that adopting standard assumptions about preferences and technologies makes Kiyotaki and Moore's model unable to generate persistent or amplified shocks. Thus, their results call into question the quantitative relevance of credit frictions as a transmission mechanism. In this paper, I show that the magnitude of shock amplification is related to the degree of credit rationing. The findings of Cordoba and Ripoll hold only for economies with the least possible degree of credit rationing allowed by the model. However, the magnitude of amplification is quantitatively more significant the lower the degree of credit market development.

The second part of the paper tests the main predictions of the model on actual data. For this purpose, I use data for a panel of 22 OECD countries over the 1983-

[8] According to the Schumpeterian view, aggregate shocks generate an inter-firm reallocation of resources, and evidence of this is well established as pertains to job flows. Recent empirical studies have demonstrated the relevance of physical capital reallocation over the business cycle; see Maksimovic and Phillips (2001), Andreade, Mitchell, and Stafford (2001), Schoar (2002), Jovanovic and Rousseau (2002), and Eistfeld and Rampini (2005). However, there is no empirical evidence regarding either capital reallocation and credit market development or capital reallocation and macroeconomic volatility.

2004 period. I also show that among OECD countries, the degree of credit market development is negatively related to output variability over the business cycle. Moreover, I demonstrate that, in accordance with the predictions of the model, a larger credit market more effectively dampens the propagation of productivity shocks to output.

The paper proceeds as follows. Section 2 presents the model, while section 3 discusses the solution method and 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 relationship between credit market size and business cycle volatility. Section 7 compares model predictions with data for a panel of OECD countries. Section 8 presents the conclusions of the study.

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 depreciates at the rate of δ. The commodity good, c, is produced using the durable asset and cannot be stored. At time t there are two competitive markets in the economy: the asset market in which one unit of the durable asset can be exchanged for q_t units of the 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). To impose the existence of credit flows in this economy, I assume that the ex ante heterogeneity is based on different subjective discount factors.

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*

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

Unlike Kiyotaki and Moore (1997), I assume that agents have access to the same concave production technology[9]. Kiyotaki and Moore also take the two groups of agents to represent two different sectors of the economy; on the contray, I assume technology to be the same for both groups of agents ($\alpha_1 = \alpha_2$). Moreover, I also allow for reproducible capital and assume that each agent is able to produce both consumption and investment goods[10]. For simplicity, I will assume that both types of production are identical[11].

However, I do follow Kiyotaki and Moore (1997) in assuming that the technology is specific to each producer and that only the household that initiated a particular

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

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

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

type of production has the skills necessary to complete it. Thus, if agent i decides not to put effort into production between t and t + 1, there would be no production outcome at t + 1, but only the asset k_{it}. The agents cannot precommit to produce; moreover, they are free to walk away from the production and debt contracts between t and t + 1. This results in a default problem that prompts creditors to protect themselves by collateralizing the household's assets. Creditors know that if the household abandons its production and debt obligations, they will still get his asset. However, following Iacoviello (2005), I assume that 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 the expected value of the asset in the next period, as follows:

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

where $\gamma < 1$ and $(1 - \gamma)$ represent both the cost lenders must pay to repossess an asset and the degree of credit rationing of the economy, respectively. 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, a high γ representing a developed financial sector while a low γ represents an underdeveloped system.

2.1 Agents ' optimal choices

Step 1: Optimal allocation of capital

I divide the agents' problem into two steps. First, in any given period each agent allocates the existing capital to produce either consumption or investment goods by solving

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

This leads to the first-order condition,

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

It is possible to express the amount of capital allocated to each type of production as a fraction of the total capital owned by each agent, as follows:

$$k^c_{it-1} = \theta k_{it-1}$$

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

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

Step 2: Utility maximization

Now it is possible to simplify the maximization problem, obtaining

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

s.t. the *budget constraint*

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

and the *borrowing constraint*

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

The 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

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

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 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 greater than or equal to the expected discounted marginal product of capital.

It is possible to show that impatient agents borrow up to the maximum possible amount in the neighborhood of the deterministic steady state. In fact, if we consider the Euler equation for the impatient household in the steady state,

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

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

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

and

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

where $W_{2,t} = F_{2,t} + q_t (1-\delta) k_{2,t-1} - b_{2,t-1}$ 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 this agent can borrow against a unit of capital, i.e., the down payment required to buy a unit of capital.

Thus, in the neighborhood of the steady state for constrained agents, the marginal benefit is always greater 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:

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

In contrast, patient households are creditors in the neighborhood of the steady state. Thus, the lender's capital decision is determined by the point at 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 parameter values

I calibrate the model at quarterly intervals, setting the patient households' discount factor to 0.99, such that the average annual rate of return is approximately 4%,while the impatient households' discount factor[12] is 0.95. I assume the following utility function:

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

[12]Lawrance (1991) estimates that the discount factors of poor households are in the 0.95 to 0.98 range, while according to Carroll and Samwick (1997), the empirical distribution of discount factors lies in the 0.91 to 0.99 interval.

and set θ to equal 3.3. The productivity parameter, α is 0.36, as in the tradition of the real business cycle literature[13]. The baseline choice for the fraction of borrowing-constrained population is set to 50. The parameter representing the degree of credit rationing, γ, is in the [0,1] range. Figure 4 shows that by using these parameter values and varying γ between zero and unity, it is possible to reproduce the same private credit-to-GDP as found in the data. Finally, I calibrate the technology shocks according to standard values in the real business cycle literature[14]. Table 2 summarizes the parameter values.

3.2 Dynamics

The agents' optimal choices of borrowing and capital, together with the equilibrium conditions, represent a non-linear dynamic stochastic system of equations. Since the equations are assumed to be well-behaved functions, the solution of the system is found by using standard local approximation techniques. All the methods commonly used for such systems rely on the use of log-linear approximations around the steady state to obtain a solvable stochastic system of difference equations.

By finding a solution, I mean to express all variables as linear functions of a vector of variables, both endogenous state, x_{t-1}, and exogenous state, z_t, variables, i.e., I am seeking 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.

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

[14] For technology shock, see chapter 1 in Cooley and Prescott (1995) or Prescott 1986.

To solve for the recursive law of motion, I need to find the matrices $P, Q, R, andS$, so that the equilibrium described by these rules is stable. I solve this system using the undetermined coefficients method of, for example, McCallum (1983), King, Plosser, and Rebelo (1987), Campbell (1994), and Uhlig (1995).[15].

4 Credit Market Size and the Deterministic Steady State

Now, I analyze how the degree of credit rationing affects the deterministic steady state of the model. Since total output is maximized when 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 the deterministic steady state, so their capital holdings are less than those of the patient 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 $\gamma < \frac{1}{\beta_1}$,

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

The steady-state allocation of capital depends on the subjective discount factors, ($\beta_1 and\ \beta_2$), the fraction of the two groups of agents, n, the depreciation rate, δ, and the degree of credit market development, γ. Compared to the first-best allocation, the allocation under credit constraints reduces the level of capital held by the borrowers. In fact, as long as $\gamma < \frac{1}{\beta_1} = 1.0101$, it implies a difference in the marginal productivity of the two groups. Figure 5a shows how the steady-state productivity gap in total

[15] See Uhlig (1995), *A Toolkit for Analyzing Nonlinear Dynamic Stochastic Models Easily*, for a description of the solution method.

production between the two groups of agents varies with respect to γ. In fact, less credit rationing allowing for a more efficient allocation of capital between the two groups implies a smaller productivity gap, and thus smaller losses in terms of total production. In the presence of credit frictions it is not possible to reach the efficient equilibrium, but a higher γ does reduce the output loss. As Figure 5b shows, the higher the value of γ the greater the amount of capital assigned to the production of consumption goods (middle panel), despite a lower share of total capital allocated to this sector (top panel). At the same time, greater access to credit decreases the difference between the amount of capital assigned to the production of both consumption and investment goods by the two groups of agents (bottom panel). However, the difference in the amount of capital assigned to the two sectors is always greater for the production of consumption goods.

Figure 6, a and b, shows how the deterministic steady-state values of the model's variables change with respect to the degree of credit market development, γ. Increased access to the credit market implies credit expansion, *ssb*, and thus a rise in the level of investment by borrowers, *ssk2*. 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, *ssy*. Hence, the amounts of both total capital, *ssK*, and consumption, *ssC*, are higher as well. 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 from both greater access to debt financing and the increasing value of their assets. However, as expected, 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, thus reducing the steady-state consumption level.

It is important to stress the increasing trend of asset prices in the steady-state *ssq*. The lenders' optimal choice of capital gives

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

Thus, in a steady state, asset prices depend on the marginal productivity of capital and increase with γ.

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. I assume that the productivity shock follows an AR(1) process given by

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

Figure 7 shows the response of total aggregate output to the productivity shock. As we see, after a 1% increase in aggregate productivity, total output increases by approximately 1.3% in the first period and still further in the second. In what follows I will show that the amplification channel in the first period is given by the reallocation of existing capital between different sectors of production, while in the second period the redistribution of capital between the two groups of agents also contributes to generate amplification.

Looking at the effects of the shock on the two different types of production in aggregate terms, we see that the production of investment goods displays evidence of significant amplification, while the production of consumption goods reacts much less markedly (Figure 8a). When aggregate productivity exogenously increases, agents optimally reallocate the existing capital between the two sectors. 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 asset amplifies the effect of the productivity shock on the aggregate production of investment goods. On the other hand, for the same reason, the impact of the shock on the production of consumption goods is reduced (the initial impact is under 1%). The response of θ indicates that capital is indeed reallocated towards the production of investment goods, coinciding with the two major amplification peaks.

Borrowers that were limited in their capital holding by the existence of borrowing constraints, increase their demand for productive assets. For the capital market to clear, the user cost of holding capital has to increase as shown in Figure 8b. The productivity shocks affect borrowers' decisions not only directly, but also indirectly through asset price dynamics, which contribute to loosening the collateral constraint. In fact, the rise in asset prices implies a credit boom[16]. For the patient agents to be willing to increase the amount of funds offered for borrowing, the interest rate must increase in the first period. Moreover, with asset prices increasing and the production of investment goods strongly reacting to the shock, the response of aggregate real output to the productivity shock is greatly amplified. Figure 8d presents the dynamics of the two groups' production in more detail. Since in the first period the agents all decided to reallocate their own capital optimally in the same

[16]
$$\hat{b}_{t+1} = \hat{q}_{t+1} + \hat{k}_{t+1}$$

way, independently of ownership, both types of production behaved identically[17]. In the second period, given the redistribution of capital towards this group of agents, the production specific to constrained agents is more strongly affected by the shock and displays a significant degree of amplification[18]. In contrast, the amplification of lender production is minimal[19]. In the second period, the reallocation of capital between the two sectors is still affecting the production behavior of both groups. However, what generates differences in the impact of the shock is the fact that the capital held by constrained agents increases substantially. Constrained agents can smooth the effects of the shock only by buying more capital assets. The rise in current investment expenditures propagates the positive effect of the shock to borrowers' production over time (see Figure 8c). Moreover, since the marginal productivity of capital is higher for borrowers, this generates a persistent effect on aggregate production as well[20]. While in the first period the only source of amplification was the reallocation of capital in terms of use (to the most relevant sector)[21], in the second period both physical and ownership reallocation take place[22].

Figure 9 compares the reaction of total aggregate production in the present model with that in the standard Kyotaki and Moore one-sector model. As in Corboda and Ripoll (2004), in this version of the model aggregate capital is fixed in supply and

[17] Amplification is 0.34% of total production and 0.21% of investment goods production.

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

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

[20] In fact, when the capital used by the most productive agents increases — as well as their share of production $(F_{2,t}/F_t)$ – the effect of the shock is amplified even more.

[21] As for the individual production, amplification is 0.34% of total production and 0.21% of investment goods production.

[22] Amplification is 0.45% of total production, 0.36% of investment goods production, and 0.0081% of consumption goods production.

only one consumption good is produced. The two-sector model displays greater amplification and persistence of productivity shocks. In the standard one-sector model, the only source of amplification is the redistribution of capital in favor of the borrowers. Thus, there is amplification of the shock only in the second period. In contrast, in the two-sector model, even in the first period the reallocation of capital towards investment goods production and the increase in the price of these goods already generated significant amplification. In the second period still greater amplification is generated, not only by this mechanism, but also by the redistribution of capital. Thus, the existence of collateral constraints in the two-sector version of the model generates more amplification and persistence of productivity shocks than does the standard Kyiotaki and Moore setup.

6 Credit Market Size and Business Cycle

6.1 Benchmark model: quantitative results

Limiting borrowing to a fraction of the expected liquidation value of the collateral takes into account different degrees of development of the banking technology for liquidating collateral[23]. Thus, as in Aghion, Baccheta, and Banerjee (2003) and Campbell and Hercowitz (2004), credit market development is modeled by relaxing credit restrictions. At the same time, the ability of lenders to repossess collateral, and thus their willingness to extend credit, affects the size of the credit market in the model. In what follows, I consider how the reaction to productivity shocks is affected by the size of the credit market. Unlike previous studies, by allowing for the reallocation of existing capital between sectors, my results show that the reaction to

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

shocks already varies, even in the first period.

Figure 10, a and b, shows the initial impact of productivity shocks – i.e., the reaction intensity for any given value of γ. As a result, more-developed credit markets display reduced sensitivity of output to productivity shocks. Looking at the decomposition of output, a larger credit market magnifies the reaction of consumption goods production while weakening the response of investment goods production. The difference between the reactions of the two sectors is explained by the dynamics of capital allocation between the two groups of agents. As shown in Figure 10b (top panel), the magnitude of capital reallocation is lower in economies with a more-developed credit market. With less capital flowing to the production of investment goods, the response of this sector decreases even further. Since the decreased reaction intensity of this sector is greater than the amplification of the shock in consumption goods production (note that the response of this sector never reaches 1%), a larger credit market dampens the propagation of productivity shocks to output. In economies with greater access to credit, ceteris paribus, less capital (as collateral) is needed to be able to borrow the same amount, so less capital is reallocated to the production of investment goods. On the other hand, less capital is needed to fill a smaller productivity gap.

Figure 10c depicts the impact of the shock on asset prices. As we see, reducing financial frictions reduces the sensitivity of asset prices to productivity shocks. This effect contributes to the same shock having a weaker impact on total aggregate production.

Cordoba and Ripoll (2004), assuming $\gamma = 1$, show that the Kyotaki and Moore setup in a standard business cycle framework renders collateral constraints unable to generate amplification, a finding that still holds in the two-sector setup. However, if we allow for different degrees of credit market development, we see that in the Kyotaki and Moore model the magnitude of the initial amplification impact does vary with credit market size. Thus, the amplification of productivity shocks to output is greater in economies with tighter collateral constraints. Once we allow for γ to be lower than unity, the amplification generated in the model is no longer negligible.

Figure 10d shows how the size of the credit market affects the transmission of productivity shocks in the standard one-sector model. An inverted U-shaped relationship is delivered by the model. As pointed out by Cordoba and Ripoll (2004), in the one-sector model, the elasticity of total output to technology shocks can be written as follows[24]:

$$\epsilon_{yz} = \epsilon_{yk_2}\epsilon_{k_2z} = \frac{F_{k_2} - F_{k_1}}{F_{k_2}} \alpha \frac{y_2}{y} \epsilon_{k_2z}$$

The first term is the productivity gap between constrained and unconstrained agents, α is the share of collateral in production, $\frac{y_2}{y}$ is the production share of constrained agents, and ϵ_{k_2z} is the redistribution of capital. In the one-sector model, the fraction of total output produced by constrained agents increases with increasing values of γ because more capital is held by the constrained population. However, for the same reason, the productivity gap decreases with γ. Thus, the second impact of productivity shocks on total output depends on these two opposing forces[25]. As a result, the degree of credit market development affects the reaction of output to

[24] Since the initial impact of the shock would always be equal to the shock itself, we are now looking at the second-period effect of the shock.

[25] Regardless as to the shape of the capital reaction to technology shocks, the relationship between γ and the second impact of z_t on y_t assumes an inverted U shape; this is, of course, more pronounced when ϵ_{k_2z} is not monotonic.

productivity shocks differently in the two models.

6.2 Credit market size and output volatility: a computational experiment

Now I examine the relationship between the volatility of the cyclical component of output and the size of the credit market delivered by the model. I simulate the model for 1000 values of γ in the [0,1] range. The number of simulated series for the calculation of moments is 5000 for any given γ. The productivity shock follows an AR(1) process, i.e., $\ln(Z_t) = \rho_Z \ln(Z_{t-1}) + \varepsilon_{Zt}$, $\varepsilon_{Zt} \backsim^{iid} N(0, \sigma_\epsilon)$. The standard deviation of the productivity process is calibrated to match the average standard deviation of the cyclical component of the Solow residual for all sampled countries during the 1983:1-2004:4 period. Thus, I set the standard deviation of the productivity equal the average value ($\sigma_z = 0.9875$, $\rho_z = 0$), and generate artificial series for asset prices, output, and investment and consumption goods, for any given credit market size.

Figure 11a shows that, according to the model, the standard deviation of total output decreases with the degree of credit friction. The same result holds for asset prices (see Figure 11a, right panel). Less credit friction implies lower volatility of both output and asset prices. This result is in accordance with the findings of Justiniano and Primiceri (2005). To support their explanation that the "Great Moderation' was based on a reduction in financial frictions, they demonstrate that the volatility of the relative price of investment in terms of consumption goods decreased following financial deregulation in the U.S. in the early 1980s. This decline in the volatility of the relative price of investment was simultaneous with the timing of the "Great Moderation."

Table 3c reports the results of a mean equality test of the simulated series. A larger credit market significantly reduces the amplification and persistence of productivity shocks to output, investment, and asset prices. In contrast, the volatility of consumption goods production is higher the greater the degree of credit market development[26]. When we apply the same test to actual data for OECD countries, we see that the sampled countries with credit markets below the median in size had higher average output and investment volatilities, while there was no significant difference in terms of consumption volatility. Figure 11b indicates the standard deviation of output for both the actual data and the simulated series. In both cases we find a negative relationship between credit market size and output volatility. In both the actual and simulated series we find some evidence that smoother fluctuations in output are associated with higher credit-to-GDP ratios.

Let us compare the predicted relationship between output volatility and degree of credit market development in the two-sector and one-sector models (Figure 11c). Unlike the two-sector model, the one-sector model in unable to generate a negative relationship between credit market size and output volatility found in the data.

To evaluate the performance of the two-sector model still further, I calibrate the amount of credit as a share of GDP and the process of productivity shock as in the data, and test to what extent the model economy can generate artificial data regarding output with the same standard deviation as that of the actual data. I use quarterly data for OECD economies, 1983-2004. Figure 12 displays the behavior of

[26] Using the ratio of standard deviation of output to shock as a measure of amplification, I compare two economies with different sizes of credit market (see Table 3b). 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 with the smallest credit markets. Furthermore, investment volatility is 70 higher when credit as a share of GDP equals 1.11.

credit market size over the past 20 years for the sampled countries. For each country I have calibrated credit market size according to the amount of credit extended 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 as equal to the standard deviation of the cyclical component of the Solow residual. Table 4 presents the results for seven OECD economies that differ substantially in terms of credit market size. I consider 4 EMU countries – Germany, Spain, Ireland, and Italy – as well as Sweden, the UK, and the USA. The model succeeds in reproducing the actual output volatility for Germany, Spain, Ireland, and Italy and generating fairly accurate results for Sweden.

7 Empirical Analysis

In the following, I analyze the relationship between credit market development and the size of business cycle fluctuations using OECD data. I use a cross-country approach, following existing literature dealing with business cycle determinants; see, for example, Karras and Song (1996), Beck et al. (2000), Denizer et al. (2002), Ferreira da Silva (2002), and Buch et al (2005). The dataset includes quarterly time-series data from 1983 to 2004 for 22 OECD economies[27].

The theoretical model developed above asserts that economies with more developed credit markets experience lower macroeconomic volatility. Both correlations (see Table 4a) and mean equality tests (see Table 4b) indicate that smoother fluctuations are indeed associated with higher credit-to-GDP ratios. To test for causality, I present more systematic evidence regarding the relationship between credit market

[27]All OECD data used are obtained from the OECD database, while the data regarding private credit come from the IFS.

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-period measure of credit market development to emphasize how the established credit-to-GDP ratio affects volatility in the following period. All other variables refer to non-overlapping five-year periods. Thus, the dataset contains a panel of 22 countries and 4 time periods.

For each period, I observe the level of credit development at the beginning of the period (first quarter of the first of the five years) as well as 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[28]. In the regression, I also control for other potential determinants of business cycle fluctuations, such as the variability of Solow residuals, short-term interest rate, prices, and terms of trade. As is standard in the panel literature dealing with business cycle determinants, I attempt 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

[28]See, e.g., King and Levin (1993) and Levine, Loyaza, and Beck (2000).

and Song (1996), and Ferreira da Silva (2002), I define this as the change in the log of real GDP minus 1-α times the change in the log of employment. 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 on the supply side, measured as the standard deviation of the terms of trade. I also control for price flexibility, measured 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 rates, the first differencing and the Hodrick-Prescott filter are used to remove the estimated trend of the series. (In these tables only HP)

The simple bivariate regressions presented in Table 5 confirm that, despite the inclusion of country and/or period fixed effects, credit market development is negatively and significantly related to output volatility. Although the fixed-effect specification reduces concern about potentially omitted variables, I introduce into the regression a set of variables that may help to explain volatility. The negative relationship also holds when I control for different sources of business cycle volatility (Table 6). As to the other variables, the results are in accordance with those presented in the literature. Output volatility is strongly related to the volatility of the Solow residual, of the interest rate, and of the terms of trade. The correlation coefficient related to consumer price variability has a negative sign, although the value is not significant. Columns 3 and 5 include terms for interaction 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 estimates, a larger credit market does dampen the propagation of Solow residual volatility. I also use a set of instrumental variables to correct for potential endogeneity between the size of the credit market and output volatility; these variables are the lagged level of credit to the private sector as a share of GDP and "creditor rights" (La Porta et al. 1998, La Porta et al. 2005). This second instrumental variable is an index aggregating creditor rights, where the rights of secured lenders are defined in laws and regulations; it ranges from 0 (indicating weak creditor rights) to 4 (indicating strong creditor rights), and is constructed from 1978 to 2003 on a monthly base. To increase the variability of the instruments, I measure volatility on a three-year basis and use the value from the beginning of the period. Table 6b shows that the relationship between credit market development and output volatility remains unchanged. The Sargan test of overidentifying restrictions shows that the instruments used are valid (i.e., not correlated with the error term) and are correctly excluded from the regression.

The empirical results, interesting in themselves, confirm that in accordance with the model, a larger credit market does reduce the sensitivity of output to productivity shocks. Thus, even among OECD countries, the size of the credit market is found to be negatively related to output volatility.

8 Concluding Remarks

In this paper I revisit the relationship between credit market development and business cycle volatility. I present some evidence concerning the fact that industrialized countries with better-developed credit markets experience smoother business cycle fluctuations. Relying on a business cycle model that takes account of credit frictions, I demonstrate that a simple model with collateral constraints can generate the same kind of relationship as is found in the data. I develop a two-sector business cycle model, built on that of Kiyotaki and Moore (1997), to investigate the contribution of credit market development to the decrease in macroeconomic volatility. I introduce aggregate uncertainty and capital reproducibility into the model. 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 modeling the collateral constraint. I identify the reallocation of existing capital as the key mechanism shaping this relationship.

In a standard one-sector model, the propagation of shocks is implied by the redistribution of the capital that flows from lenders with lower marginal productivity to borrowers with higher productivity. This effect predicts an inverted U-shaped relationship between credit market size 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 generates greater amplification and persistence of shocks for any given credit market size. However, the contribution of reallocation of existing capital is greater in economies with smaller credit markets, and diminishes with increasing credit market size. Thus, the reallocation of capital between sectors shapes the relationship between macroeconomic volatility and credit market size.

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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.

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.: Mean Equality Test simulations

5-years	σ(y)	σ(c)	σ(I)	σ(Q)
credit < *median* *vs* *credit* > *median*	**.1675341** (.0049298)	**−.1058145** (.0035229)	**.2033866** (.0052499)	**.2033866** (.0052499)

σ(y),σ(I), σ(c), σ(Q), standard deviation of respectively detrended log real output, investment, consumption and asset prices. *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**	**-0.76518**	**-0.44495**	**-1.20046**
	(0.02284)	(0.23833)	(0.06185)	(0.40714)
c	**2.23392**	**2.87908**	**2.20203**	**3.95013**
	(0.13769)	(0.56633)	(0.13076)	(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 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)]

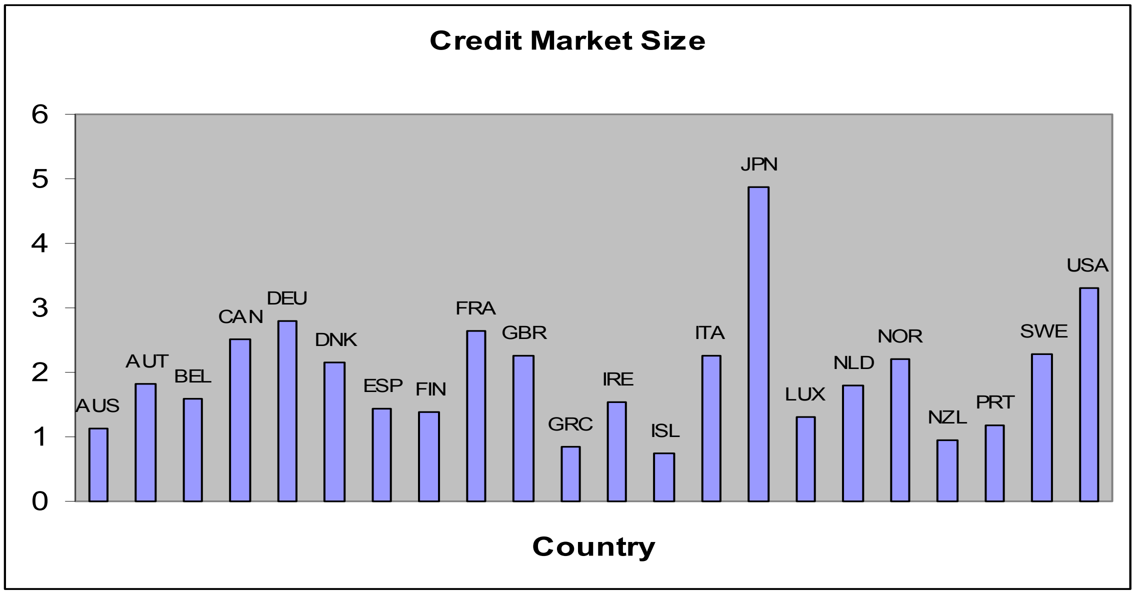


Figure 1: size of the credit market measured by the credit to the private sector as a share of gdp over the time period 1983-2004.

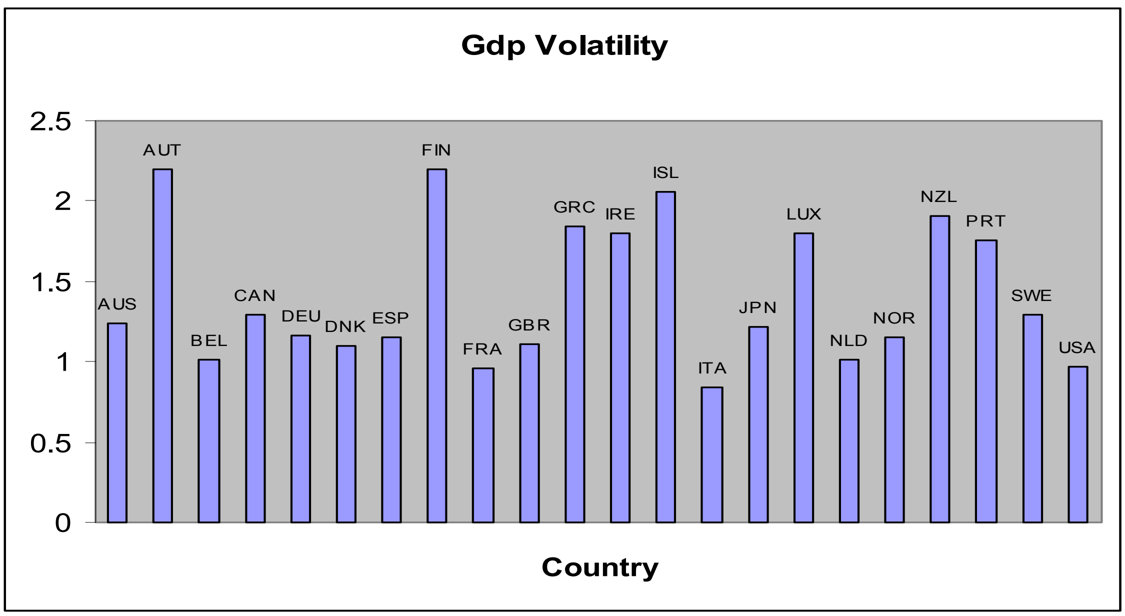


Figure 2 volatility of output measured as the standard deviation of the log detrended real output over the time period 1983-2004.

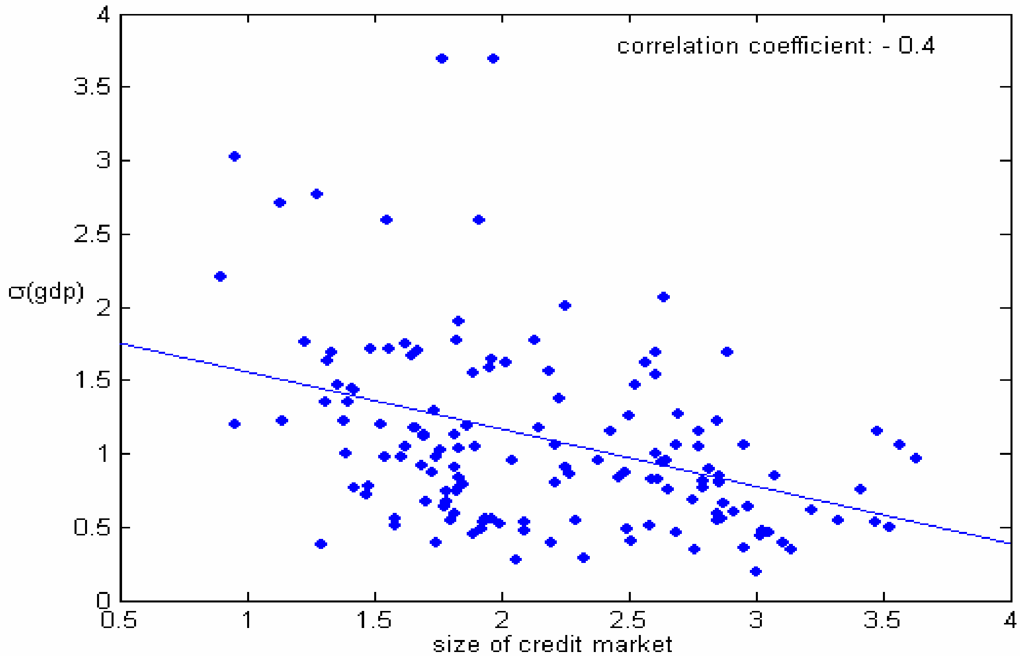


Figure 3 plots the measure of credit market development against the measure of business cycle volatility. Output's standard deviations as well as the average of private credit as a share of Gdp are calculated on quarterly data for 5 non-overlapping years.

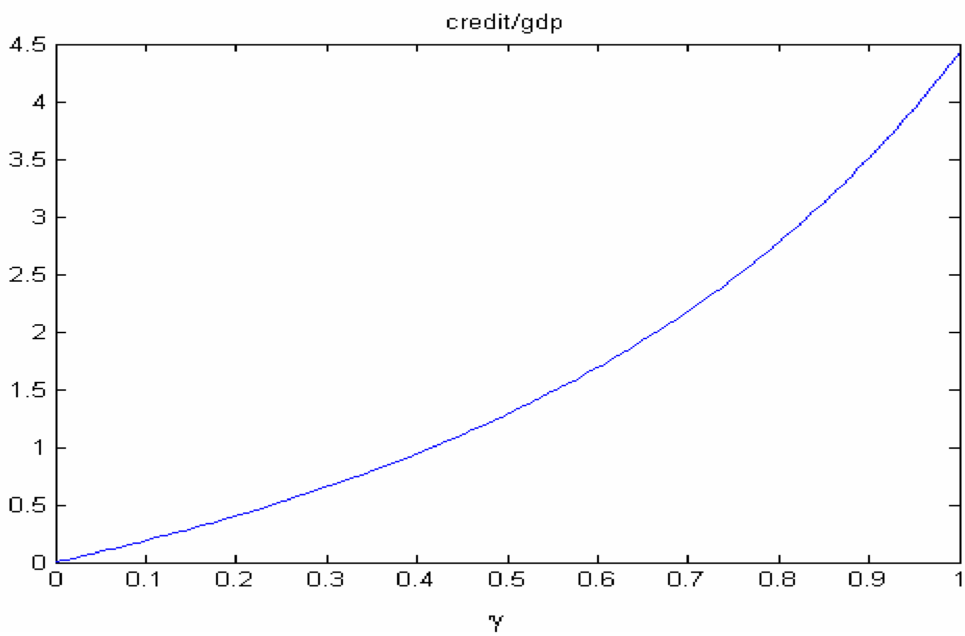


Figure 4 ratio of private credit to gdp as in the data reproduced by varying γ.

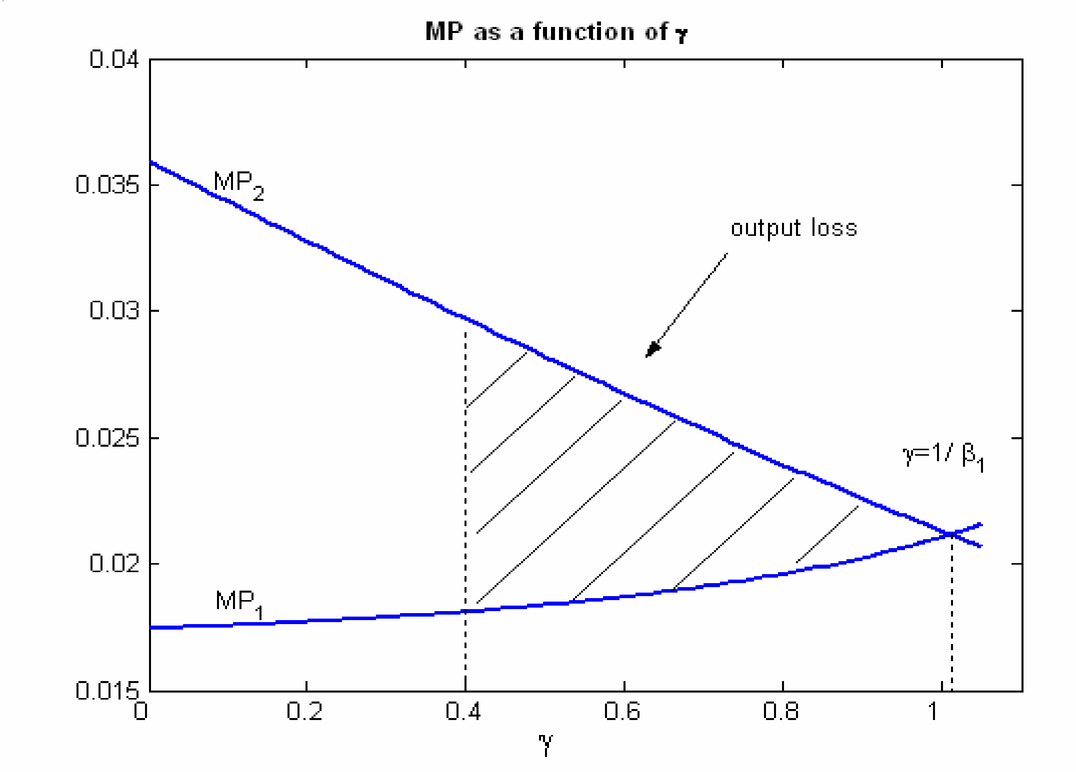


Figure 5a shows how the steady state productivity gap in total production between the two groups of agents varies with respect to γ.

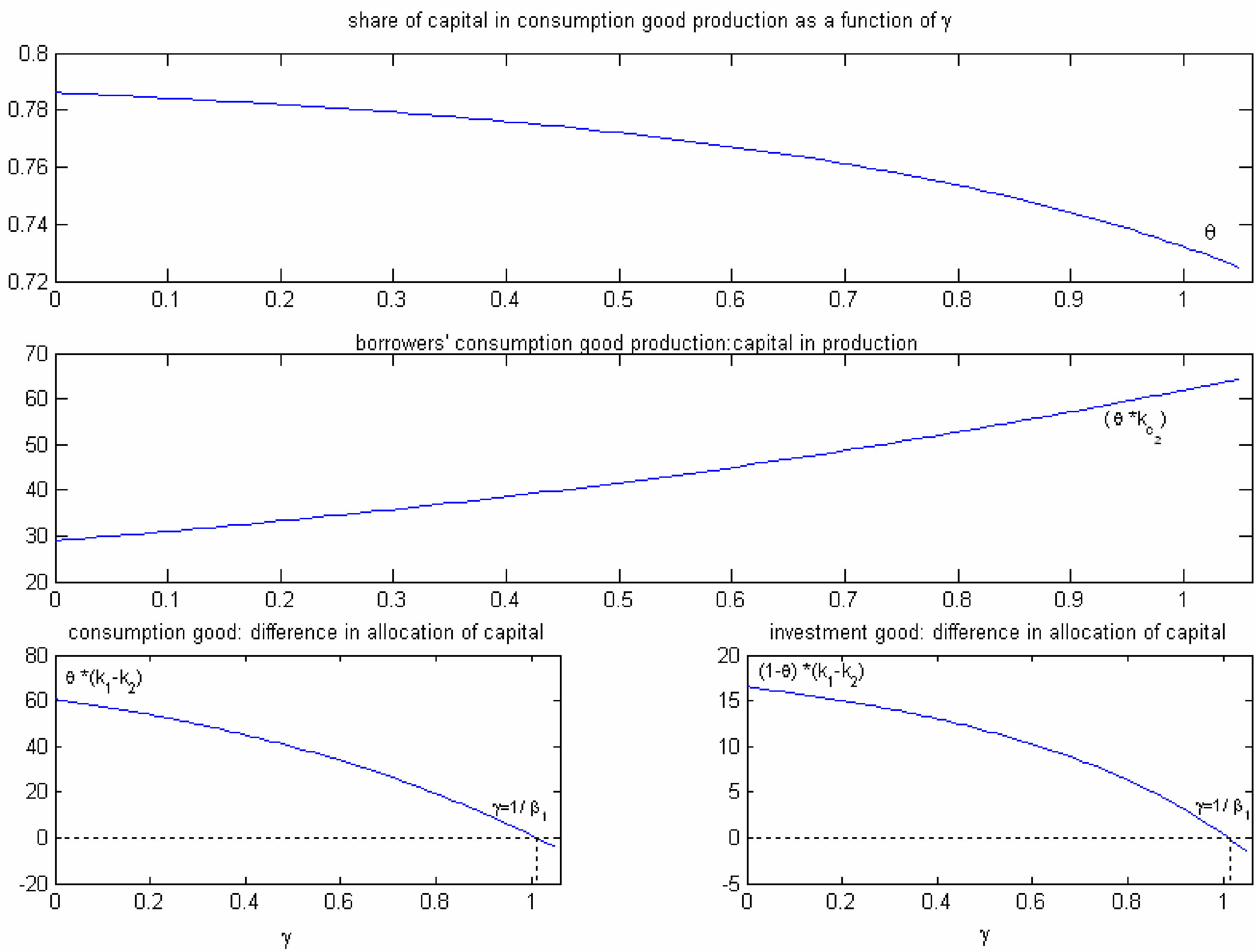


Figure 5.b capital assigned to the production of both consumption and investment goods by the two groups of agents.

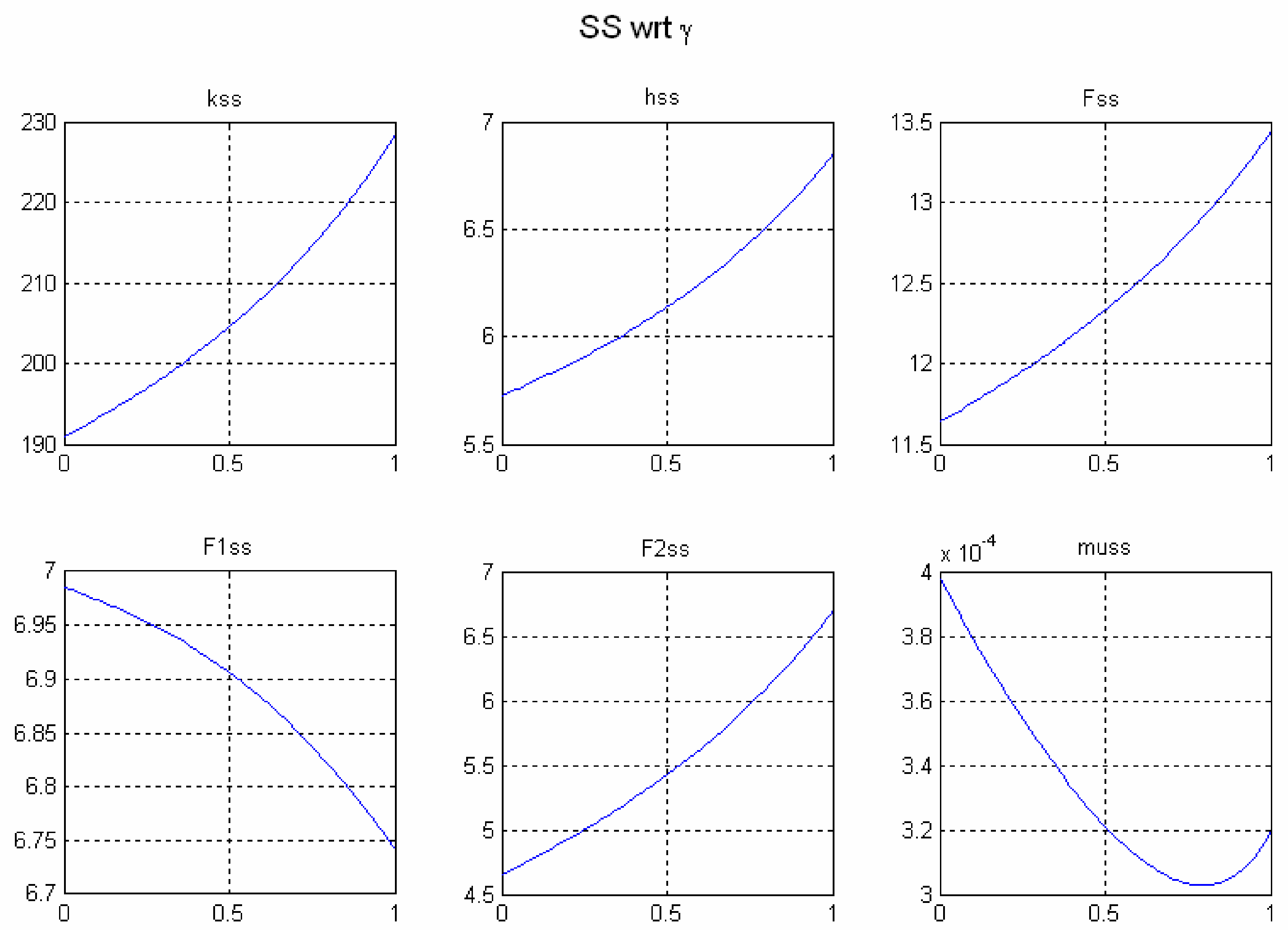


Figure 6a show how the steady state values of the model's variables change with respect to the degree of credit market development.

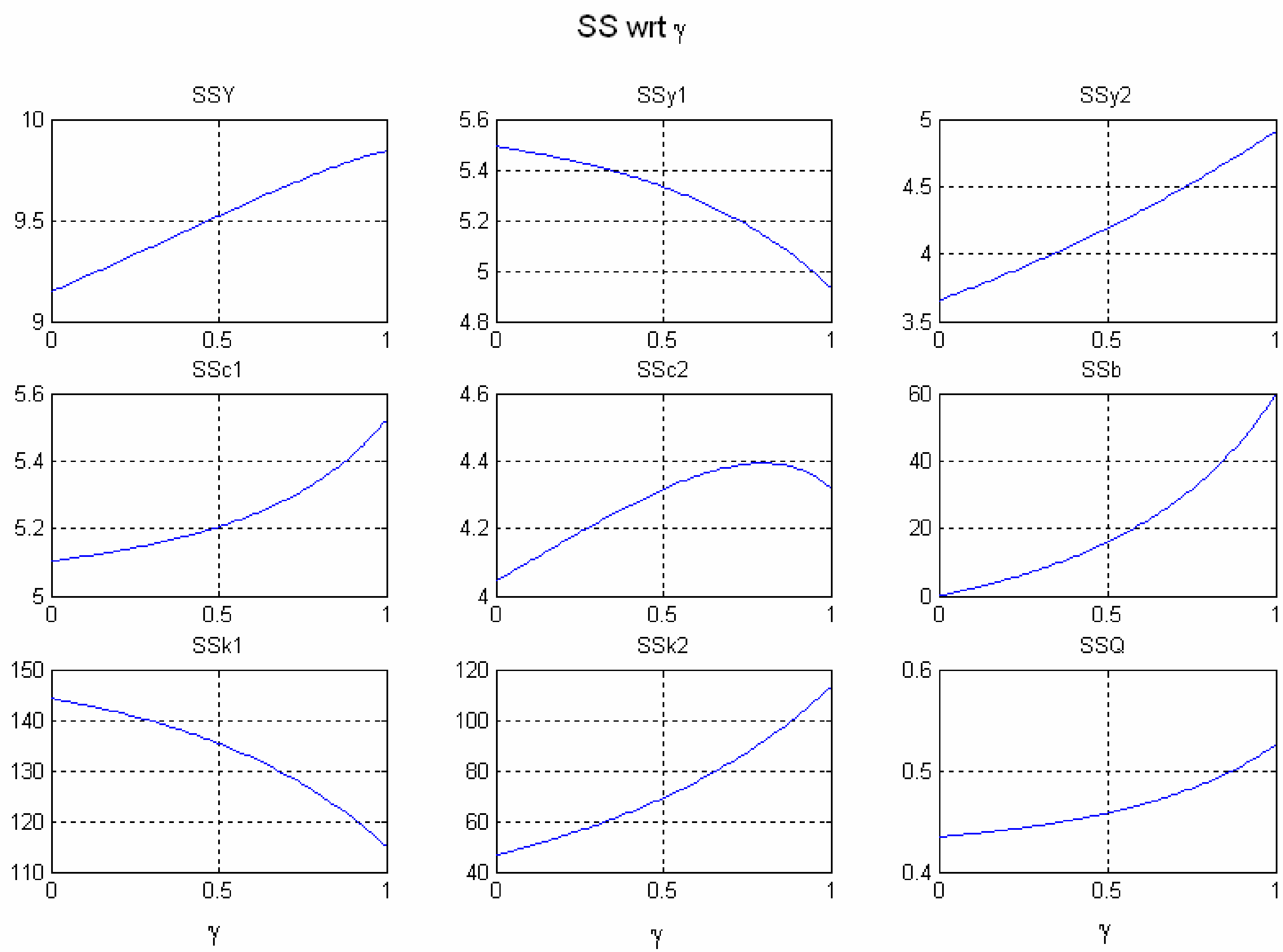


Figure 6b show how the steady state values of the model's variables change with respect to the degree of credit market development.

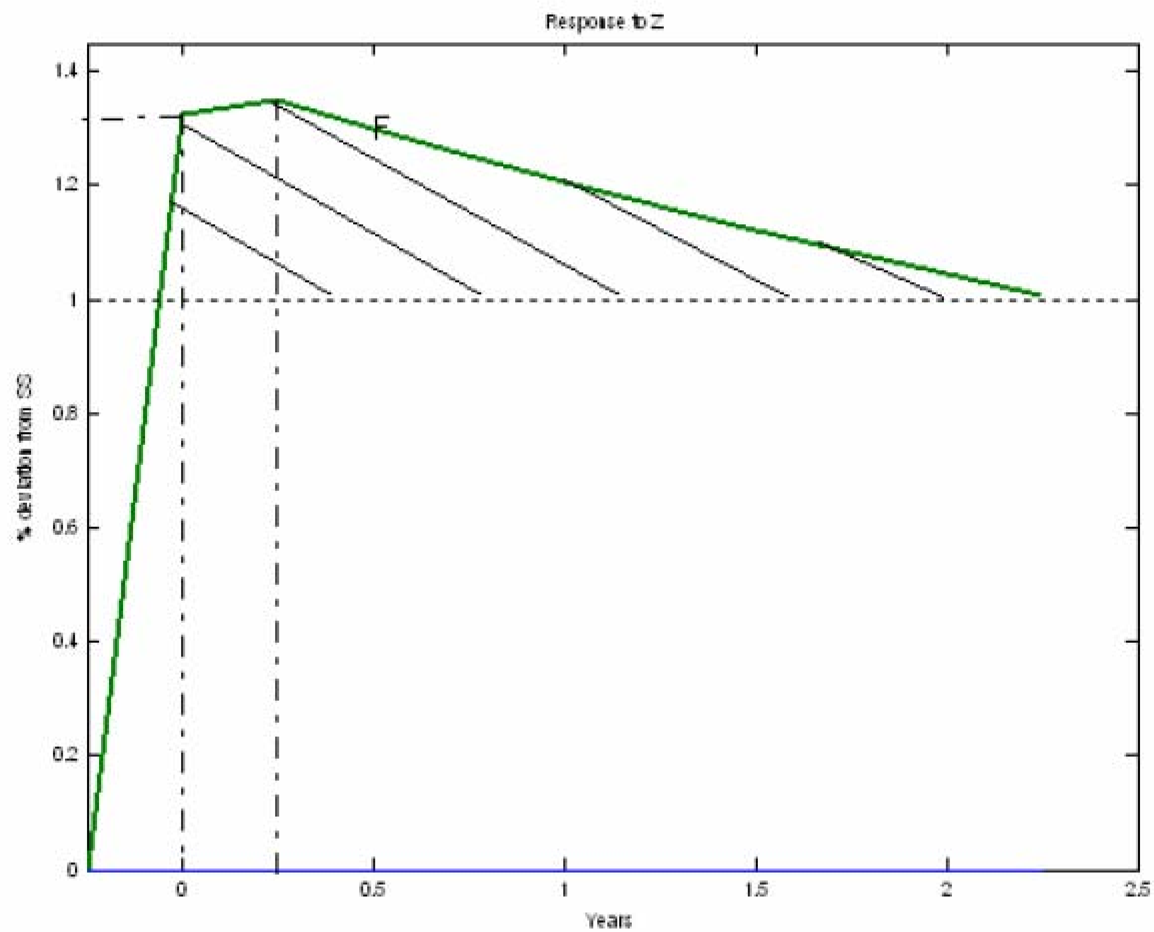


Figure 7 shows the response of total aggregate output to a 1% increase in productivity

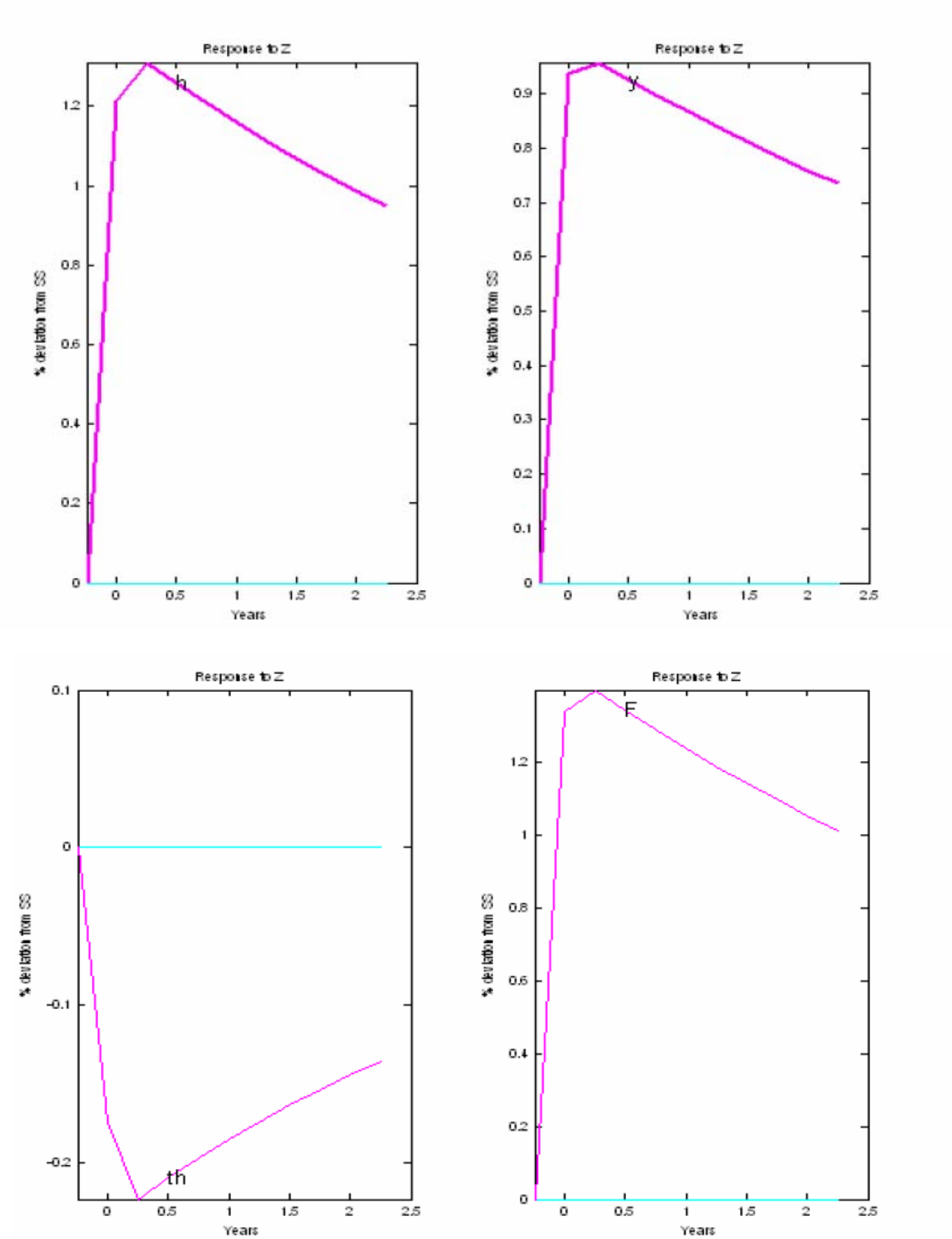


Figure 8a shows the responses to a 1% increase in productivity

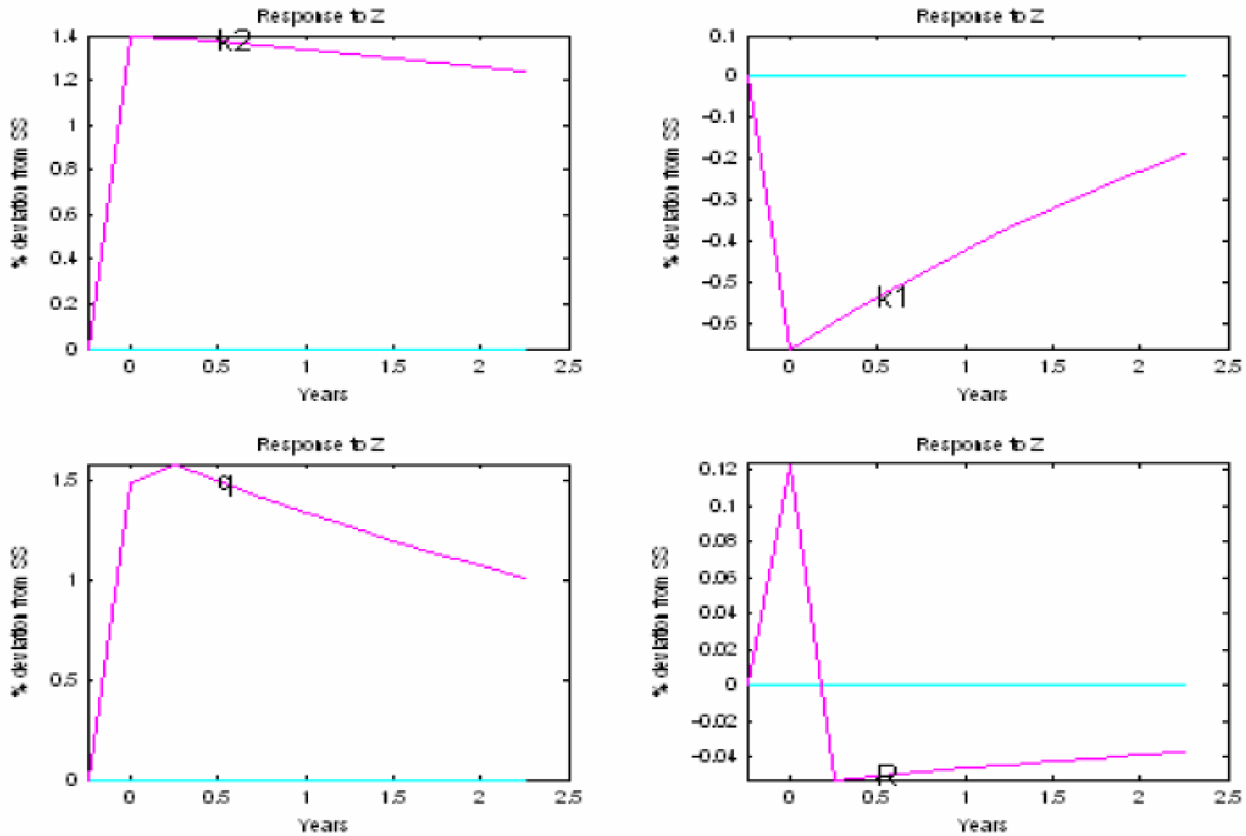


Figure 8b shows the responses to a 1% increase in productivity

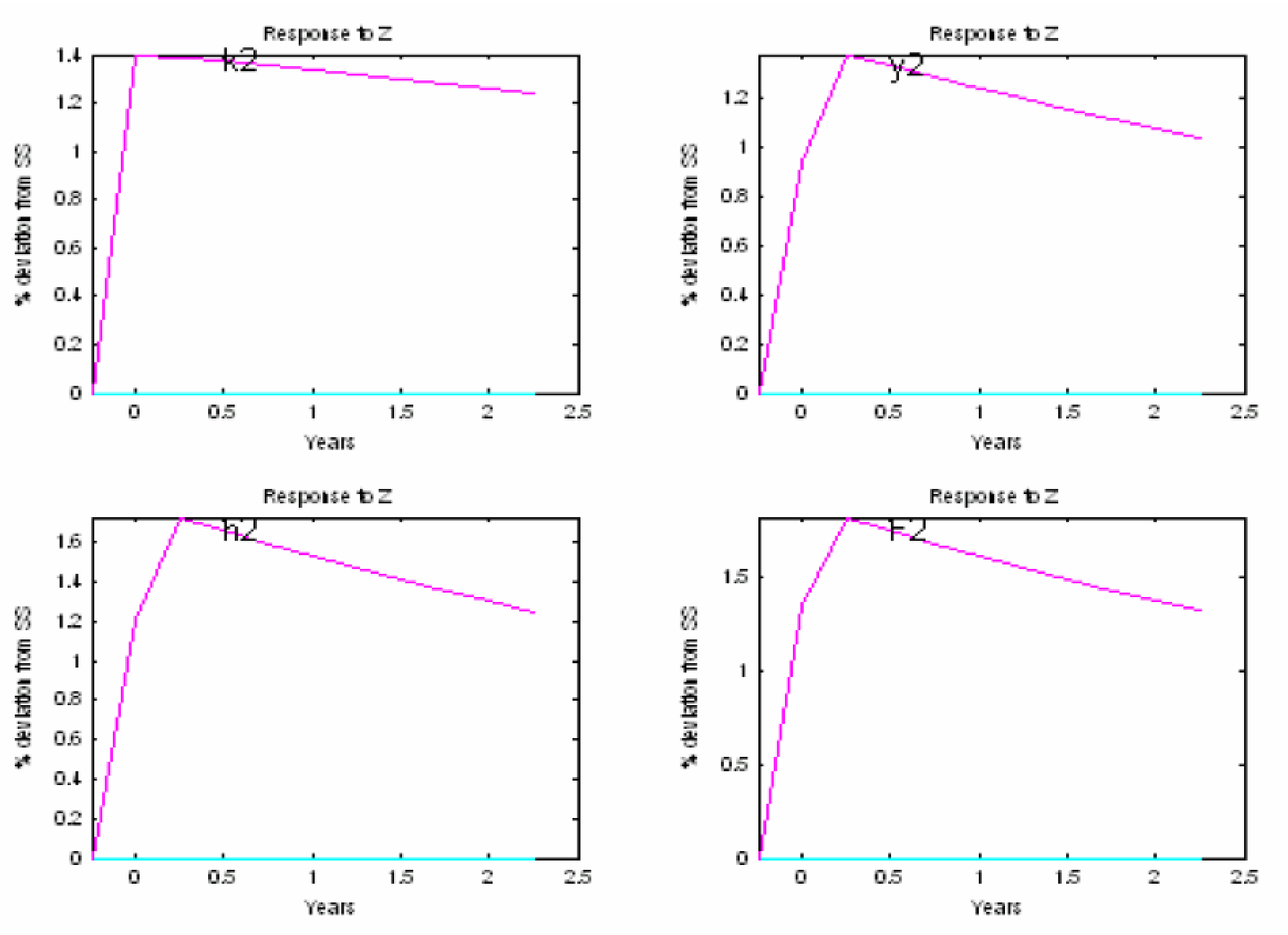


Figure 8c shows the responses to a 1% increase in productivity

1% increase in productivity

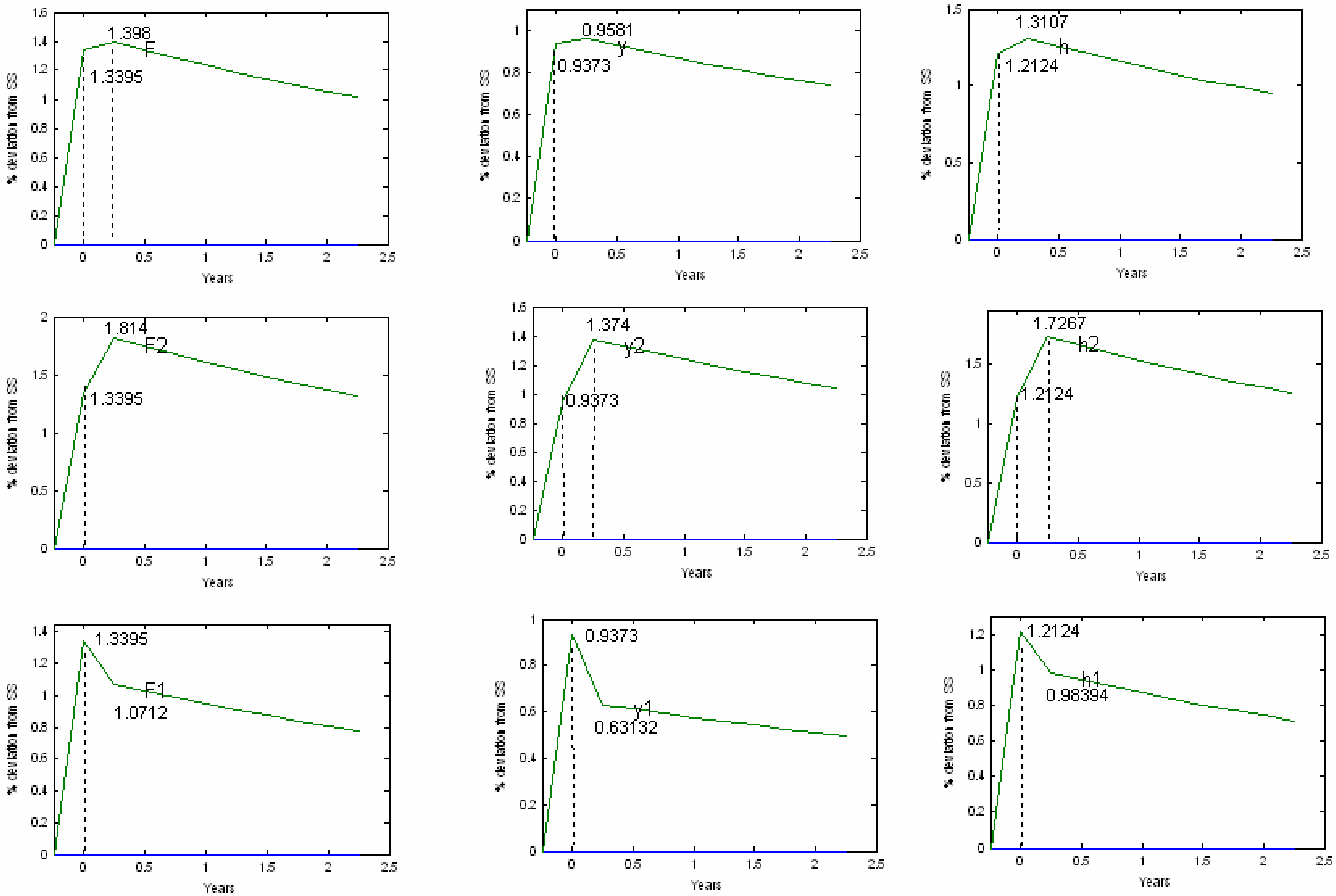


Figure 8d responses of the model economy to an unexpected 1% increase in aggregate productivity. The units on the vertical axes are percentage deviations from the steady state, while on the horizontal axes are years.

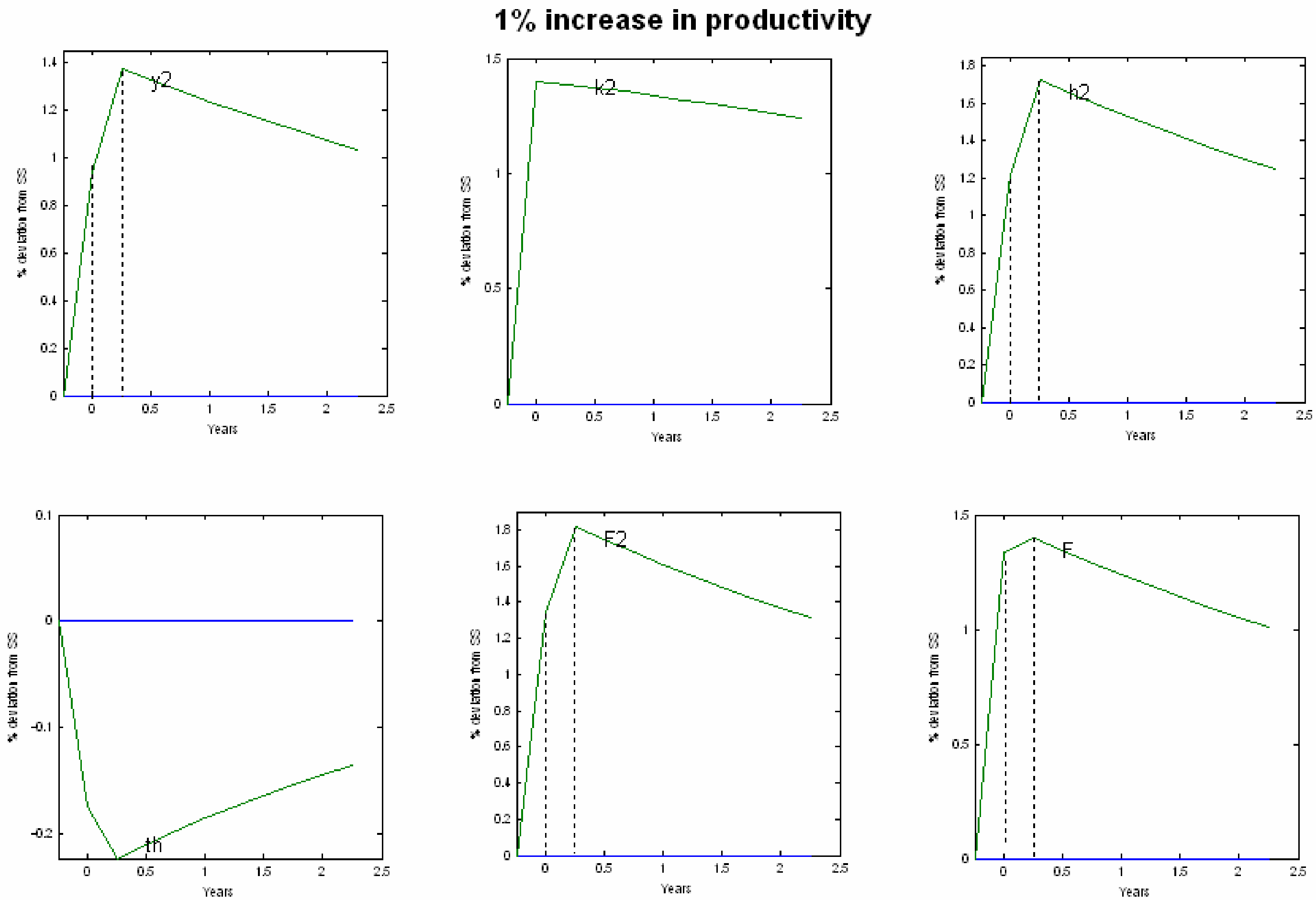


Figure 8e responses of the model economy to an unexpected 1% increase in aggregate productivity. The units on the vertical axes are percentage deviations from the steady state, while on the horizontal axes are years.

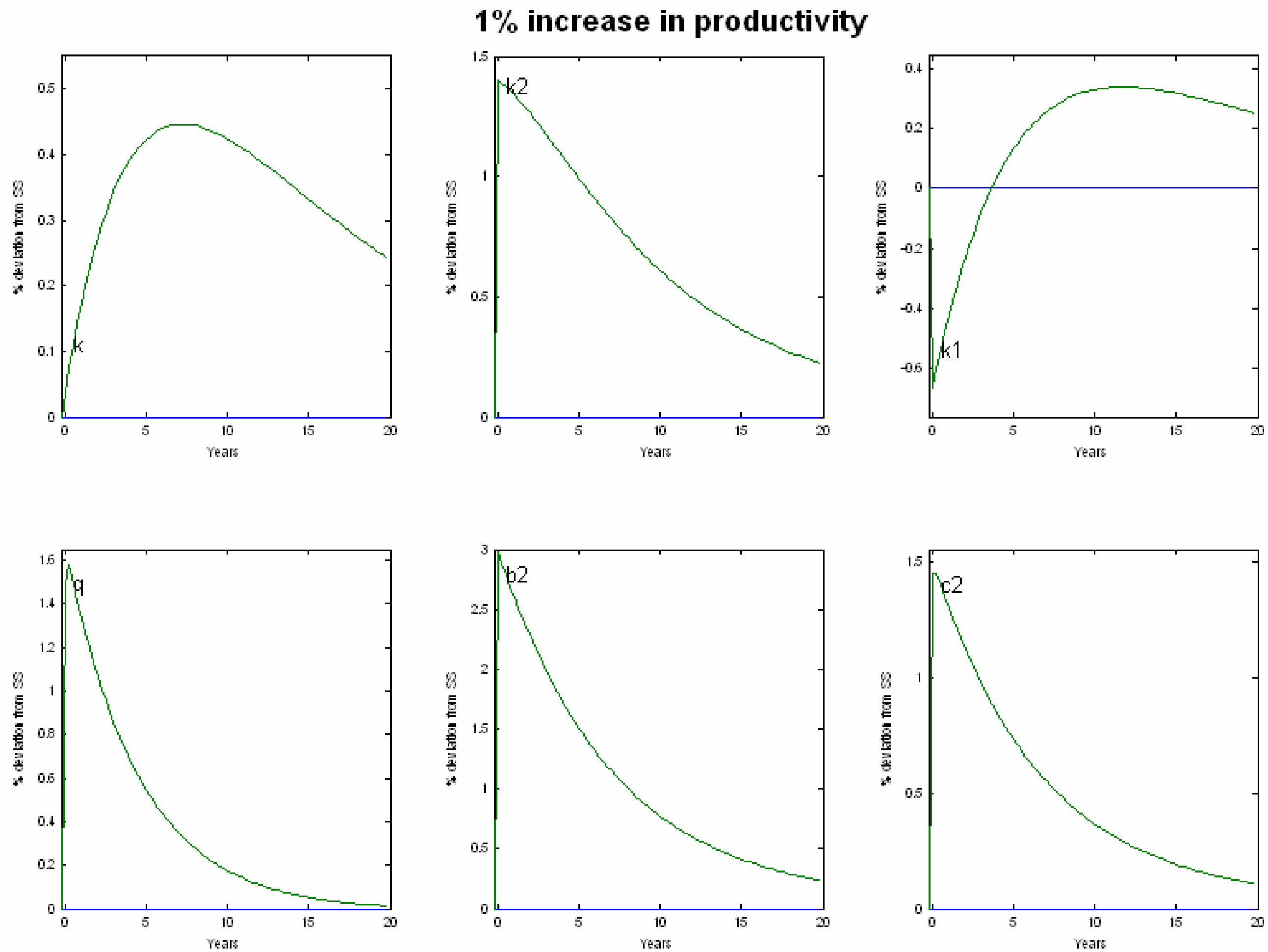
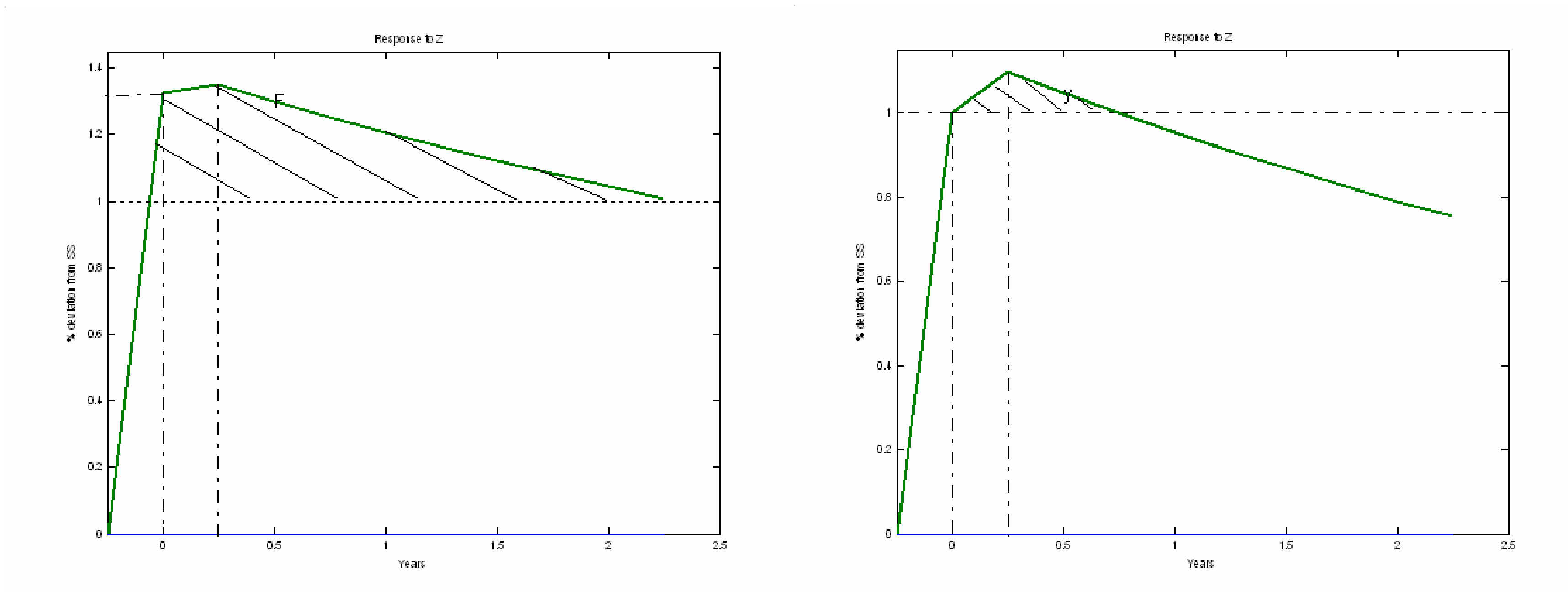


Figure 8f responses of the model economy to an unexpected 1% increase in aggregate productivity. The units on the vertical axes are percentage deviations from the steady state, while on the horizontal axes are years.



$F_t = Z_t k_{t-1} (\theta_t{}^{\alpha} + q_t (1-\theta)_t{}^{\alpha})$ $Y_t = Z_t k_{t-1}{}^{\alpha}$

Figure 9 shows the response of total aggregate output to a 1% increase in productivity in the two-sector and one-sector model

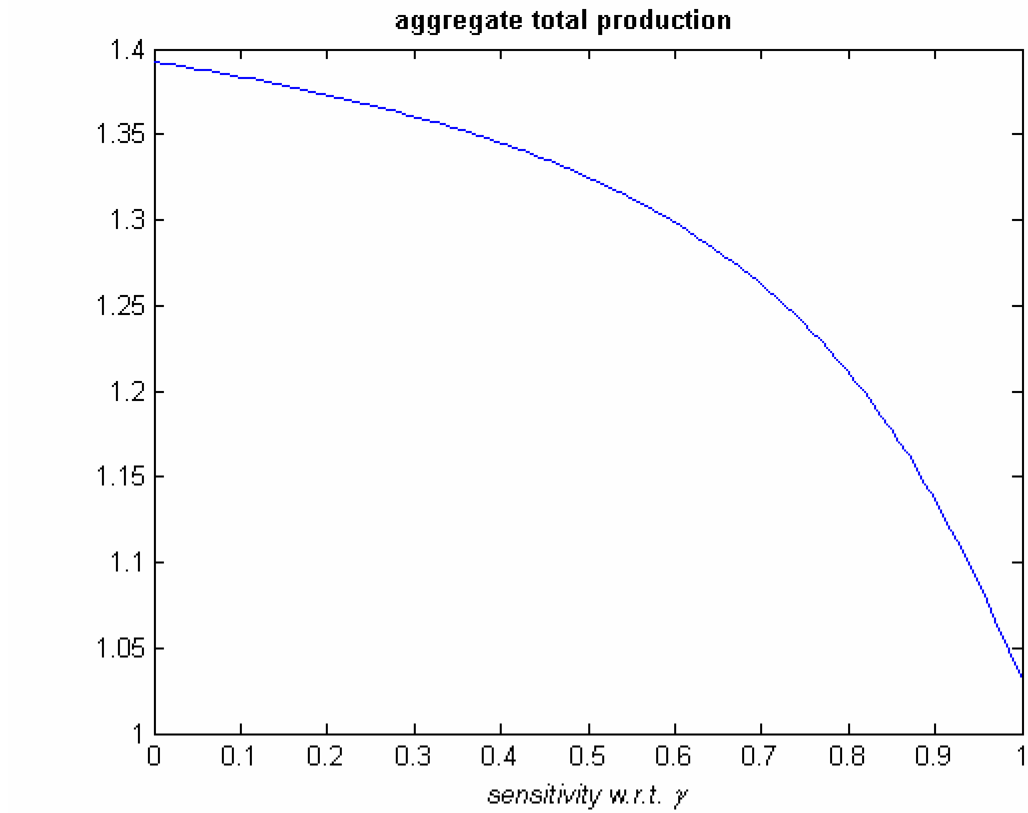


Figure 10a first impact of the shock on production -- i.e. the intensity of reaction for any given γ

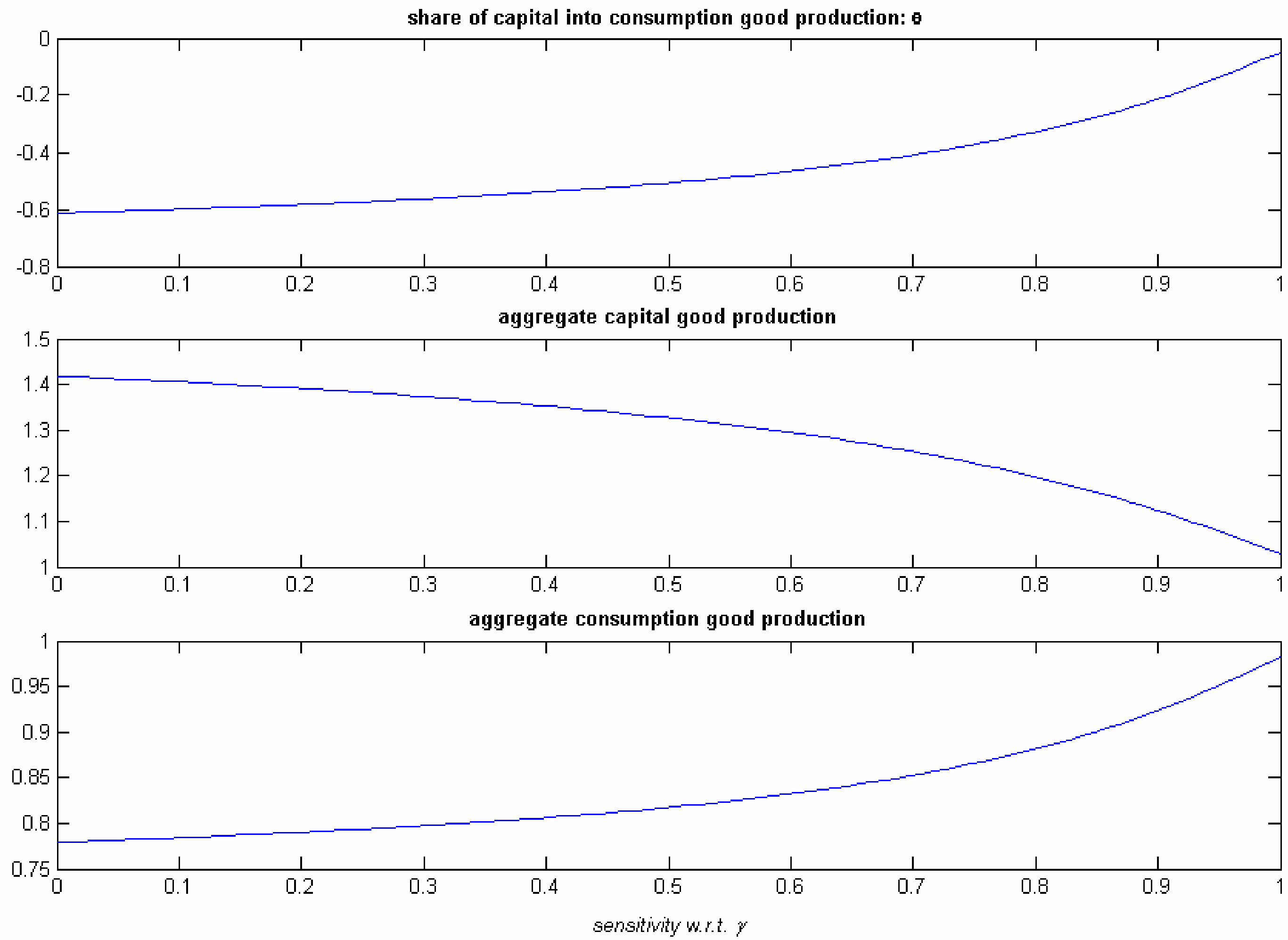
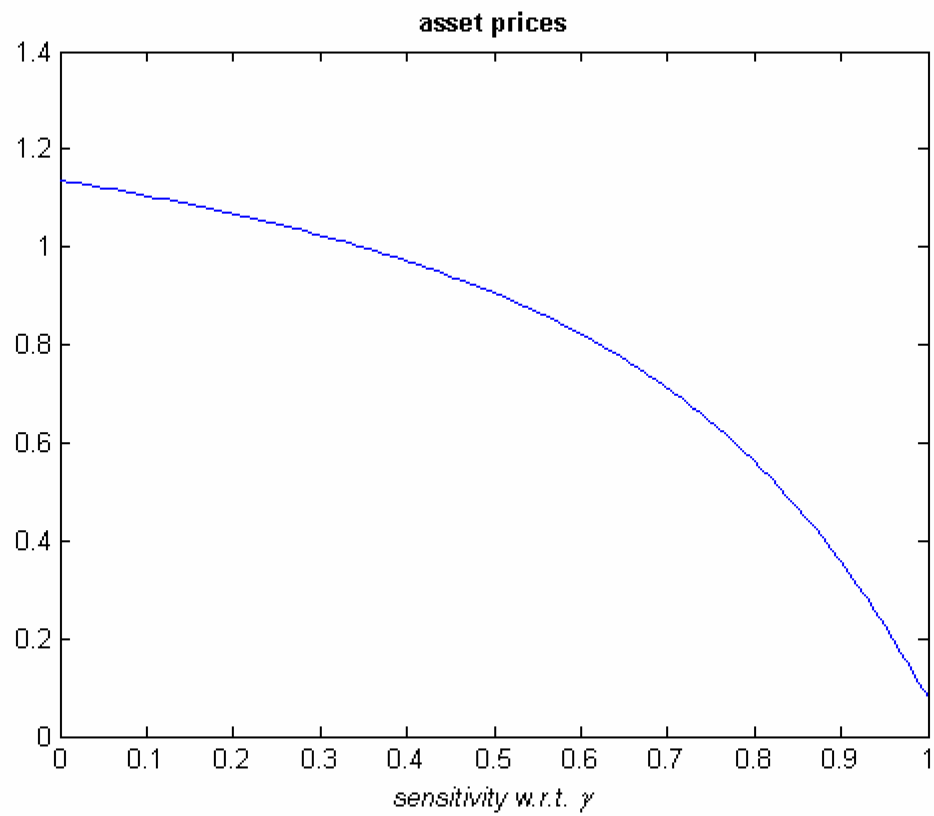


Figure 10b first impact of the shock on production -- i.e. the intensity of reaction for any given γ



10c first impact of the shock on asset prices-- i.e. the intensity of reaction for any given γ

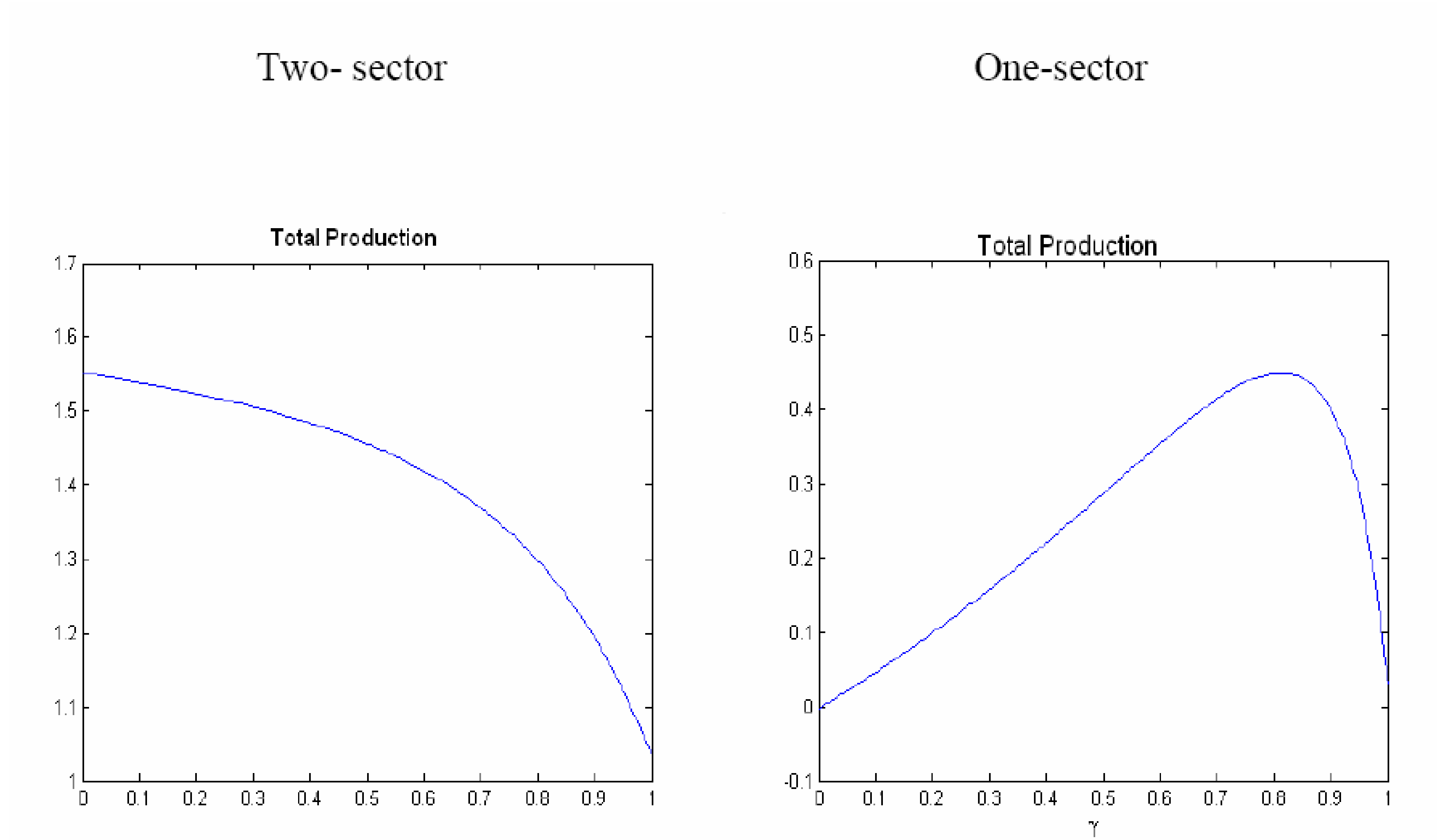


Figure 10d first impact of the shock on production -- i.e. the intensity of reaction for any given γ

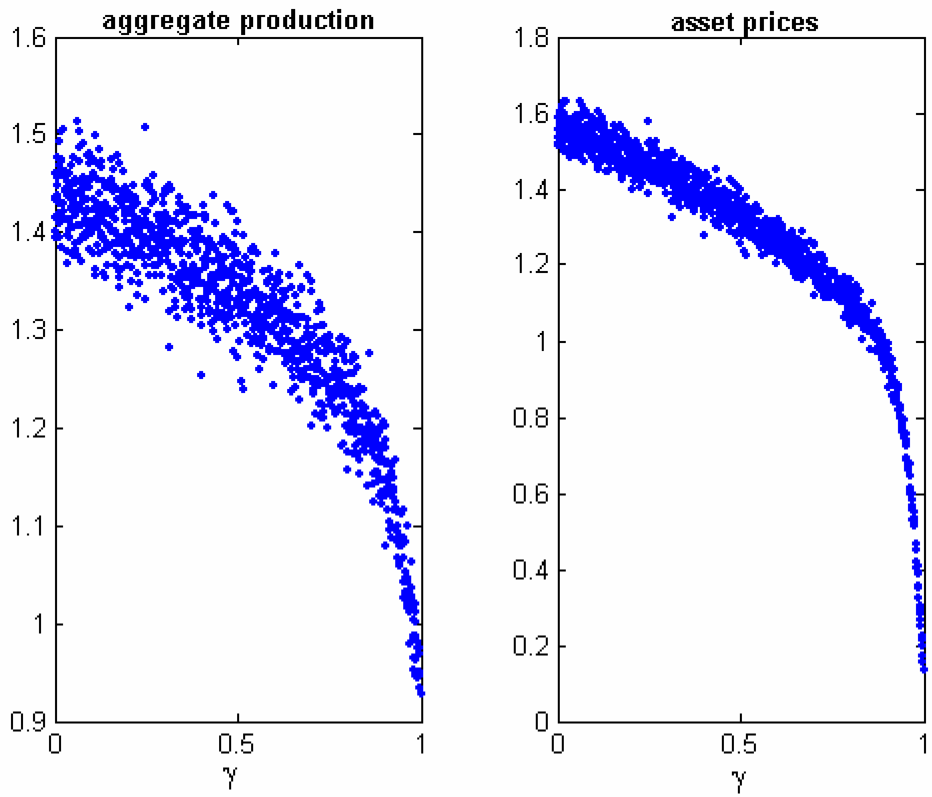


Figure 11.a standard deviations given a particular value for γ.

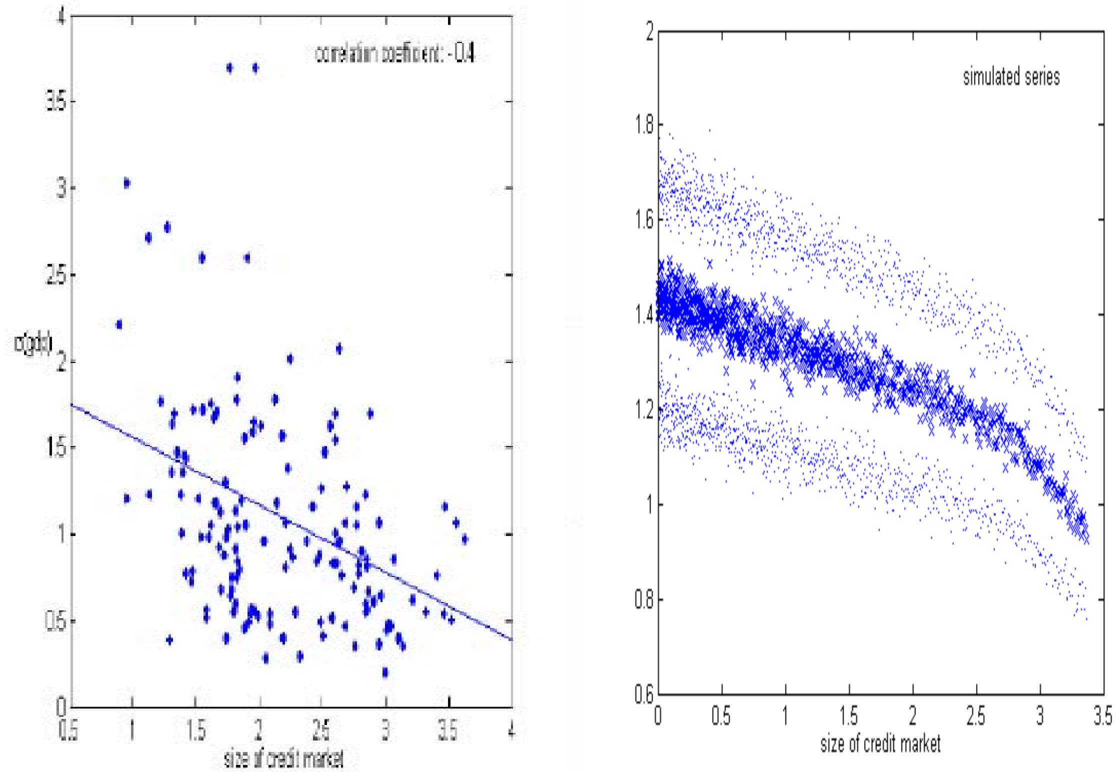
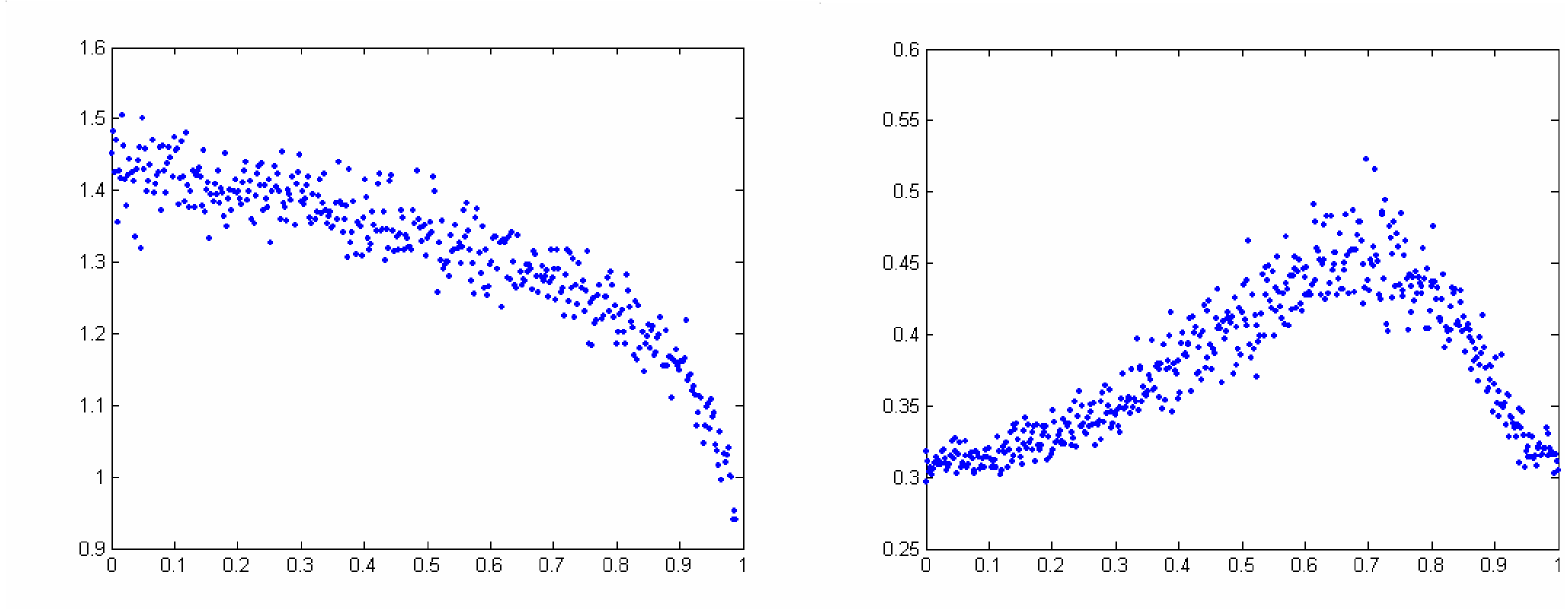


Figure 11.b Each point represents the standard deviations given a particular value for γ. I simulate the model for 1000 value of γ in the range [0,1]. The length of the simulated series is of 5 years while the number of simulated series for the calculation of moments is 5000 for any given γ.

Two-sector One-sector



$\mathbf{F_t = Z_t k_{t-1} (\theta_t^{\alpha} + q_t (1-\theta)_t^{\alpha})}$ $\mathbf{Y_t = Z_t k_{t-1}^{\alpha}}$

Figure 11.c Each point represents the standard deviations given a particular value for γ.

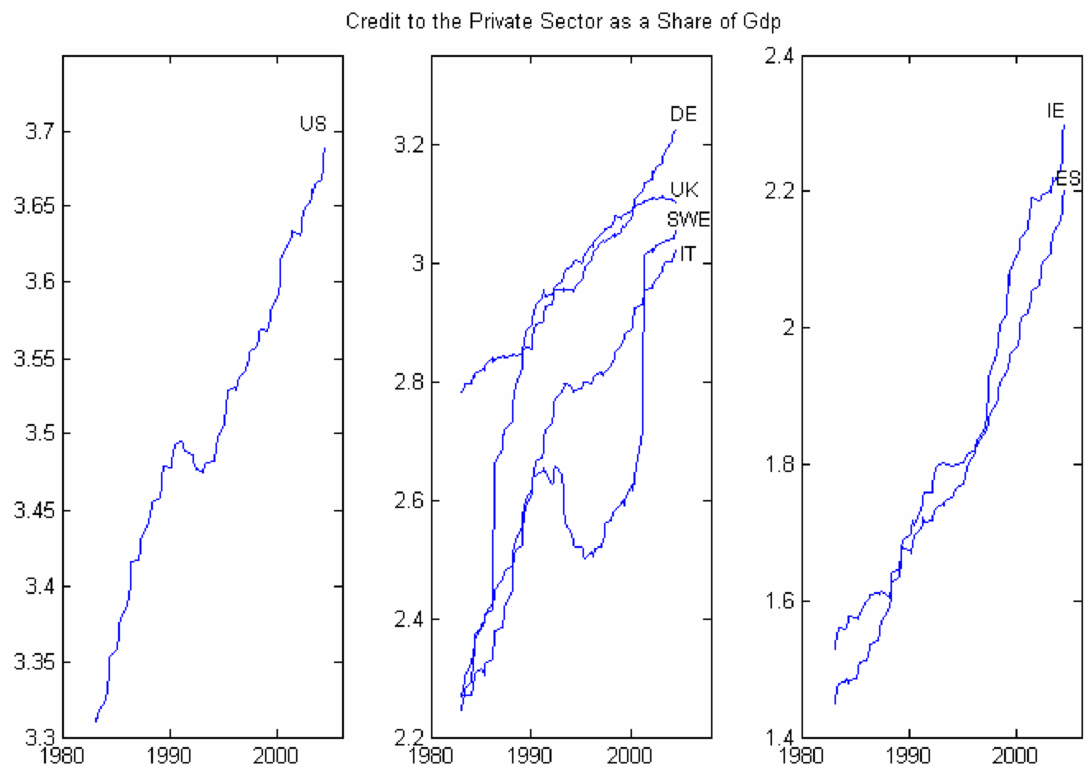


Figure12 behavior of the size of the credit market during the last 20 years