Some Additional Evidence from the Credit Channel on the Response to Monetary Shocks : Looking for Asymmetries*

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Abstract

The credit channel of monetary policy has both cross-sectional and time-series implications for the reaction of the economy to monetary shocks. This paper focuses on the more rarely investigated time-series aspect and shows that the economy has varying sensitivity to monetary shocks over time. By using a Threshold VAR model, we find that output and credit spreads react much stronger to monetary shocks when cash flows or dividends are low. This distinction in the regimes is in particular more significant than one based on the stage of the business cycle or on the stance of monetary policy. In this sense, the response to a tightening for instance cannot be considered as constant and traditional impulse-response functions have to be taken with some caution.

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1 Introduction

The traditional interest rate channel of monetary policy has been shown to have only modest effects on the real economy. In this framework, it appears difficult to explain how small changes in interest rates would be able to trigger important responses in the economy. As a response to this argument, economists have been looking for other channels of transmission of monetary policy, which could complement the traditional one and magnify the reaction of the economy. One important direction that has been investigated attributes a central role to the presence of imperfections on credit markets. Authors such as Bernanke, Gertler and Gilchrist [7] have developed models where next to the traditional interest rates channel, a credit channel is also present and act as a financial accelerator. Following the presence of imperfections on the credit market, a tightening of monetary policy which produces a deterioration of firm's net worth, is also reducing their capacity to raise funds and therefore amplifies the reaction of the economy.

The credit channel setup has both cross-sectional and time-series implications. First, as firms are heterogeneous in terms of financial capacity, they should also be affected to a varying degree by a monetary policy shock. Second, as net worth varies over time, the whole economy should be affected differently over time by a monetary policy shock. The cross-sectional side has been investigated quite intensively in papers such as Gertler and Gilchrist [26] or Fisher [19], whereas the time-series implications have received much less attention. Traditional studies characterising the response of the economy to a monetary policy shock and notably those based on VAR framework, see for instance Christiano, Eichenbaum and Evans [12] or Bernanke and Blinder [3], have assumed that the response of the economy is constant over time. Some authors, see for instance Garcia and Schaller [24], Weise [52] or Choi [11] have adressed the issue of time-varying response of the economy but this has never been done in connection with the credit channel of monetary policy.

The objective of this paper is to characterize the response over time of the economy to a monetary policy shock using the implications of the credit channel of monetary policy. We will in particular use this latter framework to try to identify criteria in order to determine what are the periods where financial constraints have been more severe. We will then investigate whether the reaction to monetary policy in these periods is significantly different than in periods where firms are less financially constraint. For this purpose, we will make an extensive use of credit spreads. It has been shown by some authors (see Gertler and Lown [27] or Gertler, Hubbard and Kashyap [25]) that credit spreads play a central role in the credit channel framework as a proxy for agency costs. This arises because the presence of imperfections on credit markets creates a wedge between the cost of internal and external finance.

The econometric framework we use is a threshold vector autoregression (TVAR). This kind of model has been first put forth by authors such as Tong [49] and [50] or Potter [41]. It has the advantage of allowing for non-linear relationships between the variables. This is done by defining different regimes so that the model is composed of different piece-wise linear processes but is globally non-linear. The structure of the underlying VAR follows most of the literature on the effects of monetary policy and in particular the identification scheme of Christiano, Eichenbaum and Evans [12].

Results show that the response of the economy to a monetary policy shock cannot be considered as constant and that there are considerable asymmetries over time. In particular, we show that the reaction is substantially stronger when cash flows are low or when dividends are low. These periods are supposed to be time where financial constraints bind the most. The results are therefore in accordance with the implications of the credit channel of monetary policy. Moreover, cash flows and dividends seem to be better proxy to identify periods of financial constraints than industrial production or the stance of monetary policy.

The remaining of the paper is structured as follows. Section 2 gives an overview of the existing literature related to the present issue. Section 3 presents a simple model of the credit channel and shows why this type of model should gives raise to asymmetries over time in the response of aggregate variables and credit spreads. Section 4 presents the empirical model and section 5 the results of the tests. Finally, section 6 concludes the paper.

2 Literature

There are two types of literature, which are closely related to the present topic. The first one deals with the transmission channels of monetary policy. In particular it adds new mechanisms which can complement the traditional view of monetary policy and therefore enhance the effects on the real economy. The second part of the literature investigates the response of the economy to monetary shocks. It emphasizes the reasons why monetary policy might have assymetric effects on the economy and draws some empirical implications.

2.1 The credit channel of monetary policy

2.1.1 The credit view

An enormous amount of literature has been devoted to the investigation of effects of monetary policy on the real economy. According to the traditional view, a contraction of monetary policy influences the economy trough an increase in the cost of capital and thus has a dampening effect on activities such as investment and the purchase of durable goods. While it has been empirically acknowledged that there are some effects, at least in the short term, see e.g. Friedman and Schwartz [21], Romer and Romer [44], Bernanke and Blinder [3] or Christiano et al. [12], authors have also noticed that changes in interest rates are small with respect to the alleged effects[1]. Therefore, part of the literature has focused on exploring alternative transmission mechanisms for monetary policy, which could complement the traditional view of monetary policy. The objective was to explain how relatively small shifts in interest rates could be at the origin of a sustained response of the economy.

The main response of academics was a new transmission mechanism called the credit channel of monetary policy. The leading contributions in this field have been brought by authors such as Greenwald and Stiglitz [30], Bernanke and Gertler [4], Carlstrom and Fuerst [9], Kiyotaki and Moore [37] and Bernanke, Gertler and Gilchrist [7]. This alternative view of monetary policy assigns a central role to the presence of imperfections on the credit market due especially to information asymmetries between agents. Indeed, the presence of asymmetric information leads to a gap between the cost of internal funds and the cost of obtaining finance from outside. Being unable to observe all the relevant information, lenders will require a premium to make funds available, compensating for the risks linked to adverse selection or moral hazard problems. The difference in the cost between internal and external funds will be a function of the financial position of the borrower. The healthier the position of the borrower is, the smaller the premium required by the lender. Therefore, in this context, the financial position of the firm matters and the Modigliani-Miller theorem does not hold anymore. In this framework, monetary policy will have an impact through its effect on the balance sheet of the borrower. In general, a contraction of monetary policy leads to a lower net worth of the firm by, for instance, lowering the value of collateral assets. In so doing, the borrower faces less favourable conditions for financing its project and decreases the scale of its investment plans. Therefore, monetary policy will affect not only the level of interest rates (traditional view), but also the size of the external finance premium.

Among the most recent contributions, the paper by Bernanke, Gertler and Gilchrist [7] is certainly one of the most comprehensive and representative of this literature. Their paper illustrates a general equilibrium model in which credit market imperfections have been endogeneized. The presence of imperfections propagates and amplifies the effects of both nominal and real shocks, giving rise to a "financial accelerator" effect. In this setting, imperfections on the credit markets arise because the presence of asymmetric information between lenders and borrowers implies agency costs. Due to the presence of agency costs, intermediaries will require a premium to finance firms. This premium is inversely related to the net worth of entrepreneurs. In turn, changes in net worth happen mostly through changes in the price of capital, but also through changes in entrepreneurial income. Therefore net worth is procyclical. As a consequence, a positive shock to the economy is amplified because it also improves the net worth of the firm, thereby facilitating the possibility to obtain credit. In a final step, the authors integrate this mechanism in a sticky price model and show that

[1] For a review of the weaknesses in the conventional view of monetary transmission, one should refer to Bernanke and Gertler [5].

monetary policy shocks are amplified by the presence of credit market imperfections.

Other relevant contributions of the same type are found in Kiyotaki and Moore [37] and Carlstrom and Fuerst [9]. Kiyotaki and Moore emphasized the role played by changes in asset prices in the determination of credit conditions. In a model where land is used as collateral, they show for instance that a negative shock to the economy lowers the value of land and therefore the value of collateral. This is equivalent to a tightening of credit conditions and impacts the reaction of firms. Carlstrom and Fuerst on the other hand uses the same type of model as Bernanke, Gertler and Gilchrist [7] and illustrate that it is able to generate hump-shaped responses of output to shocks.

2.1.2 Empirical evidence

Following the emergence of these new models, academics have also started to investigate empirical evidence on the credit channel of monetary policy. These studies can be classified in two main streams.

The first type of approach focuses on the cross-sectional implications of the credit channel. Indeed, if the financial position of the borrower matters, then firms with different balance sheets should be impacted differently by a monetary shock. In particular, Gertler and Gilchrist [26] and Fisher [19] show that small firms are relatively more affected by a shock. In this study, sales, inventories and debt of small US manufacturing firms react more strongly than those of large firms. In the same vein, Perez-Quiros and Timmermann [40] show that small firms' stock returns display a higher sensitivity to variables representative of credit market conditions. Moreover, the sensitivity of small firms is particularly enhanced during recession periods. In another interesting paper, Ehrmann [16] extends the study of Gertler and Gilchrist to Germany and finds similar results. He also shows that the distributional asymmetries are enhanced in periods of weak activity. Finally, one must also mention the important literature related to the seminal paper by Fazzari, Hubbard and Petersen [18]. In this paper, the authors try to show that companies facing large financial constraints, and therefore more disposed to rely on external finance, will be less sensitive to investent opportunities. This happens because expansion is more expensive using external finance than it is using internal funds. As a proxy for the degree of financial constraint of a firm, they use the level of dividends paid. A company paying a higher dividend is supposed to be less liquidity constrained and have more internal funds at its disposal. Thus, firms paying higher dividends are less sensitive to financial constraints.

The second type of approach works with aggregate data, focusing on the amount of credit levered by the economy over time. Bernanke and Blinder [3] have looked at the information content of changes in the federal funds rates and their impact of the economy. In a first stage, they find that federal funds rates is an appropriate measure of monetary policy and that it provides substantial information about the future evolution of real variables. In a second step, they lend support to the credit channel by showing that loans react substantially to changes in monetary policy. Furthermore, the reaction of loans corresponds in timing to the reaction of employment. A second important paper is the one by Kashyap, Stein and Wilcox [36]. These authors investigate the developments of the mix between bank loans and commercial paper issuance following a monetary shock. They find that, following a contraction of monetary policy, issues of commercial paper increase and bank loans decline. They interpret this movement as a shrinking credit supply from banks and therefore evidence for the credit channel of monetary policy. Moreover, they illustrate that the mix between the two variables helps predict future movements in inventories and investment. However, some authors have disputed the interpretation of changes in the mix as evidence for the credit channel. Indeed, Oliner and Rudebush [38] and Friedman and Kuttner [20] have argued that shifts in the mix are due mainly to fluctuations in the issue of commercial papers by large firms rather than to a contraction in bank loans during recessions.

All in all, one can note that evidence using aggregate data is rather scarce and mitigated with respect to what has been done on a cross-sectional basis.

2.1.3 The role of credit spreads

The literature mentioned above attributes a key role in the transmission mechanism to the gap in the cost between external and internal finance. Following this implication, numerous authors have identified the spread between risky interest rates and risk-free rates as a good proxy of the external finance premium. In the wake of this assumption, they have tried to characterize the behavior of credit spreads, both at the short and at the long end of the curve.

Gertler, Hubbard and Kashyap [25] develop a framework where financial contracting between lenders and borrowers includes asymmetric information. Very much in the same vein as the Bernanke and Gertler [4] model, the adverse selection problem arising from the presence of imperfections in the credit market gives raise to a wedge between the cost of internal and external finance.This gap is estimated through the use of the difference between six-month commercial paper and Treasury bill rates. The authors then show that, in accordance with the credit channel, movements in agency costs play a significant role in amplifying investment fluctuations. Interest rates spreads are then shown to signal efficiently movements in these agency costs. These results therefore shed some light on the reason why interest rate spreads help to predict future investment and output fluctuations.

More recently, Gertler and Lown [27], focusing on the high yield bond market since the beginning of the eighties, confirm the predictive power of credit spreads with respect to output fluctuations. They also argue that the spread between high yield bond rates and risk-free rates can be interpreted as a measure of overall financial conditions and more particularly of the premium for external funds. Furthermore, they show that, in the recent period, interest rate spreads have outperformed other traditional financial indicators such as the term spreads or fed funds in forecasting economic activity. The authors argue that this change in forecasting power is linked to the change in US monetary policy after the Volcker period between 1979 and 1982.

Finally let us also mention a very large literature focusing on the predicting power of financial variables with respect to future economic fluctuations. A large number of these studies have included credit spreads in the set of forecasting variables and have found them to help significantly in predicting future real variables. Some of the main papers in this area are Stock and Watson [46] or Estrella and Mishkin [17].

2.2 The response to monetary policy

2.2.1 The traditional view

The background of the model we will use in this paper is the literature which deals with the empirical investigation of the effects of monetary policy on the economy. In particular, there is a series of papers, which uses a VAR system and the ensuing impulse-response functions to simulate the reaction of some variables to a monetary shocks. With respect to our study, some key papers are Bernanke and Blinder [3], Sims [45], Strongin [47] or Christiano, Eichenbaum and Evans [12]. We have already mention the Bernanke and Blinder [3] paper in the previous section and said that one of its main finding is to show that fed funds rates are certainly a good proxy, if not the best, in order to identify monetary shocks. Christiano, Eichenbaum and Evans [12] rely on the same type of framework, but use the flow of funds statistics. They show in particular that a contraction of monetary policy leads on one hand to a fall in some monetary agregates such as nonborrowed reserves or M1 money supply and on the other hand to a persistent decline in some economic agregates such as real GNP, employment and retail sales. They also show that, in the aftermath of the monetary contraction, net funds raised by the corporate sector rise for roughly a year, but then decline as the policy shock gains momentum. Using nonborrowed reserves instead of fed funds rate as a proxy for monetary policy, Strongin [47] show that monetary shocks have a strong liquidity effect and therefore it explains most of output variance in a two years horizon.

As it will become clear in what follows, we believe that one of the drawback of this literature is that it assumes that the reaction of the variables investigated is constant over time. Following the intuition given by the credit channel, we will show that the impulse-responses described in this literature can indeed hide substantial shifts over time, depending in particular on how tight general financial conditions are.

2.2.2 The presence of asymmetries

As a matter of fact, there is already some literature dealing with the possible presence of asymmetries in the response of the economy to monetary shocks. Some authors have argued that a variety of economic theories imply that the economy should adjust asymmetrically to exogenous shocks. This is the case of models with sticky wages, sticky prices or menu costs for instance. Therefore, empirical researchers have investigated the presence of asymmetries in the response of different real variables to exogenous disturbances such as demand shocks or monetary shocks.

Cover [15] looks at the impact of money-supply shocks on output in the US in the after-war period. He observes that positive money-supply shocks have no effect on output, whereas negative money-supply shocks cause output to decline. He also shows that negative shocks have larger effects. In the same spirit, Rhee and Rich [43] and Karras and Stokes [34] confirm these results and notice that the asymmetries are exacerbated in periods of high inflation. They also show that the asymmetric responses apply particularly to investment, whereas consumption responds more symmetrically. Following these papers, Ravn and Sola [42] show that the most relevant asymmetry is to be found between big and small changes rather than between positive and negative changes. Their paper illustrate that small shocks have real effects, while big shocks are mostly neutral. Garcia and Schaller [24] explore the asymmetric effects of changes in interest rates. They find that changes in interest rates have larger effects during recessions than during expansion phases. Moreover, interest rates and spreads with risky interest rates have significant effects on the probability of changes in regimes between recessions and expansions. A recent paper by Weise [52] goes very much in the same direction by showing that money-supply shocks have larger effects when output growth is initially low. Finally, Choi [11] finds that the effects of changes in the money-supply on interest rates vary significantly across monetary policy stances.

3 The Model

3.1 Theoretical background

There has been numerous versions of the credit channel of monetary policy. Whereas authors have used different frameworks, they all share a few common conclusions. First, external finance is more expensive than internal finance. Second, the premium of external finance varies inversely with net worth of the entrepreneur. Finally, a negative shock reducing a borrower's net worth, reduces as well spending through an increase in the external finance premium. These results are most easily seen with the following simple partial equilibrium model drawn from Bernanke, Gertler and Gilchrist [6]. Assume there are two periods, 0 and 1. The entrepreneur has a technology where he can produce using a fixed factor K (already in place) and a variable input X (to be acquired). The fixed factor can be sold at the end of period 1 at a market price Q_1. Output in period 1 is

$$A_1 f(X_1)$$

where A_1 is a technology parameter. At the beginning of the period, the firm has a gross cash flow $A_0 f(X_0)$ and debt $R_0 B_0$ where R_0 is the gross interest rate on the debt. The budget constraint for the entrepreneur is therefore

$$X_1 = A_0 f(X_0) + B_1 - R_0 B_0 \tag{1}$$

which means that the quantity of input purchased must be equal to previous period net cash flow plus new borrowing. Consequently, the entrepreneur chooses X_1 and B_1 in order to maximize period 1 output net of debt repayment. Suppose now that K serves as collateral for new borrowings, i.e. the ownership of K is transferred to the lender if the borrower does not pay his debt. In this case, the purchase of variable input is limited by the present value of K, i.e.

$$B_1 \leq (Q_1/R_1) K \tag{2}$$

Combining the last two equations yields the following

$$X_1 = A_0 f(X_0) + (Q_1/R_1) K - R_0 B_0 \tag{3}$$

This last equation emphasizes the main results mentioned above. When the financial constraint binds, spending X_1 is below the optimum and $A_1 f'(X_1) > R_1$. The difference between these two terms can be interpreted as an implicit measure of agency costs. As net worth declines, the company is more severely constrained, spending is lower and agency costs are increasing. As a result, agency costs vary inversely with net worth. One of the main implication of this equation is that it leads to an asymmetry in the reaction to external shocks both cross-sectional and over time. On a cross-sectional basis, firms with a lower level of net worth will have to pay a higher premium to finance investment and will therefore be more financially constrained. On a time-series perspective, there are periods in which the general level of net worth is lower. Therefore, in these periods, the economy is likely to be more constrained financially and consequently more sensitive to external shocks. In the rest of the paper, we will focus on this second aspect.

The interesting side of equation (3) is that it provides good hints of how to determine a period of financial constraint. By looking at the right-hand side of the equation, you see that the different factors that can affect net worth. First, a change in net worth can happen through changes in cash flow linked to the previous period business. Second, it can happen through a fall in the price of asset prices, Q_1 in this case. Third, it might happen through a rise in interest rates which in turn increases the debt burden and lowers the price of assets.

Following the intuition contained in equation (3), authors have in turn emphasized these different channels of fluctuations in net worth. The most simple process, such as in Carlstrom and Fuerst [9] for instance, directly links net worth to the evolution of output through an elasticity coefficient. This coefficient is positive so that net worth in this case is procyclical.

$$N = N(output) \tag{4}$$

Kyiotaki and Moore [37] put more emphasis on the effect of changing asset prices on net worth.

$$N = N\left(asset\,prices\right) \tag{5}$$

This happens in particular because financial assets are used as collateral by firms in order to obtain external finance. Another possibility is given by Bernanke, Gertler and Gilchrist [7], who provide us with a more sophisticated process where net worth is a function of both firm's cash flow and entrepreneur wage. Cash flows are the most important part and is determined by both retained earnings and changes in the value of capital. In this case we have

$$N = N(asset\,prices,\ cash\,flows) \tag{6}$$

Finally, Fazzari, Hubbard and Petersen [18] assume that firms that pay more dividends are less likely to be financially constrained. In this case, the level of dividends would be a good proxy for the financial soundness of the firm

$$N = N\left(dividends\right) \tag{7}$$

3.2 The channel of monetary policy

These processes for the determination of net worth provides us with insights in the way monetary policy can impact net worth and in turn the external finance premium. Indeed, Bernanke and Gertler [5] have classified the effects as direct and indirect.

Direct effects of monetary policy are of two kinds. The first one is linked to the debt burden. When monetary policy is tight, interest rates are high and firms see their interest rate charges increase. This expands the debt burden, lowers cash flow and thus weakens the balance sheet. Second, increasing interest rates are usually linked to declining asset prices. In turn, this leads to weaker value of the assets of the firm.

Moreover, monetary policy also has an indirect effect on borrowers' balance sheet. A tightening of monetary policy is generally linked with slowing economic activity and therefore firms will face declining sales. On the other hand, costs are slow to adjust, so that, for some time, margins will be under pressure and cash flows weaker. This in turn weakens the balance sheet conditions of the firms.

The effects of monetary policy can also be understood with the use of figures 1 and 2. In the first figure, one can see how the credit channel is functionning in relation to the traditional view of monetary policy. The demand for investment is represented by the curve D and the supply of funds by curve S. The later is horizontal at the level of the risk-free rate R^f as long as investment is covered by internal funds N. After that, the company has to borrow and will have to pay an external finance premium. This premium is increasing with the amount borrowed. At the equilibrium E, investment is I, funds borrowed are $I - N$ and the interest charged is R^b. The external finance premium is therefore $P = R^b - R^f$. In the traditional money view, a tightening of monetary policy, represented by an upward shift in risk-free rates, moves the supply curve to S', so that investment declines to I'. However, since changes in balance sheet conditions are not taken into account, the external finance premium remains roughly unchanged and plays no role in the transmission channel. On the contrary, in the credit view of monetary policy, the supply curve moves to S'', so that the spread this time increases from P to P''. The reason for this increase is twofold. First, as monetary conditions become tighter, the level of net worth diminishes from N to N'' so that the kink of the supply curve is moved to the left. Second, the level of interest rates is also affecting the premium and shifts the slope of the curve upward. This happens because, even if the current level of net worth remains unchanged, the lender would require a higher premium in order to compensate for a higher probability of default in the future. This increase in the probability of default arises because after a monetary contraction, the economy is expected to be weaker, affecting therefore future cash flows of the firm. As a result, the effect of the monetary shock is amplified and production declines futher to $I'' < I'$. This mechanism is called the financial accelerator.

In figure 2, we try to show why the reaction of the economy should vary according to the state of the net financial position of the firm. In fact, it might happen that in some cases, even in the presence of a credit channel, the increase in the spread is minor. This would happen if the contraction of monetary policy happens at a time where balance sheets are very sound and net worth is high. For instance, the contraction could enter in a period where cash flows are generous or when asset prices are very high. In this case, the risk of lending is increased only marginally, so that the premium required by borrower would not increase substantially. On the other hand, if the tightening of monetary policy happens when cash flows are already weak or asset prices depressed, then this might increase dramatically the probability of default of firms, pushing the external premium much higher. As a result, whereas in the baseline case the supply curve would shift to S', it might be that in periods of severe constraints, the curve shifts even further to S'''. In this case, we would see the spread increasing to $P''' > P'$ and output would decline more dramatically to I'''. On the other hand, in periods where firms are less constrained, the reaction would be less significant and the supply curve would stay closer to the baseline case, for instance in S''. The spread would then remain very low in P'' and the reaction of output would be rather muted to I''.

4 The empirical model

4.1 The baseline VAR

The benchmark linear model against which we will be testing for non-linearity is a standard structural VAR, such as in Christiano, Eichenbaum and Evans [12] for instance. The model has the following form:

$$y_t = c + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + ... + \Phi_p y_{t-p} + \varepsilon_t \tag{8}$$

where y is a vector of k variables included in the model, p is the number of lags, Φ_n are the matrices of coefficients and ε_t is the vector of errors, assumed to be serially uncorrelated with a variance-covariance matrix . An alternative way to represent the model, which will be useful later is the following:

$$y_t = \Phi x_t + \varepsilon_t \tag{9}$$

where $x_t = \begin{pmatrix} 1 & y_{t-1} & y_{t-2} & ... & y_{t-p} \end{pmatrix}'$ and $\Phi = \begin{pmatrix} c & \Phi_1 & \Phi_2 & ... & \Phi_p \end{pmatrix}$.

In order to identify properly the shocks to monetary policy, we will assume that the VAR disturbances ε_t are related to true economic shocks through the relation

$$\varepsilon_t = S u_t \tag{10}$$

with $SS' =$ and where S is lower triangular and u_t has a covariance matrix equal to the identity matrix. Coefficients in this model will be estimated by ordinary least squares, equation by equation. Thanks to the decomposition in 10, we will be able to use the coefficients in order to look at the reaction of the variables to the true economic shocks through the use of impulse-response functions.

4.2 Threshold VAR

The alternative model which allows for non-linearities is a threshold VAR (TVAR). It was originally developped in an univariate setting by Tong [49] and [50] and extended to a multivariate framework for instance by Choi [11]. In this model, one can allow the relationship to be piece-wise linear, i.e. linear in specific regimes, but globally non-linear. Regimes are determined by the position of a given variable with respect to one or several thresholds. If one does not have an a-priori idea of the level of the threshold, then the later is also estimated in the model using a grid search procedure developed for instance in Hansen [31] and [32], Pesaran and Potter [39] or Choi [11].

The model we use is a TVAR with two regimes[2] :

$$\begin{aligned} y_t = & \left(c_1 + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + ... + \Phi_p y_{t-p}\right) I\left(\tau_t > \tau^*\right) + \\ & + \left(c_2 + \Psi_1 y_{t-1} + \Psi_2 y_{t-2} + ... + \Psi_p y_{t-p}\right) I\left(\tau_t < \tau^*\right) + \varepsilon_t \end{aligned} \tag{11}$$

in which $I(\cdot)$ denotes the indicator function, τ_t is the threshold variable and τ^* is the level of the threshold. Again, a more compact way to express the model is

$$y_t = \left(x_t'\Phi\right) I\left(\tau_t > \tau^*\right) + \left(x_t'\Psi\right) I\left(\tau_t < \tau^*\right) + \varepsilon_t \tag{12}$$

[2] A TVAR model with three regimes was also investigated. However, it did not provide additional insights into the issue. Furthermore, responses are more noisy and difficult to interpret as regimes are more difficult to distinguish.

where x_t and Φ have been defined in the previous section and $\Psi = \begin{pmatrix} c & \Psi_1 & \Psi_2 & ... & \Psi_p \end{pmatrix}$. The parameters are therefore the coefficients in each regime as well as the level of the threshold τ^*. For the former, the appropriate estimation method is again ordinary least squares, equation by equation and regime by regime. For the threshold, and since we have in some cases no ex-ante idea of what it should be, Hansen [31] proposes to determine it as the one which minimizes the determinant of the variance-covariance matrix of the model:

$$\hat{\tau}^* = \arg\min_{\tau \in \Gamma} [\det (\quad (\tau^*))] \tag{13}$$

with $\Gamma = [\tau^*, \bar{\tau}^*]$. The threshold is therefore determined through a grid search procedure.

4.3 Data

To estimate the model, we use monthly data ranging from January 1959 to December 2000. The choice of variables largely follows previous literature on the impact of monetary shocks such as Christiano, Eichenbaum and Evans [12] or Strongin [47]. The vector of variables will therefore include the consumer prices inflation rate (P), the commodity prices inflation rate ($PCOM$), the interest rate on fed funds (FF), the percentage ratio of non-borrowed reserves to total reserves (NBR) and the percentage ratio of total reserves to total reserves in the previous period (TR). The use of the index of commodity prices is motivated by the necessity to tackle the so-called "price-puzzle", according to which a rise in fed funds is associated with a protracted rise in consumer prices. Studies such as Sims [45] or Christiano, Eichenbaum and Evans [12] show that the introduction of an index of commodity prices allows for a more traditional reaction of consumer prices to a monetary shock.

The objective of the paper is to look at the reaction of the economy to a monetary shock, with a particular emphasis on the evolution of agregate output and the external finance premium. Therefore, in a first step, we will review the reaction of a traditional output variable and the log of industrial production (IP) will also be included in the model. In a second step, we would like to assess the reaction of some proxies for the external finance premium, i.e. credit spread variables, to monetary shocks. Therefore, we will add to the model in turn the credit spread between bonds with Baa rating and bonds with Aaa rating ($CSBMA$) and the spread between the 3 months prime rate and 3 months T-Bills ($CSPRI$). The former investigates the reaction of spreads at the long end of the curve. It was in particular used by Gertler and Lown [27] and Gertler, Hubbard and Kashyap [25], who show that this variable is closely related to the external finance premium identified in the theoretical section of this paper and therefore can be used as a good proxy of it. The second spread is also informative since it is computed on the short end of the curve and allows therefore for a comparison also in the maturity of the instruments. This spread was used in a similar context in particular by Bernanke, Gertler and Gilchrist [7] as a proxy for the external finance premium as well.

The identification of monetary shocks is done following the scheme of Christiano, Eichenbaum and Evans [12] where monetary shocks are assimilated to shocks in fed funds rates. This is in accordance with results in Bernanke and Blinder [3] where it is shown that fed funds are a good proxy for monetary shocks[3]. The residuals of the equation on fed funds can be observed in figure 3. To get a better picture and since residuals are by definition uncorrelated, we have plotted the centered three months average of fed funds residuals. We have also added the recession periods as defined by the NBER in shaded areas and the episodes of monetary tightening as identified by Romer and Romer [44] and reported in table 2. One can see that monetary policy, as proxied by fed funds, use to be more restrictive in periods preceding recessions and becomes more relaxed and the end of the recessions and beginning of expansion periods. Note also the increased volatility of the residuals during the Volcker period, i.e. approximately between 1978 and 1982.

As a consequence of this identification scheme, we have used the following ordering of the variables : P, $PCOM$, FF, NBR, TR. The variable for which we want to investigate the reaction, i.e. in turn IP, $CSBMA$, and $CSPRI$, will be added at the first place. This ordering is consistent with the assumption that monetary shocks have no contemporaneous effect on output and price variables (see for instance Christiano, Eichenbaum and Evans [12]) and that credit spreads do contain some relevant information for setting monetary policy[4]. The later assumption is indeed in accordance with numerous studies mentioned previously, which highlight the predictive power of credit spreads with respect to various agregate economic variables.

4.4 Threshold variables

For selecting the switching variables, we will make use of the insights we got in section 3. According to the intuition of the simple model presented, we select five different switching variables.

Based on equation (4) and models such as the one developed by Carlstrom and Fuerst [9], we will assume first that net worth is fluctuating in accordance with the business cycle. In this sense, a variable used as proxy for the business cycle, industrial production for instance will be appropriate. We therefore include the annual change[5] in industrial production (IP) as one possibility for the switching variable. Another possibility is given by equation (5), developed in papers such as Kyiotaki and Moore

[3] One possible alternative was presented by Strongin [47] where shocks are identified with shocks to non-borrowed reserves.

[4] Alternatively, and for robustness check, we have also used the ordering of Bernanke, Gertler and Gilchrist in which credit spreads come after the fed funds. This follows the assumption that credit spreads do not contain relevant information in setting monetary policy. Results are mostly unchanged.

[5] Annual changes, instead of monthly changes, will be used for the switching variables since it is less volatile and allows for a clearer distinction between regimes.

[37], where net worth is essentially a function of the price of assets. We thus introduce annual changes in the S&P 500 (SP) as a proxy for asset prices changes and this will be a second type of switching variable. Other papers, for instance Bernanke, Gertler and Gilchrist [7], determine net worth as in equation (6). In this case, net worth fluctuates mainly as a function of cash flows of companies. We will therefore include annual changes in cash flows (CF) as indicated in the national accounts statistics (NIPA) in our list for threshold variables. Other authors such as Fazzari, Hubbard and Petersen [18] determine net worth as in equation (7). For this purpose, we use as well the annual changes in dividends (DIV), also released in the NIPA statistics. Finally, one can also argue that the stance of monetary policy might affect the level of net worth. As a matter of fact, when monetary policy is tight, interest charges are high and asset prices are lower, which means that net worth will also be lower. Thus, the last switching variable we consider is the Boschen-Mills index (BM), which accounts for the stage of monetary policy. This index takes values of -1 or -2 when monetary policy is tight, 1 or 2 when it is expansive and 0 when it is neutral. For each variable except BM, we run the grid search from the 33% percentile to the 66% percentile so that sub-samples do always include at least one third of the full sample[6][7].

Table 1 gives some summary statistics about the threshold variables (expressed in annual changes in percent). Furthermore, figure 4 display the evolution of the variables from the beginning of the sixties until December 2000. To get some more insights in the relation to the business cycle and monetary policy, we have added again in each chart in shaded areas the periods of recession as computed by the NBER, together with monetary policy tightening episodes reported by Romer and Romer [44]. By looking at the first chart in figure 4, one can observe clearly that phases of low industrial production correspond quite accurately to official phases of recession. Indeed, every time that industrial production dropped below zero, then an official recession was declared. Therefore, using industrial production is certainly an accurate way to identify business cycles regimes. On the other hand, one can also observe that the concomitance with the business cycle is not respected as faithfully anymore when one looks at the other variables in figure 4. Cash flows, for instance, where depressed also in other periods than the official recessions, such as around 1967, in the mid-eigthies or at the end of the nineties. Moreover, cash flows where rather improving during the last recession at the beginning of the nineties. The same observation can be made for dividends. In 1967 for example, dividends plunged dramatically while the economy was not officially in recession. Identical cases can be identified around 1987 and 1992. These remarks are even more valid for stock

[6] In this case there is no estimation for the threshold since it is determined ex-ante.

[7] Another choice for the switching variables would have been to look at credit spreads, which can be considered as a good proxy of agency costs. We have tried this alternative, but it proves difficult to identify sensible regimes. This is mostly due to the fact that spreads have not been stationary across the sample considered, i.e. the last 50 years.

returns. As can be seen from table 1, they are, as expected, the most volatile series. Moreover, we note that equity markets tend to weaken slightly before recessions and improve before the end of recessions. This is due to the well-known property of leading indicator of stock returns. Finally, as for the two previous variables, there are several cases where returns were low while the economy was not officially in recession. The most obvious cases are 1963, 1967, 1978, 1987 and, last but not least, the very recent episode of the end of 2000.

One can also see, when looking at Romer's episodes, that the correspondence to monetary policy is not identical for all variables neither. Indeed, whereas industrial production seems to react with a certain lag, cash flows and dividends seem to react much more promptly to the tightening. Stock returns on the other hand have generally weakened before the tightening and tend rather to improve afterward.

All in all, the observation of these charts lead us to conclude that regimes determined by cash flows, dividends and stock returns will certainly not totally coincide with the one determined by industrial production, i.e. the classical business cycle. It will thus be interesting to see whether the former regimes are more significant than the later classical one.

Indeed, the regimes determined by the different threshold variables are described in table 3 as well as in figures 5 to 7. Table 3 gives for each threshold variable and each level of the different thresholds determined in the systems, the number of low regimes as well as the average length of both high and low regimes. One can note first that the number of regimes is clearly not constant depending on the threshold variable considered. For instance, the number of regimes is much higher when they are determined by cash flows or stock returns than it is when using the Boschen-Mills index. Figures 5 to 7 plot the three variables of most interest together with the regimes in shaded areas. Figure 5 for instance is a plot of industrial production, with regimes determined according to all the threshold variables and with the levels reported in table 4. Figures 6 and 7 do the same respectively for the credit spread on long-term bonds ($CSBMA$) and the credit spread on the prime rate ($CSPRI$). As described in table 3, one can note that dividends allow to determine much longer low regime periods than the other variables. One further feature that will prove important later is that dividends and cash flows are the only variables which are still finding some low regimes in the nineties. Therefore, these figures illustrate that there will be some important differences in regimes, depending on which threshold variable is considered.

5 Results

5.1 Linearity tests

The first step in order to assess the reaction of the investigated variables is to determine whether the hypothesis of linearity against the alternative of the presence of a threshold is rejected or not. In order to test for the presence of asymmetry, one could use the conventional test of equality of the coefficients among the regimes only if the threshold is fixed a priori. This will be the case only for the BM variable in our framework. When thresholds are not fixed ex-ante but rather determined endogeneously, authors such as Andrews and Ploberger [1] or Hansen [31] have shown that the conventional tests are not appropriate. This happens because of the presence of a nuisance parameter which is not identified under the null hypothesis. In this case, the usual Wald statistic does not follow the standard chi-square distribution. The same authors proposed a new procedure which allows to approximate the unknown asymptotic distribution by simulations.

In the spirit of Hansen [31], [32], Andrews and Ploberger [1] and Pesaran and Potter [39], we test for each equation included in the model the hypothesis of equality in parameters among regimes.

$$H_0 : \Phi = \Psi \tag{14}$$

As suggested more particularly by Andrews and Ploberger [1], one can then compute three statistics which are functionals of the collection of Wald statistics over the grid space. Those are the supremum, the average and the exponential average. Significance levels are then computed using simulated empirical distributions.

Table 4 presents the results of the tests for the equations which are of particular interest for us, i.e. those which determine credit spreads and industrial production. The last column also indicates the level of the threshold determined in the model. One can observe that the hypothesis of equality of coefficients among regimes is clearly rejected at all significance levels. Therefore, these tests provide considerable evidence that there is a shift in the coefficients across regimes. This is valid when the regimes are determined according to all variables, be it cash flow variables, output variable or stock prices. Moreover, as far as credit spreads are concerned, the asymmetry is valid both at the short and the long end of the curve.

5.2 Impulse - responses

Notwithstanding the presence of non-linearity in the model, it is not yet fixed whether the reaction of the variables to monetary shocks is different across regimes. Indeed, it might happen that coefficients are altered in a way such that effects are compensating each other, leaving therefore the reaction to a monetary shock unchanged. Moreover, non-linearities might arise mainly from coefficients not linked to monetary policy, whereas coefficients on fed funds are only marginally non-linear. These issues can be investigated through the use of impulse response functions. The case of interest will obviously be the reaction of industrial production and credit spreads to a shock on fed funds.

5.2.1 Baseline case

We start by reviewing the reaction of variables to monetary shocks in the full sample. Those can be observed in figure 8. As expected, industrial production falls in reaction to a contraction of monetary policy. Indeed it rises slightly in the first three months but then starts to decline for an extended period of time. More interesting and in accordance with findings of Gertler, Hubbard and Kashyap [25], Gertler and Lown [27] or Bernanke, Gertler and Gilchrist [7], we find that credit spreads also rise in reaction to an increase in fed funds. Indeed, as noted by Bernanke, Gertler and Gilchrist [7] this is already a first evidence in favor of the credit channel of monetary policy, since it highlights the fact that companies with lower credit ratings, and therefore less sound balance sheets, are more hardly hit by a contraction of monetary policy. Furthermore, one can note that the shape of the reaction is quite different according to the type of credit spread considered. The spread on short-term rates tend to increase much quicker and stronger than the spread on long-term rates. On the other hand, the persistence of the reaction is larger for long-term spreads. The maximum reaction on short-term rates is to be found after three months whereas the maximum effect on long-term rates is reached after about two years. Finally, one should also observe that the amplitude of the reaction of spreads on short-term rates is much more important than the one on long-term rates. Indeed, the spread on prime rates reaches a maximum of more than 20 basis points, whereas the spread on long-term bonds rises only by 4 basis points at the peak. One reason for this might simply be that the short end of the curve is generally much more volatile and sensitive than the long end.

5.2.2 Non-linear case

What we want to investigate further is the issue of asymmetrical responses depending on regimes over time. This is done by looking further at figures 9 to 13 where the impulse responses of credit spreads and industrial production are plotted according to the regimes. Curves denoted with a H (long-dashed lines) represent the reaction when we are in a high regime ($\tau_t > \tau^*$) whereas the curves denoted with a L (short-dashed lines) represent the reaction in the low regime ($\tau_t < \tau^*$). The level of the threshold for each case is shown in table 4. For reference, we have added in each figure the reaction for the full sample described in the previous section. It will be denoted by a F (solid lines). The first intuition that one can probably have is that the reaction of variables differ according to the stage of the business cycle. It is therefore interesting to deal with the case where regimes are determined according to industrial production first. In figure 9, one can observe that there is indeed a different reaction depending on the stage of the business cycle. Credit spreads on the long end of the curve do react stronger when industrial production is growing slowly or even contracting. This is indeed again in accordance with the credit channel of monetary policy where companies are more severely affected when their internal situation is not very healthy. This is more likely to happen when aggregate output is not evolving strongly. However, this is more to be observed after a few months whereas the immediate short-term reaction is not very different. On the long-term, the difference remains and the shape of the reaction is very much similar. As far the credit spread on prime rates is concerned, here also the short-term reaction is not very different. More surprisingly, after six months, the reaction in the low regime is lower than the one in high regime. All in all, when regimes are determined according to the stage of the business cycle, there is indeed evidence for asymmetry, but not totally in accordance to the theory exposed previously.

Conclusions shift substantially when looking at the reaction when regimes are determined by variables directly linked to cash flows. Figure 10 plot the reaction with regimes defined according to high and low levels of cash flows. Looking first at the reaction of industrial production, one observes that the reaction is substantially different in the short-term. Whereas in the high regime, just like in the full sample, industrial production rises for a few months initially, it declines immediately and substantially in the low regime. It is only after a few months that the reaction becomes similarly negative. This is indeed largely corroborated by the reaction of credit spreads. For credit spreads on long-term bonds, the divergence in the reaction is much more pronounced, at least in the short-term, than it was the case when regimes were determined by the stage of the business cycle. Indeed, after about three months, the spread has already increased considerably in the low regime by about 3 to 4 basis points, whereas it is still almost unchanged after six months in the high regime. Over the long-term, the discrepancy tends to diminish but remains nonetheless present. The same kind of observation can be made about short-term spreads. The prime rate spread jumps by about 30 basis points after four months in the low regime. In the high regime, the increase is only 10 basis points after six months. After one year however, the reaction tends to equalize over the regimes.

The case when regimes are determined by the level of dividends in figure 11 is equally interesting. By observing first the reaction of industrial production, we see that there is also a substantial difference in the reaction. However, the difference happens more in the medium to long-term this time. As a matter of fact, the reaction is almost identical until six months with a rapid initial rise and then a more important move downward. But the reaction differs substantially after this period of time. In the low regime, industrial production continues to decline more severely, loosing one full percentage point at the bottom and still importanly on the down side after two years. In the high regime, the fall in activity becomes smaller so that industrial production is not declining anymore after twenty months. Again, those observations are strongly confirmed by the reaction of credit spreads. When looking first at the long-term credit spread, we can note that the initial reaction is not different across regimes. Yet, after about five months, large discrepancies start to appear. In the low regime, the reaction is the largest after 10 to 15 months with the spread increasing by almost 10 basis points while in the high regime, the maximum reaction is reached after

5 to 10 months with an increase of slightly more than 3 basis points. The difference remains large even after 20 months. Same observations for spreads on short-term rates, where the divergencies start to appear after 3 to 4 months. The peak in the low regime exceeds 25 basis points after 6 months.

Things become more difficult to interpret when turning to the case where regimes are determined by stock returns on figure 12. As far as the reaction of industrial production is concerned on the top chart of figure 12, the first conclusion that comes to one mind is that the reaction is considerably more volatile in the low regime. In fact, the reaction is stronger both on the upside in the short-term and on the down side in the long-term. Evidence on credit spreads is also mixed. While the credit spread on short-term rates displays almost no difference in reaction, the evolution of the long-term credit spreads do indeed show some difference. The case is somewhat in contrast with previous observations since the reaction is stronger in the high regime. In the low regime, credit spreads even decline in the first 4 months. Afterwards, reactions tend to equalize and, after 15 months, the increase is again larger for the low regime. Therefore, only the long-term reaction is in line with the intuition provided by the credit channel.

Finally, one can observe on figure 13 the reaction of the variables when regimes are determined by the use of the Boschen-Mills index of monetary policy. The high regime is associated with positive values of the index, i.e. when monetary policy is expansive. Conversely, the low regime reflects negative values of the index, i.e. when monetary policy is tight. Even though the difference in the reactions might be less striking than in the cases of cash flows or dividends, there are still some interesting features to observe. On the top chart of figure 13, we can note that, in the high regime, it takes approximately six months for industrial production to become negative. Moreover, at this point it hovers around zero rather than being markedly negative. Inversely, in the low regime, the reaction is quickly negative and remains so for a long period of time. In the low regime, the reaction is indeed very close to the one of the full sample. Evidence is mixed as far as credit spreads are concerned. On long-term bonds, the initial reaction is positive and stronger in the low regime. However, this does not hold very long and the reaction is marginally stronger for the high regime in the long-term. The behavior of the credit spread on prime rates is more in accordance with our model. The reaction is both larger and more persistent when monetary conditions are tight.

5.3 Discussion

In our opinion, the results described in the previous section allows to raise some doubts about the stability over time of the traditional impulse-response functions such as the one described in Christiano et al. [12]. This means that one should be very cautious in interpreting those responses and in particular should be aware that those might shift considerably over time. Furthermore, these results are in accordance with the intuition provided by the credit channel of monetary policy. As a matter of fact, the increase in credit spreads after a contraction of monetary policy is already a hint that the external finance premium is reacting substantially to monetary shocks. Therefore, the results on the full sample confirm the conclusion derived from figure 1, namely that the slope of the supply of funds curve becomes steeper with a contraction of monetary policy.

What the results using the threshold model show is that the reaction to monetary policy is even stronger in periods when the financial situation of firms is deteriorated, whereas it is closer to the baseline case when firms are less constrained. This confirms indeed the intuition of figure 2 where the upward move in the supply curve is more pronounced in periods of financial constraint. These periods are identified in particular when cash flows are low or when dividends are low. As a matter of fact, this is a time-series confirmation of results derived previously by Fazzary, Hubbard and Petersen [18]. It is striking to note how these results differ from the case where regimes are identified through the stage of the business cycle. It seems thus that the level of cash flows or the level of dividends are a better proxy for the financial health of companies than is the stage of the business cycle.

Moreover, it also appears that stock market returns are not as valuable in providing hints on the extent that firms are financially constrained. Responses are only partially in accordance to the intuition of the credit channel. The fact that only the long-term response is more conform to what we expected might be due to the leading indicator property of stock returns. Because of this feature, it might be that periods of low stock returns indeed anticipate times where firms will be financially constrained. In this case, firms will become constrained only a few months after stock returns have declined, so that only the long-term response of industrial production and spreads are really impacted by the tightening.

Finally, results using the Boschen-Mills index show that periods when monetary policy is tight also reflect periods of low net worth to some extent. This goes very much in the same direction as results derived for instance by Garcia and Schaller [24] or Choi [11].

6 Conclusion

The credit channel of monetary policy implies that monetary policy has varying effects not only on a cross-sectional basis, but also over time. Indeed, in periods during which companies are more financially constrained, the economy should be more sensitive to a tightening of monetary policy and therefore react stronger. This should be reflected in the reaction of both output and the external finance premium. The objective of this paper is first to investigate whether this asymmetry over time in the reaction to monetary policy is confirmed. In a second step, we try to identify what is the best variable to use in order to determine the periods during which firms are more financially constrained.

For this purpose, we use a Threshold VAR model based on the structural VAR set forth by authors in order to look at the reaction of the economy to monetary policy. Our model, however, allows for non-linearities over time in the reaction of the variables to the various shocks. Following the intuition provided by previous papers on the credit channel, we use five different variables in order to differentiate the level of financial constraint. Those variables are industrial production, cash-flows, dividends, stock returns and the Boschen-Mills index of monetary policy.

Our results show that the reaction of both industrial production and credit spreads varies over time according to the different regimes of financial constraint. Consequently, the tests confirm the intuition of the credit channel according to which firms are more affected by a monetary tightening in periods where the financial situation is already stretched. Moreover, the evidence is particularly strong for the case where we use cash-flows or dividends as a switching variable. Conversely, results are less convincing, albeit still positive, for the other variables. It seems therefore that the level of cash-flows or dividends are a good proxy in order to determine the level of financial constraint of the economy.

One of the most important implication of this paper is that traditional impulse-responses computed in VAR system in order to look at the reaction of the economy to a monetary shock must be considered with caution. We show that those responses might mask substantial shifts over time. These shifts seem to be function of the financial conditions of the economy.

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	Mean	**Median**	**Max**	**Min**	**St. dev.**	**33%**	**66%**
CF	7.76	7.99	24.56	-11.32	7.16	5.12	11.42
DIV	8.40	8.24	23.03	-6.23	5.03	6.58	10.83
SP	7.70	9.47	42.49	-53.44	14.33	3.16	14.58
IP	3.43	4.25	12.56	-13.41	4.64	2.23	5.68

Table 1: summary statistics for switching variables expressed in annual percent changes

March 1959	December 1965	December 1968	April 1974
August 1978	October 1979	December 1988	November 1994

Table 2: Romer dates. Episodes of monetary tightening (the last date was computed by the author on the basis of the Boschen-Mills index of monetary policy)

			Average length in months	
Threshold variable	Threshold level	Number of lows	Lows	Highs
IP	0.05	13	7.1	32.1
IP	0.22	16	6.6	25.5
CF	4.84	17	9.7	22.3
CF	5.12	18	9.5	20.7
DIV	10.54	15	22.0	14.1
SP	-0.18	19	6.9	21.5
BM	0	12	14.0	29.3

Table 3: Characterization of regimes as determined by threshold variables

Threshold variable	Eq. including	**SupW**	**Prob**	**ExpW**	**Prob**	**AveW**	**Prob**	**Threshold**
CF	CSBMA	3.9623	0.000	1.3177	0.000	2.5658	0.000	4.84
	CSPRI	3.4472	0.000	1.4091	0.000	2.7700	0.000	4.84
	IP	2.5722	0.001	0.9671	0.003	1.8873	0.004	5.12
DIV	CSBMA	3.4519	0.000	1.5424	0.000	3.0229	0.000	10.54
	CSPRI	4.2798	0.000	1.8500	0.000	3.6239	0.000	10.53
	IP	2.4747	0.006	1.0203	0.004	2.0163	0.005	10.56
SP	CSBMA	4.1203	0.000	1.7900	0.000	3.5603	0.000	-0.18
	CSPRI	3.7654	0.000	1.2897	0.000	2.5115	0.000	-0.18
	IP	2.3251	0.010	0.8348	0.030	1.6432	0.033	-0.18
IP	CSBMA	2.8299	0.000	1.1255	0.000	2.2174	0.000	0.05
	CSPRI	3.1166	0.000	1.3277	0.000	2.6034	0.000	0.22

Table 4: linerarity tests and value of thresholds for equations containing industrial production and credit spreads

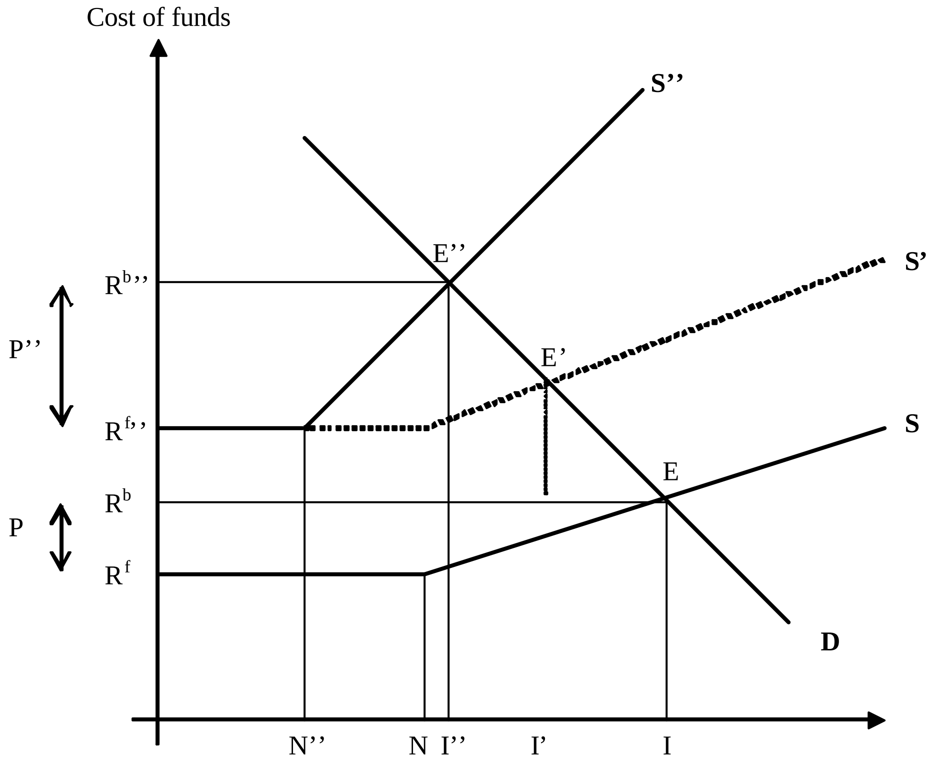

Figure 1: The credit channel of monetary policy

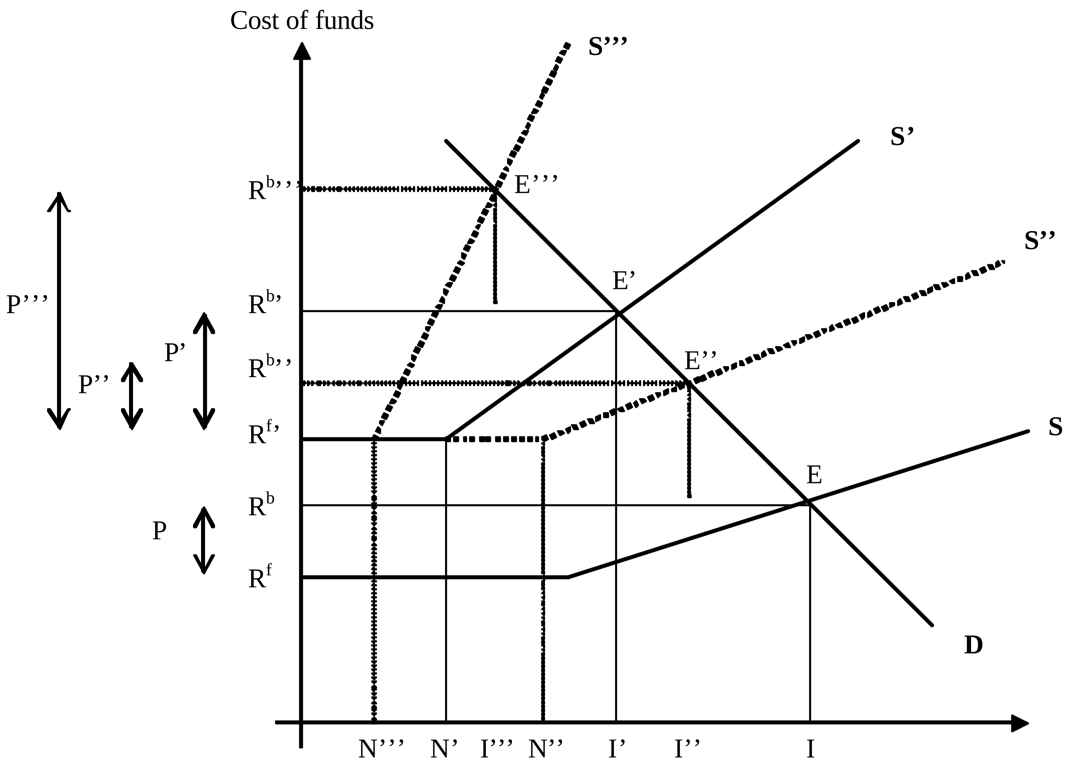

Figure 2: The credit channel with asymmetry in the reaction to monetary policy

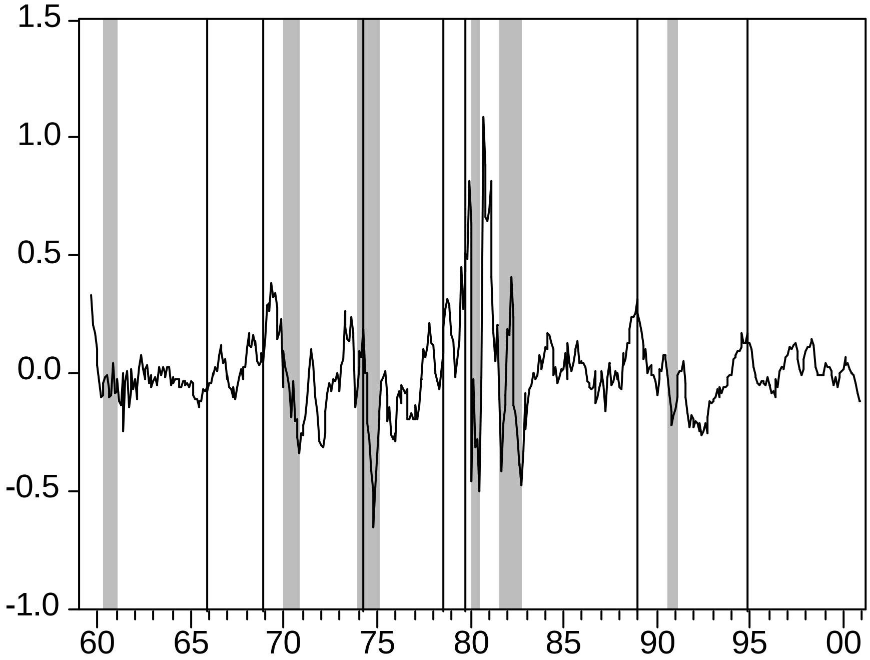

Figure 3: Fed funds shocks : residuals from six-variables VAR including industrial production in first position. Shaded areas are NBER recession periods and straigth lines are Romer & Romer episodes of monetary tightening.

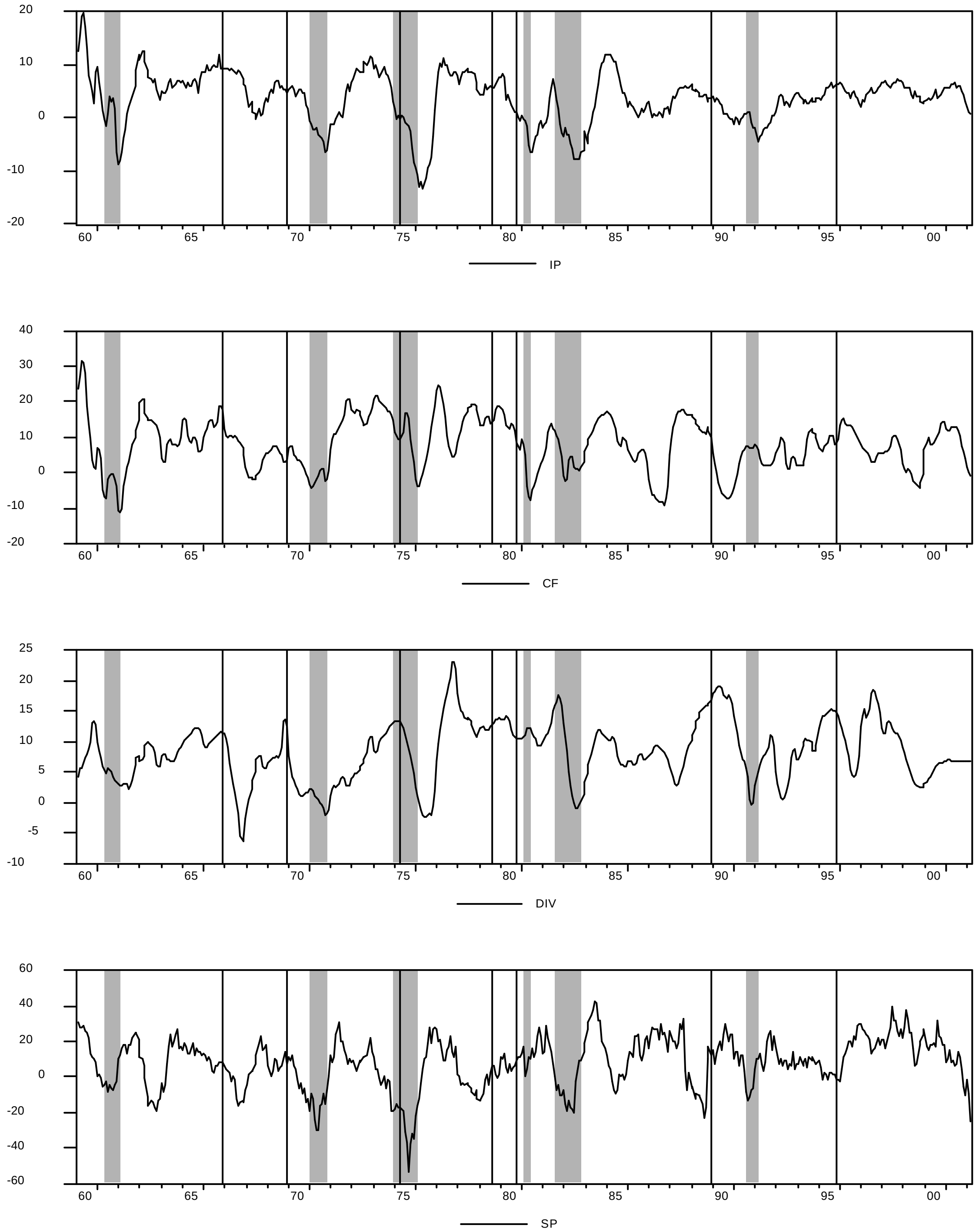

Figure 4: Threshold variables (annual changes in percent). Shaded areas are NBER recession periods and straigth lines are Romer & Romer episodes of monetary tightening.

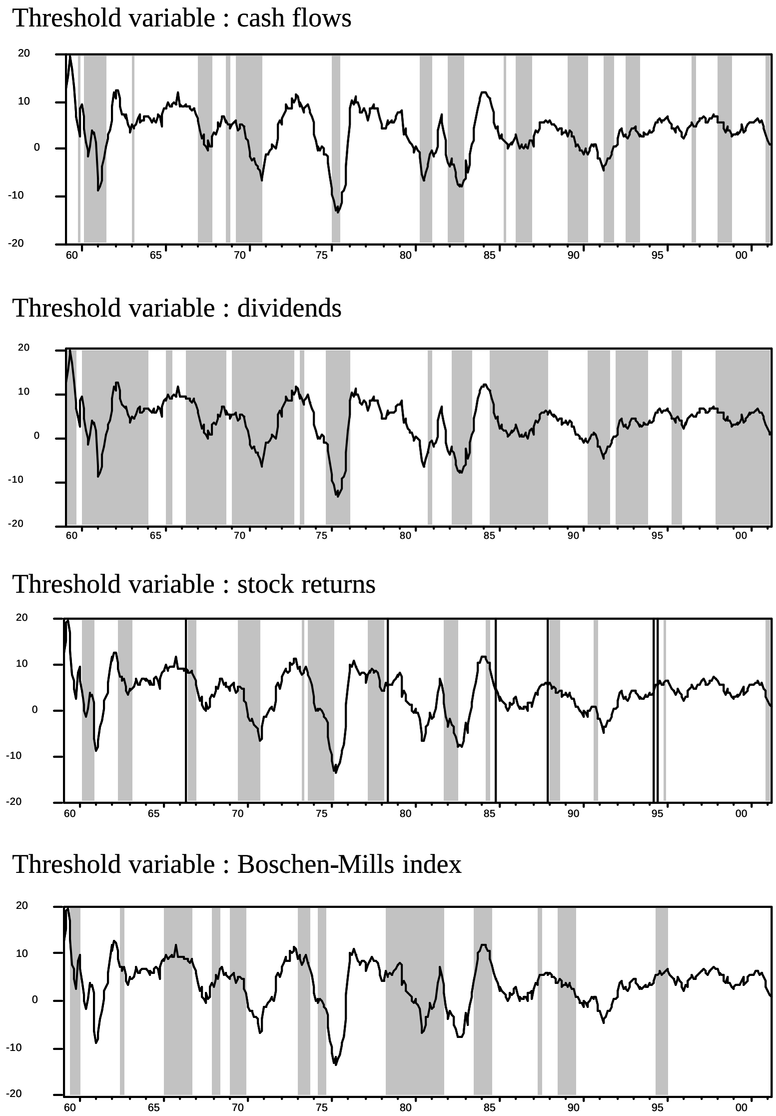

Figure 5: Industrial production (IP) with different regimes in shaded areas.

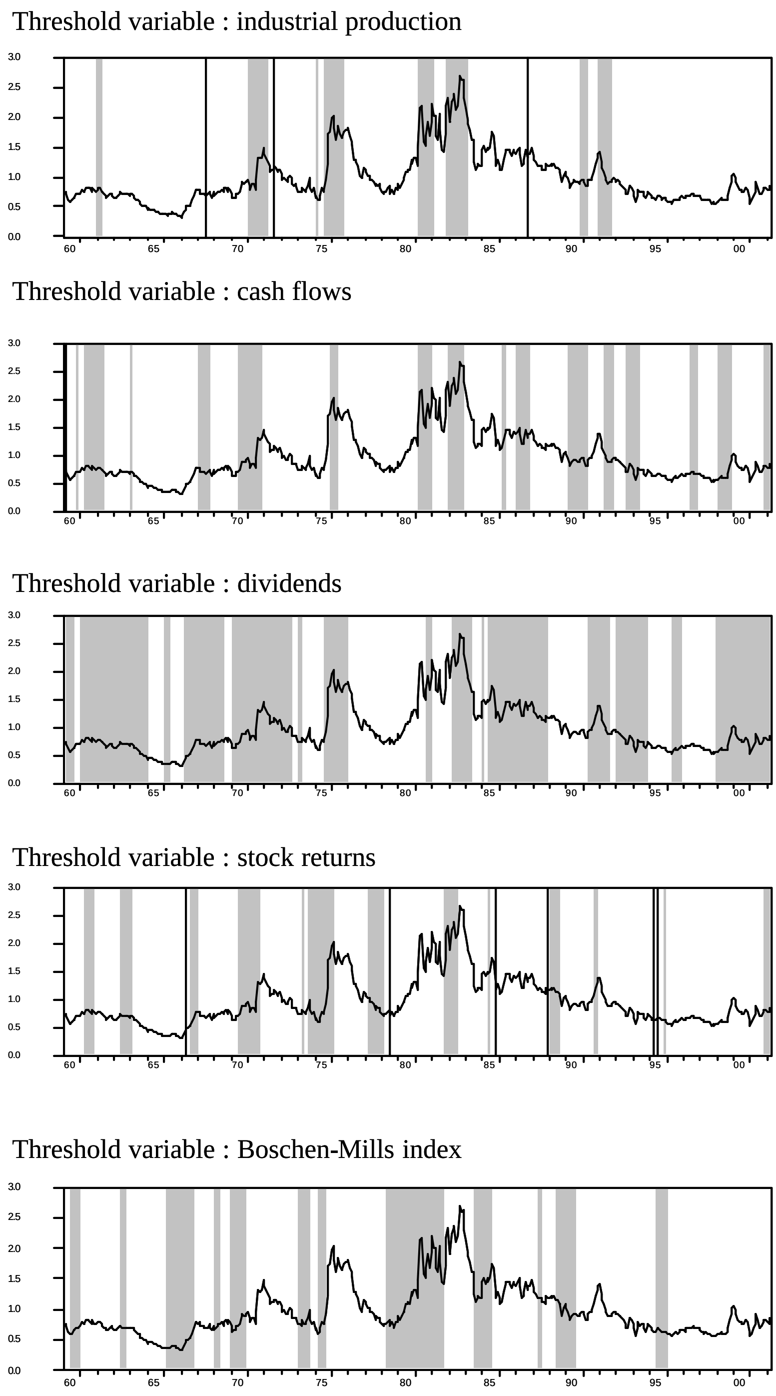

Figure 6: Credit spread on long-term bonds (CSBMA) with different regimes in shaded areas.

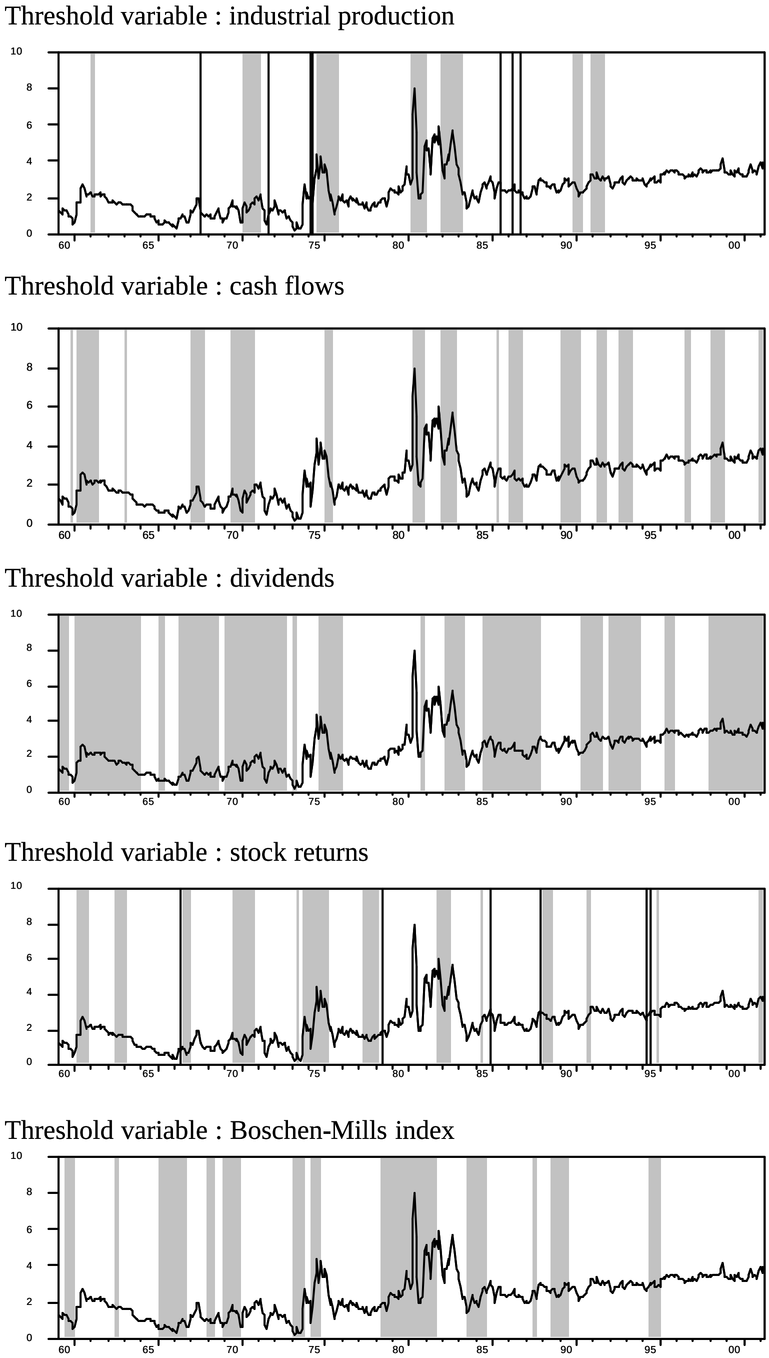

Figure 7: Credit spread on prime rate (CSPRI) with different regimes in shaded areas.

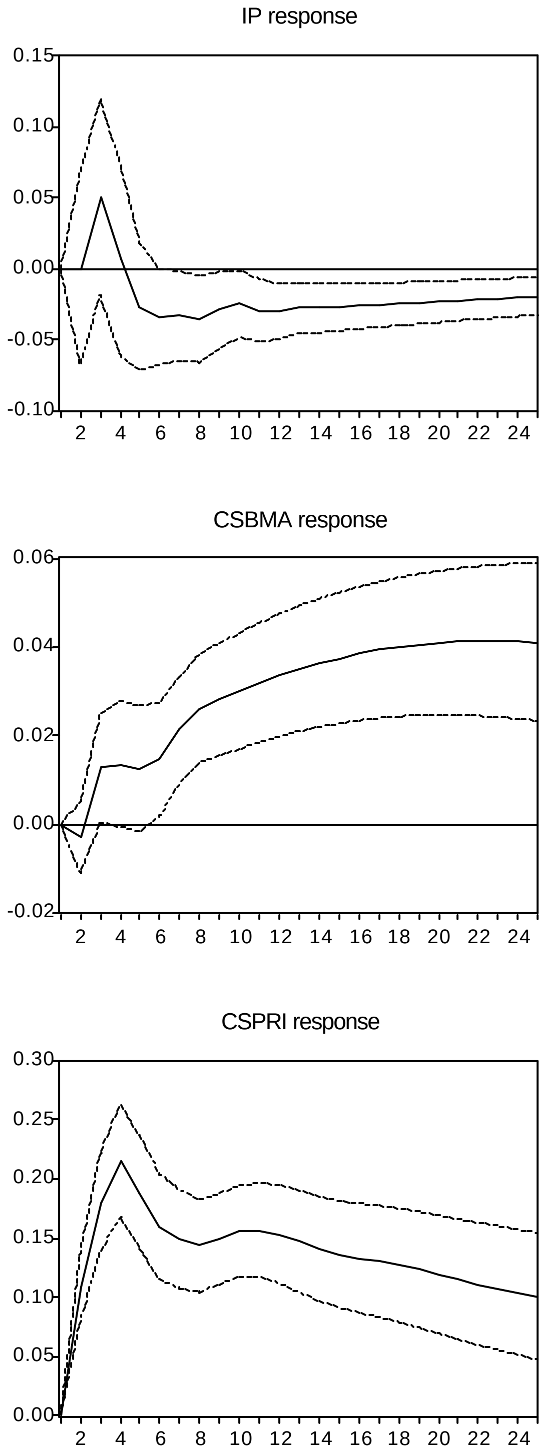

Figure 8: Impulse-response to fed fund shock in full sample

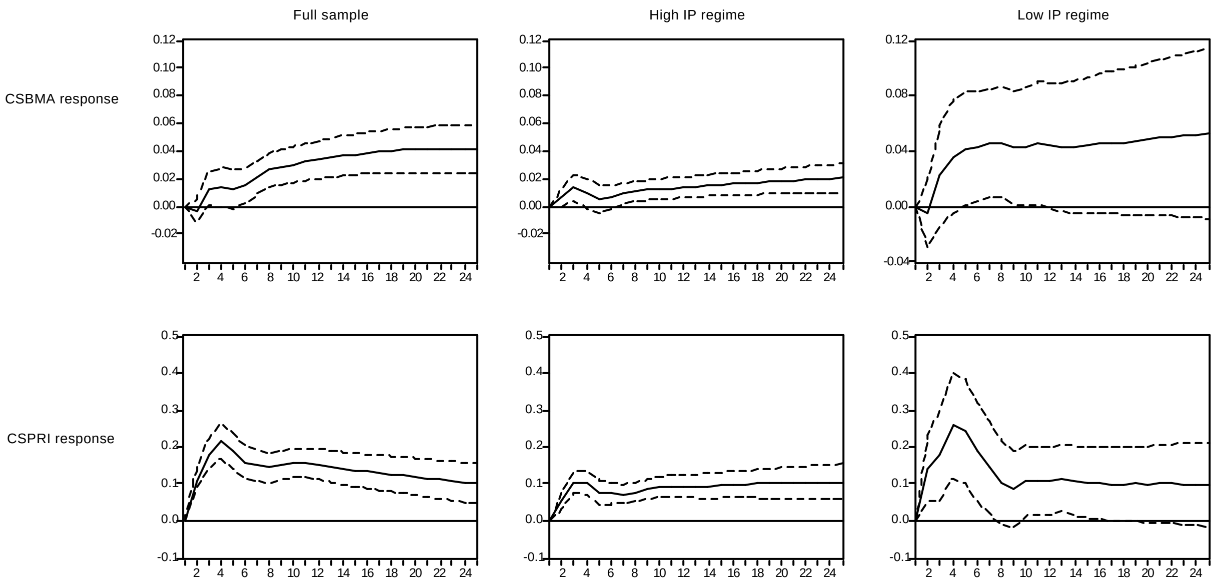

Figure 9: Impulse-response to fed fund shock with regimes determined by industrial production.

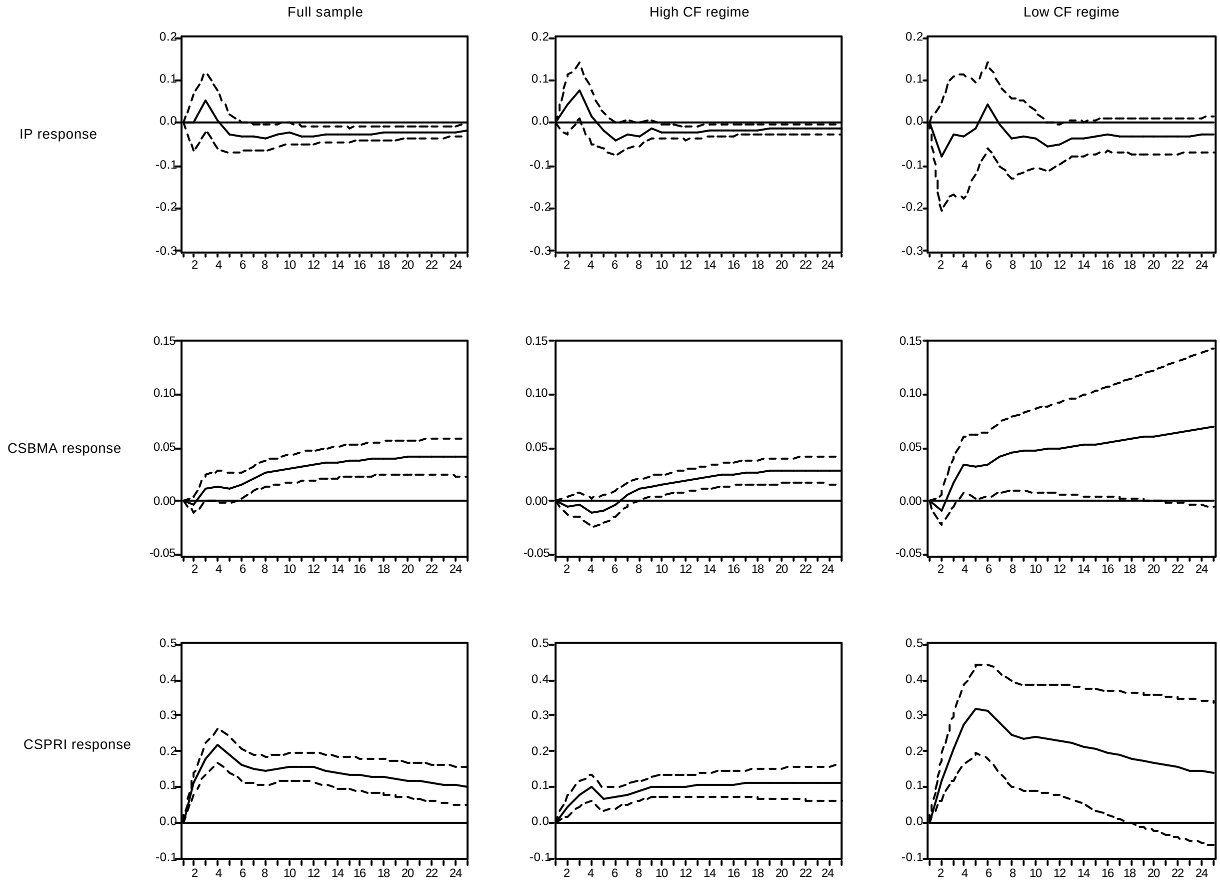

Figure 10: Impulse-response to fed fund shock with regimes determined by cash flows.

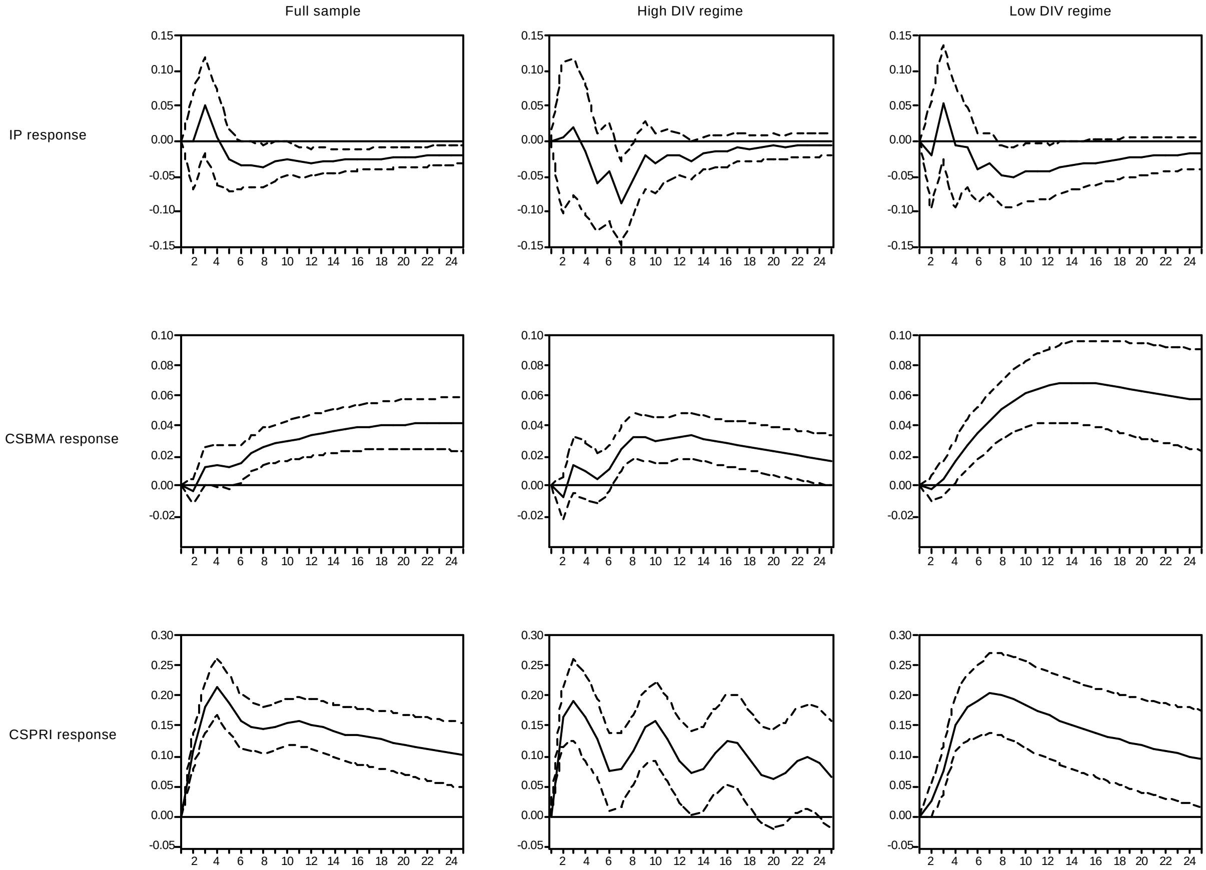

Figure 11: Impulse-response to fed fund shock with regimes determined by dividends.

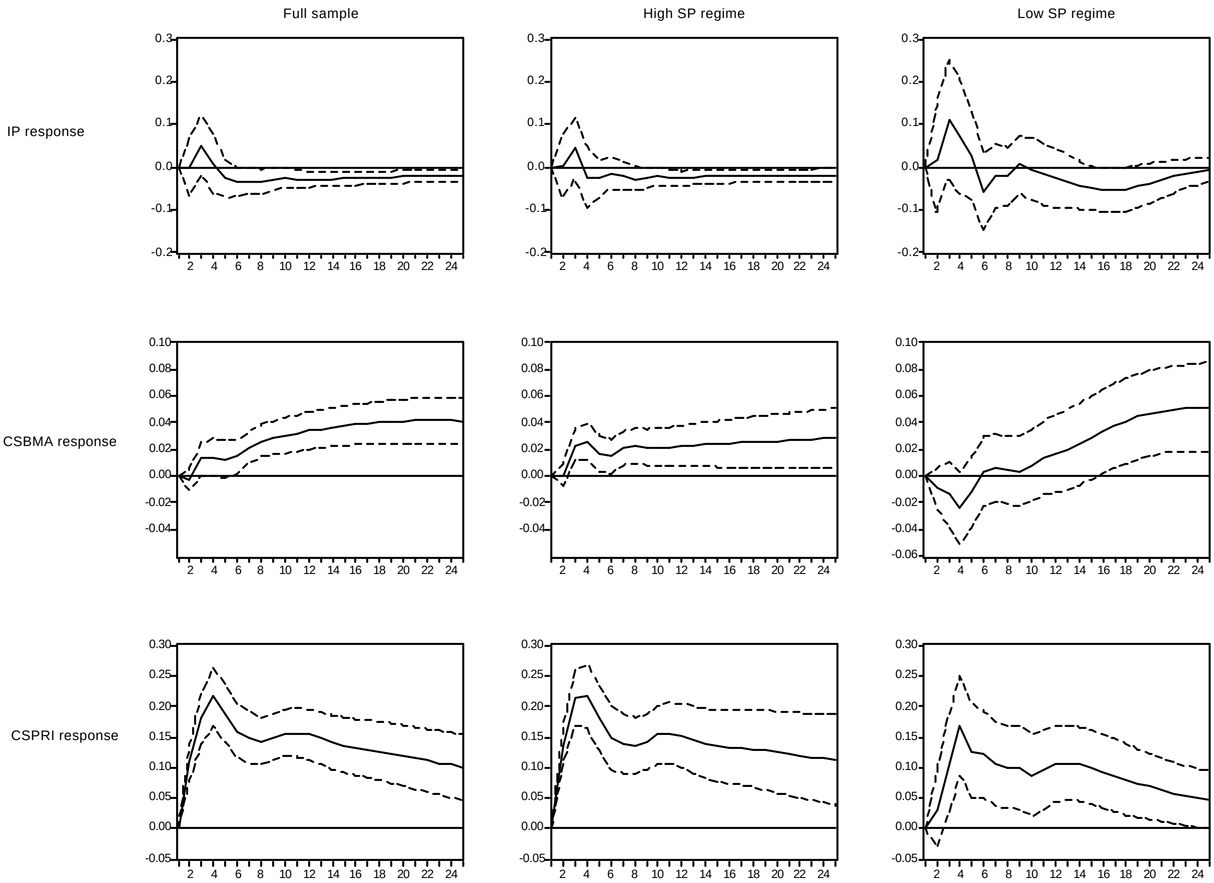

Figure 12: Impulse-response to fed fund shock with regimes determined by stock returns.

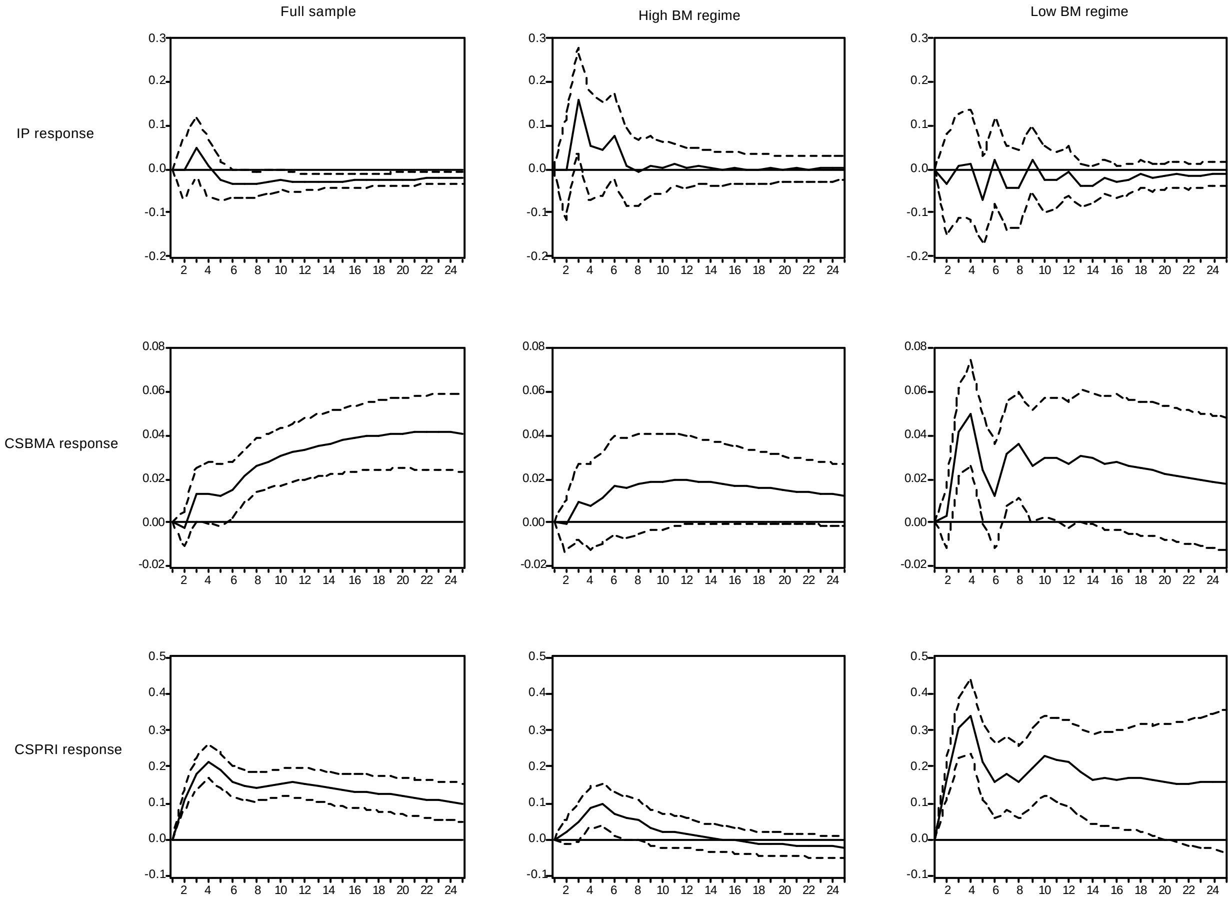

Figure 13: Impulse-response to fed fund shock with regimes determined by Boschen-Mills index of monetary policy.