Optimal monetary policy in a small open economy with financial frictions*

Rossana Merola†
Université catholique de Louvain la neuve

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Abstract

I analyze how the introduction of financial frictions can affect the trade-off between output stabilization and inflation stability and whether, in the presence of financial frictions, the optimal outcome can be realized or approached more closely if monetary policy is allowed to react to aggregate financial variables. Moreover, I explore the issue of whether an inflation targeting *cum* exchange rate stabilization and a price-level targeting are more suitable rules in minimizing distortions generated by the presence of liabilities defined in foreign currency and in nominal terms. I find that, when the financial accelerator mechanism is working, a price-level targeting rule is dominating. A *caveat* is that the advantage of the price-level targeting rule is significantly linked to the main trigger for the financial accelerator mechanism.

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Keywords: Monetary policy, Taylor rule, financial accelerator, price-level targeting, asset prices.

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†Address: IRES, Collège L. H. Dupriez. 3, Place Montesquieu. B- 1348 Louvain-la-Neuve (Belgium). E-mail: rossana_merola@hotmail.com

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Non technical summary

The goal of this paper is to analyze the optimal monetary policy reaction function in the context of a New Keynesian small open economy model. Two features are worth to be highlighted because of their potential importance for emerging market economies. The first key factor is the presence of two sectors: a non-tradable sector and a tradable sector. This particular set-up allows to introduce different degree of stickiness. In this framework, while firms set their prices as monopolistic competitors in the non-tradable sector, firms are price-taker in the export sector. The second key factor is the dollarization of liabilities that assumes particular importance in the context of emerging economies because it introduces an additional source of vulnerability to external shocks.

This model is closely related to the analytic framework developed in Gertler, Gilchrist and Natalucci (2003) and in Devereux, Lane and Xu (2004). Unlike this strand of literature, I highlight mainly the effects of changes in financial variables, rather than in the exchange rate. The underlying reason is that financial frictions are closely related to financial premium. Therefore, it is straightforward to investigate the performance of a rule that includes also a response to this variables.

I compare outcomes under three alternative Taylor rules: a "standard" inflation targeting rule (hereafter, IT), an "augmented" Taylor rule (that is an inflation targeting rule that is responding also to financial variables) and a price-level targeting rule (hereafter, PLT). The analysis is based on a social loss function that penalizes the deviation of output and inflation from their steady-state values. Moreover, a large floating in the nominal domestic interest rate is also penalized.

A first finding is that in a model with both nominal and financial frictions, a simple policy rule is not able to close the output gap and realize a zero inflation rate at the same time. Indeed I find that in a model with both nominal and financial frictions, a simple policy rule is delivering a higher value of loss than in a model without financial frictions. Moreover, the presence of financial frictions requires more inertia in the optimal rule, in order to stabilize interest rates. In such a way, the monetary rules is successful in minimizing the risk embedded in the repayment of nominal debt. Nevertheless, this argument depends on the source of the shock. Indeed the gain from a super-inertial rule is significantly reduced if the economy is not affected by the financial shock.

A second result is that a monetary rule responding to changes in the aggregate financial premium is not improving on loss, but it needs a lower degree of inertia.

A third result is drawn from the analysis of a monetary rule that stabilizes CPI inflation, output and exchange rate. I find that reducing the volatility of the exchange rate limits the ability of the central bank to enact stabilizing monetary policy by devaluating the exchange rate, Then , the monetary authority is forced to increase the interest rates exacerbating the contraction in investment spending which in turns affects net worth and output.

Finally, a PLT rule produces the best outcomes in terms of the variance of inflation and volatility of nominal interest rates. This result arises from the fact that a PLT rule introduces a desirable inertia in the monetary rule. A *caveat* is that the source of the shock plays an important role. Once the financial shock is not operative, the gain from PLT significantly decreases.

1 Introduction

The financial crises over the last decade have generated interest in the design of monetary policy for emerging market economies. Many economists have argued that if credit frictions are quantitative important for cyclical fluctuations, models used for monetary policy analysis should take them more seriously in order to offset the propagation of transitory shocks.

The goal of this paper is to analyze the optimal monetary policy reaction function in the context of a New Keynesian small open economy model. Two features are worth to be highlighted because of their potential importance for emerging market economies. The first key factor is the presence of two sectors: a non-tradable sector and a tradable sector. This particular set-up allows to introduce different degree of stickiness. In this framework, while firms set their prices as monopolistic competitors in the non-tradable sector, firms are price-taker in the export sector.

The second key factor is the dollarization of liabilities. This assumption does not seem to stretch plausibility, given that essentially all lending to emerging markets is denominated in the world's four major currencies. The dollarization of liabilities assumes particular importance in the context of emerging economies because it introduces an additional source of vulnerability to external shocks. With foreign currency denominated debt, the depreciation of the exchange rate reduces the entepreneurial net worth, enhancing the role of financial frictions. A number of authors have stressed the significance of having debt denominated in foreign currency in order to explore which exchange rate regime is more desirable to insulate emerging market economies from external shock.

To this extend, I consider different policy rules, for both the model with and without financial accelerator. I consider four kinds of shocks: two productivity shocks, a price mark-up shock and a financial shock. A kind of financial shock could be a risk premium shock, e.g. a shock to the elasticity of the premia to the leverage ratio.

At a first step, I consider the case where the central bank targets the same variables as in the historical rule, i.e. aggregate CPI inflation and the output gap. Moreover, the central bank should allow for a moderate degree of nominal interest rate smoothing.

I analyze the optimal policy and the trade-off that may arise between output stabilization and price stability both in the model with financial accelerator and in the model without financial accelerator.

In a model with both nominal and financial frictions, a simple policy rule is not able to close the output gap and realize a zero inflation rate at the same time. To this extend, at a second step, I investigate whether the optimal outcome can be realized again or approached more closely if monetary policy is allowed to react to the aggregate or the sector specific financial variables.

This further analysis has to be framed in the recent debate regarding whether or not the setting of short term interest rates should actively consider movements in asset prices. This view stems from the fact that financial market imperfections create distortions in investment and consumption, leading to excessive increases and then falls in both real output and inflation. A policy rule that reacts to asset prices movements prescribes that interest rates should raise modestly as asset prices rise above what are estimated to be warranted levels. In such a way, the monetary policy tends to offset the impact on output and inflation of these financial market imperfections, thereby enhancing overall macroeconomic stability. In the particular case of an emerging economy where the financial accelerator plays a significant role, a financial bubble leads to higher investment as firms can borrow more easily, given the higher value of their collateral. More investments stimulate aggregate demand and output in the short run, but in the end creates overcapacity and results in a sharp downturn. Some authors argue that a central bank should react to the asset price misalignment in order to reduce the overall volatility in economic activity.

As summarized above, many authors have used a two-sector small open economy set-up in order to stress the impact of exchange rate fluctuations on the indebtedness and therefore on the net worth position of the firm. They have drawn policy guidelines for the choice of the exchange rate regime more suitable to absorb shock. I also explore whether reducing the volatility of the exchange rate may be improving in order to mitigate the effect of financial frictions.

Finally, I explore the issue of whether price level is a better target for the monetary policy. This analysis is justified by the opinion that not only fluctuations in the exchange rate, but also movements in the price level are affecting the real value of the debt denominated in foreign currency. The "deflationary effect" is one of the main sources of the financial accelerator mechanism, as it generates an increase in financial premia and it propagates the negative effect of a shock through the balance sheet effects. To this extend, I investigate whether, in the presence of a deflation, it is preferable a monetary policy that is targeting the price level instead of the inflation rate. Moreover a price-level targeting rule is more successful in controlling expectations. Therefore, the volatility of the interest rate and exchange rate remains small. I investigate whether it may help in minimizing distortions introduced by the presence of debt defined in nominal terms and in foreign currency. With the debt denominated in foreign currency, the depreciation of the exchange rate increases the domestic value of foreign debt, thus it reduces entepreneurial net worth and enhances the financial accelerator mechanism. Therefore, one would expect that the dollarization of liabilities makes the flexible exchange rate regime less attractive.

The paper is structured as follows. In section 2, I present an overview of the existing literature on the optimal monetary policy in models with financial frictions. I develop the model in section 3. In section 4, I present the Impulse Response Functions (IRFs) analysis to show whether the financial accelerator mechanism amplify the initial shocks. Section 5 describes the optimal monetary policy. First, I considers the optimal monetary policy both in a model with financial frictions and in a model without financial frictions. Then, I compare results under the "standard " Taylor rule and a Taylor rule that responds to financial variables. Moreover, I analyze the performance of an inflation targeting rule in which the nominal interest rate responds also to fluctuations in the exchange rate. Finally, I analyze the case of a price level target rule instead of an inflation target rule. Section 6 concludes.

2 Review of Literature

Recently many economists have argued that monetary policy in open economy does not operate only through traditional interest-rate and exchange-rate channels. They have emphasized the role played by credit markets and imperfect information in the transmission of monetary policy to the real economy. Under perfect capital markets, firm's financial structure is irrelevant to its real investment decisions and internal financing is a perfect substitute of external financing. Otherwise, if there are imperfections in capital markets, internal and external financing are no more perfect substitutes and investments decisions will depend on financial factors: problems in capital markets, as asymmetric information, will make costly for lenders to evaluate the quality of firms' investments. To overcome these frictions, lenders need to be compensated by rising a premium over the risk-free rate or requiring significant levels of collateral. If credit frictions are quantitative important for cyclical fluctuations,[1] models used for monetary policy analysis should take them more seriously in order to offset the propagation of transitory shocks.

2.1 Models of financial frictions

The theoretical literature on credit-markets imperfections is immense. Nevertheless, models may be distinguish with regard to the way they introduce financial frictions.

In the first approach, the mechanism of transmission operates through firms' balance sheets[2]. Credit market imperfections may create a wedge between the cost of internal

[1]Despite the widespread perception that a deterioration of financial conditions can be conducive of economic downturns and suddens stops (Braggion, Christiano and Roldos (2007), Curdia (2007)), the conclusions arising from estimated medium-scale DSGE models with financial market frictions cast some doubts on the macroeconomic relevance of financial frictions. Some works conclude that financial market frictions are relevant for the US and the euro area (Christiano et al. (2006); Levin, Natalucci, and Zakrajsek (2004); Quejo (2004)). These works show that credit markets provide an additional source of shocks, but also that financial frictions are important to understand the transmission of non-financial aggregate shocks. Conversely, other works reach opposite conclusions (see e.g. Meier and Muller (2006)).

[2]This mechanism of transmission has been introduced both in two-country models (Gilchrist, Hairault

and external financing. In Bernanke, Gertler and Gilchrist (1995, 1998) this wedge arise because of agency costs and asymmetric information that make monitoring costly for lenders. As a consequence, investment decisions will depend on variables, such as cash flows, that would not play a role if information were perfect. The underlying mechanism works in the following way. A recession will worsen firms' balance sheets, reducing the availability of internal funds, forcing firms to turn to external sources and increasing agency costs. This leads to a reduction in investment spending, amplifying the recession.

In Bernanke and Gertler (1989), shocks to the economy are amplified and propagated by their effects on borrowers' cash flows. An adverse shock lowers current cash flows, reducing the ability of firms to self-finance investment projects. This decline in net worth raises the average external finance premium and the cost of new investments. Declining investments lower economic activity and cash flow in subsequent periods, amplifying and propagating the effect of the initial shock[3].

Many authors have used a two-sector small open economy set-up in order to stress the impact of exchange rate fluctuations on the indebtedness and therefore on the net worth position of the firm. They have drawn policy guidelines for the choice of the exchange rate regime more suitable to absorb shock. This feature becomes particularly relevant for emerging economies, where partial dollarization is underway, especially if they have a history of high inflation. In these economies, while liabilities are denominated in foreign currency, assets are in terms of domestic currency. Due to such a currency mismatch, borrowers can be forced into bankruptcy by an unexpected depreciation of the exchange rate, that may reduce the entepreneurial net worth, enhancing the role of

and Kempf (2002)) and in small open economy models (Bernanke, Gertler and Gilchrist (1998); Cespedes, Velasco and Chang (2004); Devereux Lane and Xu (2004); Gertler, Gilchrist and Natalucci (2003)).

[3] A recent literature has relaxed the assumption of a single instrument of external finance. De Fiore and Uhlig (2005) build a real and a monetary extension of a financial accelerator model where heterogeneous firms in the risk of default choose among two instruments of external finance, namely corporate bonds and bank loans. This framework is used to explain long-run differences in corporate finance among the US and the euro area, and to analyze the effects of monetary policy on the composition of firms' external finance and on business cycle fluctuations.

financial frictions.

Among the authors that have explored this field on analysis, Cespedes, Chang and Velasco (2004) focus on the relationship between exchange rate risk premium and the presence of financial frictions. They provide a closed form solution for a model with endogenous risk premium à la Bernanke and Gertler (1989). Moreover, they perform a simulation for two different parameters configuration corresponding to financially fragile and robust economies depending on the level of indebtedness. A main point of their analysis is the "dollarization" of liabilities that makes effects of real devaluation more drastic for entrepreneurial net worth and hence for investments, due to the presence of financial frictions.

Gertler, Gilchrist and Natalucci (2003) emphasize the role of exchange rate policy and the interaction between exchange rate regime and the presence of a financial accelerator. They perform a quantitative analysis to matching model performance against Korea experience.

Devereux, Lane and Xu (2004) focus mainly on the degree of exchange rate pass-through and on the implications for the ranking of monetary rules. With high pass-through, stabilizing the exchange rate involves a trade-off between real stability and inflation stability and the best monetary policy rule is to stabilize non-traded goods prices. With delayed pass-through, the trade-off disappears and the best monetary policy rule is CPI price stability.

In the second approach, the effects of the financial accelerator mechanism arise from the reduction of asset price following a contractionary monetary policy. Borrowers that use these assets as collateral are now limited in their ability to borrow, and hence to invest, as the market value of collateral has been reduced.

Kiyotaki and Moore (1997) develop a dynamic equilibrium model in which endogenous fluctuations in the market price of an asset (for instance land) are the main sources of changes in borrowers' net worth and hence in spending and production. In this framework, land serves both as a factor of production and as a source of collateral for loans to producers. A shock that lowers the value of land also lowers producers' collateral, as it tightens borrowing constraints and, in such a way, it propagates the initial shock.

Christiano, Gust and Roldos (2002) focus on the role of asset prices in determining the direction of the response of output and employment to an interest rate cut. They consider land and capital as both production factors and assets used as collateral, then they assume that most of firms' liabilities takes the form of international debt. They model a financial crisis as a time when collateral constraints become suddenly binding. An interest rate cut engineered by the central bank produces a nominal exchange rate depreciation. Other things the same, this tightens the collateral constraint by producing a fall in the value of the domestic assets of firms, without affecting the value of international liabilities. However, an interest rate cut can also alleviate the collateral constraint by pushing up asset values. In this case, there is a room for domestic output and employment to rise.

2.2 Asset prices and monetary policy

An interesting recent debate in the field of monetary policy has regarded whether or not the setting of short term interest rates should actively consider movements in asset prices[4].

On the one hand, some literature suggests that the monetary policy can play a potential stabilization role by responding to misalignments in asset prices. This view stems from the fact that changes in asset prices affect the availability of credit to firms and, due to market incompleteness, they have a direct impact on the real sector of the economy. Among these authors, there are Cecchetti, Genberg, Lipsky, & Wadhwani (2000) and

[4] Siklos Werner and Bohl (2004) consider housing prices and the exchange rate as a kind of asset prices.

Models of the financial accelerator have been used to analyze not only the financing of the corporate sector through loans, but also as the financing of households through mortgages or credit lines (see e.g. Iacoviello (2005), and Aoki et al. (2004)). For instance, Aoki et al. consider a DSGE model with frictions in credit market used by households to investigate the impact of house prices on consumption via their role as collateral for household borrowings. They also consider the implication for monetary policy of recent structural changes in the United Kingdom's retail financial markets.

Quadrini (2007).

The main reason to react to asset prices misalignments is that asset price bubbles create distortions in investment and consumption, leading to excessive increases and then falls in both real output and inflation. Raising interest rates modestly as asset prices rise above what are estimated to be warranted levels will tend to offset the impact on output and inflation of these bubbles, thereby enhancing overall macroeconomic stability. In the particular case of an emerging economy where the financial accelerator plays a significant role, a financial bubble leads to higher investment as, firms can borrow more easily, given the higher value of their collateral. More investments stimulate aggregate demand and output in the short run, but in the end creates overcapacity and results in a sharp downturn. Therefore, in this view, a central bank should react to the asset price misalignment in order to reduce the overall volatility in economic activity.

Recently, Cúrdia and Woodford (2008) have showed that, in the presence of credit frictions, it is always optimal to include a spread adjustment to a simple Taylor rule. The main open issue is the magnitude of adjustment that would be appropriate, depending on the source of the shock. In some cases it is desirable to lower the interest rate by the full amount of the increase in the spread between the deposit rate and the lending rate. In other cases a much smaller adjustment would lead to a more nearly optimal policy. Furthermore, sometimes even an adjustment several times as large as the increase in credit spreads would not be sufficient.

However, other papers are more critical about the potential benefits of a monetary policy reaction to asset prices.

On the other hand, Bernanke & Gertler (1999, 2001) show that, as long as interest rates react aggressively to expected inflation, there is no need to respond to asset prices if the monetary authority controls inflation.

Carlstrom and Fuerst (2007) demonstrate that, under a "cash-in-advance" money demand, even with fairly flexible prices, targeting asset prices will produce indeterminacy.

Batini and Nelson (2000) evaluate the performance of alternative simple monetary policy rules under both bubble and no-bubble scenarios and investigate whether policymakers should react to the deviation from the steady-state of the real exchange rate, that can be considered as one of the key asset prices in the economy. They conclude that in a forward-looking model, in the absence of a bubble, responding to the exchange rate separately reduce exchange rate variability but in most cases, does not improve overall welfare because inflation variability increased. With a bubble present, reacting to the exchange rate does not even necessarily reduce exchange rate volatility, and in general led to poorer welfare outcomes[5].

Faia and Monacelli (2005) argue that strict inflation stabilization is a robust optimal monetary policy prescription. Using two different macroeconomic frameworks, they conclude that in both models reacting to asset prices does not improve on welfare in the conduct of monetary policy.

Smets (1997) and Dupor (2002) argue that the direction of the policy response to asset prices depends on the underlying source of the asset price increase. For example, when equity prices rise because of a permanent rise in total factor productivity, then monetary policy may want to accommodate the boom by keeping the real interest rate unchanged. In contrast, when equity prices rise because of non-fundamental shocks in the equity market (e.g. over-optimistic expectations about future productivity), then the optimal policy will be to respond by raising interest rates. Nevertheless, the assessment of the source of the shock will not be not be an easy task.

3 Model presentation

The structure is a standard two-sector small open economy model. Two goods are produced: a domestic non-traded good and an export good, the price of which is fixed on world markets.

Three central aspects are highlighted: a) the existence of nominal rigidities; b) the

[5] Ball (1999) finds that adding the exchnge rate to the Taylor rule improves macroeconomic performance only if the exchange rate has a significant role in the transmission mechanism of structural shocks and monetary policy.

presence of lending constraints on investment financing; and c), the dollarization of liabilities.

Referring to the first feature, the specific assumption made is that the prices of non-traded and imported goods are set by individual firms and adjusted only over time, following the specification á la Rotemberg. On the contrary, I assume that exporters are price-takers so that the law of one price must hold for exported goods.

The second feature that should be highlighted is the presence of lending constraints on investment financing. The lending mechanism outlined represents a transmission channel linking balance sheet conditions to real spending decisions. I follow the BGG approach, which assumes that entepreneurs should take up external funds to undertake investment projects. As lenders should bear agency costs to observe the returns on investments, entrepreneurs face higher costs of external financing of investments relative to internal financing. This leads investments to depend on entrepreneurial net worth. In particular these financial frictions can be summarized by two key variables: the elasticity of the premium on external funds with respect to the leverage and the degree of leverage itself. In countries where the financial system is weak and the share of investments financed through external funds is high, it is more likely to experience significant amplifications of shocks through such a channel.

Finally, a number of authors have stressed the importance of having debt denominated in foreign currency. When the firm debt is expressed to a large extend in foreign currency, exchange rate fluctuations have a strong impact on the indebtedness and therefore on the net worth position of the firm. Through this mechanism, the emerging economies are much more vulnerable to exchange rate fluctuations and the related volatility in capital inflows than countries with a more developed capital market.

There are four sets of domestic actors in the model: consumers, firms, entepreneurs, and the monetary authority. In addition, there is a "rest of world" sector where foreign-currency prices of exports and imports are set and where lending rates are determined.

3.1 Households

I will describe the model in terms of the representative consumer who has preferences given by:

$$\max U = E_0 \sum_{t=0}^{\infty} \beta^t u(C_t, H_t, \frac{M_t}{P_t})$$

where β is the discount factor, C_t is a composite consumption index, H_t is labor supply, and $\frac{M_t}{P_t}$ are real money balances.

Let the functional form of u be given by:

$$u = \frac{1}{1-\sigma}(C_t - hC_{t-1})^{1-\sigma} + \frac{b_t}{1-\varepsilon}(\frac{M_t}{P_t})^{1-\varepsilon} - \eta\frac{H_t^{1+\psi}}{1+\psi}$$

where h measures the coefficient of habit in consumption.

Composite consumption is a CES function of consumption of non-traded goods and an imported goods

$$C_t = [a_c^{1/\rho_c} C_{Nt}^{1-1/\rho_c} + (1-a_c)^{1/\rho_c} C_{Mt}^{1-1/\rho_c}]^{\rho_c/\rho_c - 1}$$

where $\rho_c > 0$ is the elasticity of substitution between non-traded goods and import goods.

The implied consumer price index is:

$$P_t = [a_c P_{Nt}^{1-\rho_c} + (1-a_c) P_{Mt}^{1-\rho_c}]^{1/1-\rho_c}$$

and the CPI inflation is defined as:

$\pi_t = \frac{P_{t+1}}{P_t}$

A consumer's revenue flow in any period comes from her supply of hours of work to firms for wages W_t, profits from firms Π_t , domestic money M_t, less taxes paid to the government and debt repayment from last period $R_{t-1}^{*n} S_t B_t^h$, where S_t is the nominal exchange rate and B_t^h is the outstanding amount of foreign-currency debt.

To introduce stickiness in wages, I assume that households bears a quadratic cost of wage adjustment. Thus, each j household maximizes the utility function subject to the following budget constrain:

$$W_t^{(j)}(1-\Omega_t^{(j)})H_t+\Pi_t+S_tB_t+M_t-M_{t-1}-R_{t-1}^{*n}S_tB_{t-1}+T_t-P_tC_t$$

where the quadratic adjustment costs are defined in terms of the price of the final good

$$\Omega_t^{(j)}=\frac{\varphi_w}{2}\left[\frac{W_t^{(j)}}{W_{t-1}^{(j)}}-1\right]^2$$

An additional constraint is represented by the optimal demand for labor:

$$H_t^{(j)}=(\frac{W_t^{(j)}}{W_t})^{-\vartheta_w}H_t$$

The first order conditions from the maximization problem are:

$$E_t[R_t^n(C_{t+1}-hC_t)^{-\sigma}]=\frac{1}{\beta}\frac{P_{t+1}}{P_t}(C_t-hC_{t-1})^{-\sigma}$$

$$\zeta(\frac{M_t}{P_t})^{-\varepsilon}=\frac{R_t^n-1}{R_t^n}(C_t-hC_{t-1})^{-\sigma}$$

$$W_t=\frac{\vartheta^W\left(-\frac{U_{Lt}}{U_{Ct}}\right)H_t+\beta\left(\frac{U_{Ct+1}}{U_{Ct}}\right)\left(\pi_{t+1}^W\right)H_{t+1}\varphi^W\varphi^W\left(\pi_{t+1}^W-1\right)}{\left(\vartheta^W-1\right)\left[1-\frac{\varphi^W}{2}\left(\pi_t^W-1\right)^2\right]H_t+\varphi^W H_t\pi_t^W\left(\pi_t^W-1\right)}$$

If the parameter φ^W is zero, households simply set wage as a mark-up$\frac{\vartheta^W}{\vartheta^W-1}$ over the marginal rate of substitutions between labour and consumption, $(mrs_{L,C})_t=-\frac{U_{Lt}}{U_{Ct}}$

For the uncovered interest parity condition, foreign interest rate is defined as follows:

$$R_t^n=R_t^{*n}\frac{S_{t+1}}{S_t}$$

For the Fisher condition, real interest rate is defined as follows:

$$R_t=R_t^n\frac{P_{t+1}}{P_t}$$

Moreover, the household will choose non-traded and traded goods to minimize expenditures conditional on total composite demand C_t.

The consumption of respectively non-tradable and imported goods is defined as follows:

$$C_{Nt} = a_c(\frac{P_{Nt}}{P_t})^{-\rho_c} C_t$$

$$C_{Mt} = (1 - a_c)(\frac{P_{Mt}}{P_t})^{-\rho_c} C_t$$

Combining the two equations above yields:

$$C_{Nt} = \frac{a_c}{1 - a_c}(\frac{P_{Nt}}{P_{Mt}})^{-\rho_c} C_{Mt}$$

3.2 Firms

3.2.1 Production

Production is carried out by firms in each sector. The two sectors, tradable and non-tradable, differ in their production technologies. Both types of goods are produced by combining labour and capital.

The technology in the non-tradable sector is defined as follows:

$$Y_{Nt} = A_N K_{Nt}^{\alpha} H_{Nt}^{1-\alpha}$$

where A_N is the productivity parameter.

Similarly, exporters use the production function[6]:

$$Y_{Xt} = A_X K_{Xt}^{\gamma} H_{Xt}^{1-\gamma}$$

Firms minimize production costs, so the first order conditions are:

$$W_{Nt} = MC_{Nt}(1 - \alpha)\frac{Y_{Nt}}{H_{Nt}}$$

$$W_{Xt} = P_{Xt}(1 - \gamma)\frac{Y_{Xt}}{H_{Xt}}$$

[6]For simplicity, I assume that all domestically-produced tradable goods are exported.

$$r_{Nt}^{K} = MC_{Nt}\alpha\frac{Y_{Nt}}{K_{Nt}}$$

$$r_{Xt}^{K} = P_{Xt}\gamma\frac{Y_{Xt}}{K_{Xt}}$$

where MC_{Nt} denotes the marginal production cost for a firm in the non-traded sector (which is common across firms).

Moreover, because of labour mobility I impose that nominal wage in the tradable sector is equal to nominal wage in the non-tradable sector:

$$W_{Nt} = W_{Xt} = W_t P_t$$

3.2.2 Investments

Production of capital goods is also carried out by competitive firms. These firms combine imports and non-traded goods to produce capital goods. There are investment adjustment costs, so that the marginal return to investment in terms of capital goods is declining in the amount of investment undertaken, relative to the current capital stock.

The produced capital goods replace depreciated capital and add to the capital stock. I assume that capital producers are subject to quadratic capital adjustment costs.

In both sectors $j = X, N$, capital producers make their production plans one period in advance. They maximize

$$\max E_{t-1}\left\{\left[\frac{I_{jt}}{K_{jt}} - \frac{\chi}{2}\left(\frac{I_{jt}}{K_{jt}} - \delta\right)^{2}\right] K_{jt}Q_{jt} - P_{It}I_{jt}\right\}$$

The f.o.c. gives the standard Tobin's Q equation:

$$Q_{jt} = \frac{P_{It}}{1 - \chi\left(\dfrac{I_{jt}}{K_{jt}} - \delta\right)}$$

Furthermore, for both the exported goods and non-traded goods, capital stock evolve according to:

$$K_{jt} = \left[\frac{I_{jt-1}}{K_{jt-1}} - \frac{\chi}{2} \left(\frac{I_{jt-1}}{K_{jt-1}} - \delta \right)^2 \right] K_{jt-1} + (1-\delta) K_{jt-1}$$

Similarly to the composite consumption good, the composite investments good is defined by a CES function as follows:

$$I_t = [a_I^{1/\rho_I} I_{NNt}^{1-1/\rho_I} + (1-a_I)^{1/\rho_I} I_{Mt}^{1-1/\rho_I}]^{\rho_I/\rho_I - 1} \ , \rho_I > 0$$

The implied price index is defined as:

$$P_{It} = [a_I P_{Nt}^{1-\rho_I} + (1-a_I) P_{Mt}^{1-\rho_I}]^{1/1-\rho_I}$$

From the optimization problem, the demand for investment goods in each sector is:

$$I_{NNt} = a_I (\frac{P_{Nt}}{P_{It}})^{-\rho_I} I_t$$

$$I_{Mt} = (1-a_I)(\frac{P_{Mt}}{P_{It}})^{-\rho_I} I_t$$

Combining the above two equations,

$$I_{NNt} = \frac{a_I}{1-a_I} (\frac{P_{Nt}}{P_{Mt}})^{-\rho_I} I_{Mt}$$

For simplicity, it is assumed that $a_c = a_I = a$ and $\rho_c = \rho_I$ so that $P = P_I$.

3.2.3 Price setting and Local Currency Pricing

In the export sector, the law of one price implies:

$$P_{Xt} = S_t P_{Xt}^*.$$

where P_{Xt}^* is exogenously given.

If prices were fully flexible, the following equations for domestic and import prices would hold:

$P_{Nt} = MC_t$

$P_{Mt} = S_t P^*_{Mt}$.

where P^*_{Mt} is exogenously given.

To introduce nominal price setting in the non-traded goods sector and import sector, it is assumed that the consumption is differentiated as follows:

$$C_{Nt} = [\int_0^1 C_{Nt}(i)^{1-\theta p} di]^{1/1-\theta p} \quad \theta p > 1$$

$$C_{Mt} = [\int_0^1 C_{Mt}(i)^{1-\theta p} di]^{1/1-\theta p} \quad \theta p > 1$$

Firms in both the domestic sector and import sector set their prices as monopolistic competitors. I follow Rotemberg (1982) in assuming that each firm bears a small direct cost of price adjustment. As a result, firms will only adjust prices gradually in response to a shock to demand or marginal cost. Firms are owned by domestic households. Thus, a firm will maximize its expected profit stream, using the households discount factor Γ_t, where the ratio $\frac{\Gamma_{t+1}}{\Gamma_t}$ is defined as $\Gamma_{t+1} = \beta \frac{P_t (C_t - hC_{t-1})^\sigma}{P_{t+1}(C_{t+1} - hC_t)^\sigma}$

Each firms (i) in the non-tradable sector chooses its price $P^{(i)}_{Nt}$ to maximize:

$$\max \sum_{t=0}^{\infty} \Gamma_t \left\{ P^{(i)}_{Nt} Y^{(i)}_{Nt} - MC_t Y^{(i)}_{Nt} - P_t \frac{\varphi_N}{2} \left(\pi^{(i)N}_{t+1} - 1 \right)^2 \right\}$$

$$s.t.\ Y^{(i)}_{Nt} = \left(\frac{P^{(i)}_{Nt}}{P_{Nt}} \right)^{-\vartheta_{Pt}} Y_{Nt}$$

The constraint $Y^{(i)}_{Nt} = \left(\frac{P^{(i)}_{Nt}}{P_{Nt}} \right)^{-\vartheta_{Pt}} Y_{Nt}$ represents total demand for firm i's product. The third expression inside parentheses describes the cost of price change that is incurred by the firm.

Let's define the inflation in both domestic and import sector as follows:

$\pi_t^N = \dfrac{P_{Nt}}{P_{Nt-1}}$

$\pi_t^M = \dfrac{P_{Mt}}{P_{Mt-1}}$

The optimal price setting equation in the non-tradable sector can be written as follows:

$$P_{Nt} = \frac{\vartheta_{P_t}}{\vartheta_{P_t} - 1} MC_t - \frac{\varphi_N}{\vartheta_{P_t} - 1} \frac{P_{Nt}}{Y_{Nt}} \pi_t^N (\pi_t^N - 1) + \frac{\varphi_N}{\vartheta_{P_t} - 1} \frac{\Gamma_{t+1}}{\Gamma_t} \frac{P_{Nt+1}}{Y_{Nt+1}} \pi_{t+1}^N (\pi_{t+1}^N - 1)$$

If the parameter φ_N is zero, firms set prices as a mark-up over the marginal cost, as in the economy with flexible prices.

In a similar way, each firms i in the import sector chooses its price $P_{Mt}^{(i)}$ to maximize:

$$\max \sum_{t=0}^{\infty} \Gamma_t \left\{ P_{Mt}^{(i)} Y_{Mt}^{(i)} - S_t P_{Mt}^{*} Y_{Mt}^{(i)} - P_t \frac{\varphi_M}{2} \left(\pi_{t+1}^{(i)M} - 1 \right)^2 \right\}$$

$$s.t.\ Y_{Mt}^{(i)} = \left(\frac{P_{Mt}^{(i)}}{P_{Mt}} \right)^{-\vartheta_{P_t}} Y_{Mt}$$

The optimal price setting equation in the import sector can be written as follows:

$$P_{Mt} = \frac{\vartheta_{P_t}}{\vartheta_{P_t} - 1} (S_t P_{Mt}^{*}) - \frac{\varphi_M}{\vartheta_{P_t} - 1} \frac{P_{Mt}}{Y_{Mt}} \pi_t^M (\pi_t^M - 1) + \frac{\varphi_M}{\vartheta_{P_t} - 1} \frac{\Gamma_{t+1}}{\Gamma_t} \frac{P_{Mt+1}}{Y_{Mt+1}} \pi_{t+1}^M (\pi_{t+1}^M - 1)$$

3.3 Entepreneurs

There are two groups of entrepreneurs. One group provides capital to the non-tradable sector, while the other provides capital to the traded sector. The entrepreneurs' behaviour is similar to that proposed by BGG (1998). The probability that an entrepreneur will survive until the next period is ν, so the expected lifetime horizon is $\dfrac{1}{1-\nu}$. This assumption ensures that entrepreneurs' net worth (the firm equity) will never be enough to fully finance the new capital acquisition, so they issue debt contracts to finance their desired investment expenditures in excess of net worth.

In both sectors $j = N, X$, the entrepreneurs' demand for capital depends on the expected marginal return and the expected marginal external financing cost:

$$E_t F_{jt+1} = E_t \left\{ \frac{r^K_{jt+1} + \left[1 - \delta + \chi \left(\frac{I_{jt+1}}{K_{jt+1}} - \delta \right) \frac{I_{jt+1}}{K_{jt+1}} - \frac{\chi}{2} \left(\frac{I_{jt+1}}{K_{jt+1}} - \delta \right)^2 \right] Q_{jt+1}}{Q_{jt}} \right\}$$

where F_{jt+1} is the external funds rate and and r^K_{jt+1} is the marginal productivity of capital, at $t+1$ in sector j. Following BGG (1998), I assume the existence of an agency problem that makes external finance more expensive than internal funds. The entrepreneurs costless observe their output which is subject to a random outcome. The financial intermediaries incur an auditing cost to observe an entrepreneur's output. After observing his project outcome, an entrepreneur decides whether to repay his debt or to default. If he defaults, the financial intermediary audits the loan and recovers the project outcome less monitoring costs. Accordingly, the marginal external financing cost is equal to a gross premium for external funds plus the gross real opportunity costs equivalent to the riskless interest rate. Thus, the demand for capital should satisfy the following optimality condition:

The real return on capital is equal to the real cost on external funds

$$E_t F_{jt+1} = E_t \left[\left(1 + \frac{S_t \frac{B^e_{jt+1}}{P_t}}{N_{jt+1}} \right)^{\omega_{jt}} R^{*n}_t \frac{S_{t+1}}{S_t} \frac{P_t}{P_{t+1}} \right]$$

where ω_{jt} is the elasticity of the external finance premium in sector j with respect to the leverage ratio $1 + \frac{S_t \frac{B^e_{jt+1}}{P_t}}{N_{jt+1}} = \frac{K_{jt+1} Q_{jt}}{N_{jt+1}}$. The gross external finance premium depends on the borrowers leverage ratio:

$$premium_{jt} = \frac{E_t F_{jt+1}}{R^{*n}_t \frac{S_{t+1}}{S_t} \frac{P_t}{P_{t+1}}} = E_t \left[\left(1 + \frac{S_t \frac{B^e_{jt+1}}{P_t}}{N_{jt+1}} \right)^{\omega_j} \right] = E_t \left[\left(\frac{K_{jt+1} Q_{jt}}{N_{jt+1}} \right)^{\omega_j} \right]$$

$\frac{B^e_{jt+1}}{P_t}$ denotes the share of total real debt denominated in foreign currency hold by entrepreneurs and it is given by:

$$\frac{B^e_{jt+1}}{P_t} = \frac{1}{S_t}(Q_{jt}K_{jt+1} - N_{jt+1})$$

The entrepreneur's net worth and consumption are respectively defined as follows:

$$N_{jt} = \nu \left[F_{jt}Q_{jt-1}K_{jt} - R^*_{t-1} \left(1 + \frac{S_{t-1}\frac{B^e_{jt}}{P_{t-1}}}{N_{jt}} \right)^{\omega_{jt}} \frac{S_t}{S_{t-1}} \frac{P_{t-1}}{P_t} S_{t-1} \frac{B^e_{jt}}{P_{t-1}} \right]$$

$$C^e_{jt} = (1-\nu) \left[F_{jt}Q_{jt-1}K_{jt} - R^*_{t-1} \left(1 + \frac{S_{t-1}\frac{B^e_{jt}}{P_{t-1}}}{N_{jt}} \right)^{\omega_{jt}} \frac{S_t}{S_{t-1}} \frac{P_{t-1}}{P_t} S_{t-1} \frac{B^e_{jt}}{P_{t-1}} \right]$$

In this model there are three main determinants of the financial accelerator mechanism.

The first one is the fluctuation in the price of capital Q_t, so that there is a link between asset price movements and credit cycle as stressed in Kyotaki and Moore (1997) and in Christiano, Gust and Roldos (2002).

A fall in the price of capital has effects on the leverage ratio, $\frac{S_t \frac{B^e_{t+1}}{P_t}}{N_{t+1}} = \frac{S_t \frac{B^e_{t+1}}{P_t}}{Q_t K_{t+1} - S_t \frac{B^e_{t+1}}{P_t}}$. As the leverage ratio rises, the risk premium also rises.

On the one side the higher risk premium will increase the cost of borrowing and on the other side the lower price of capital will decrease the return on capital. Then, the entrepreneurial net worth will decrease at the end of the period and *ceteris paribus*, the leverage ratio will be higher, amplifying the recession.

The second component of the financial accelerator mechanism is the movement in the nominal exchange rate. As it is assumed that the debt is denominated in foreign currency, a devaluation will increase the value of debt denominated in foreign currency, and then the risk premium and the ex-post cost of borrowing, amplifying the recession in a similar way as described for fluctuation in the price of capital.

The third component is the price level. During a disinflation, price level are decreases and the real value of debt increases. This "deflationary effect" has a negative impact on the risk premium. On the other side, the interest payments on the existing debt, in real terms, also decreases. This latter effect, at least partially, compensates the former one.

3.4 Monetary and fiscal policy

The general form of the interest rate rule may be written as:

$$R_t^n = \left(\frac{\pi_t}{\bar{\pi}}\right)^{\rho_\pi} \left(\frac{ygap_t}{ygap_t^{flex}}\right)^{\rho_y} \left(\frac{premium_t}{premium_{t-1}}\right)^{-\rho_{PR}} \left(\frac{S_t}{S_{t-1}}\right)^{\rho_S} (R^n)^{1-\rho_{RN}} \left(R_{t-1}^n\right)^{\rho_{RN}} \exp(\varepsilon_{RNt})$$

The parameter ρ_π governs the degree to which the CPI inflation rate is targeted around the desired target $\bar{\pi}$ .The parameter ρ_y controls the degree to which interest rates attempt to control deviation of the output gap from the target level represented by the output gap in the flexible economy. The parameter ρ_S controls the degree to which interest rates attempt to control variations in the exchange rate. I am assuming that monetary authority does not react immediately and adjust interest rate with a degree of inertia measured by ρ_{RN}.

I include in the monetary rule a response to change in the aggregate premium[7], instead of to asset prices. In a"standard" Taylor rule, the parameter ρ_{RN} is set equal to zero. The underlying logic is the following: when, following a shock, premia are increasing, then the central bank should decrease the nominal interest rate to compensate the recessionary effects of the shock, at least partially.

Instead of introducing a response to asset prices, I decide to add the financial premium as a target for the monetary policy. This choice stems from two main reasons. First, financial distortions are closely related to leverage ratio and fluctuations of the exchange rate, then it seems more natural to add in the Taylor rule a financial variable, as premium, that is linked to both leverage ratio and exchange rate. Second, as Quadrini (2007) has

[7]The aggregate premium is obtained as a weighted average, using as weights the share of sectoral output over total output, measured at their steady-state vaues, that is:

$premiun_t = \frac{Y_N}{Y} premium_{Nt} + \frac{Y_X}{Y} premium_{Xt}$

pointed out, the main implication of the globalization for emerging countries is that the economy becomes more vulnerable to external asset price shocks. Therefore, the target of monetary policy for stabilization purposes should shift from domestic asset prices to foreign asset prices. In this framework, as the debt is denominated in foreign currency, the financial premia is one of the variables more closely affected by external asset prices (i.e. the exchange rate).

If the monetary authority is concerned about price level stability, an alternative specification for the Taylor rule can be:

$$R_t^n = \left(\frac{P_t/\bar{P}_t}{(P_{t-1}/\bar{P}_{t-1})^{\eta_P}} \right)^{\rho_P} \left(\frac{ygap_t}{ygap_t^{flex}} \right)^{\rho_y} (R^n)^{1-\rho_{RN}} \left(R_{t-1}^n \right)^{\rho_{RN}} \exp(\varepsilon_{RNt})$$

where $\bar{P}_t$ is the target or steady-state value for the price level at period t. Note that for $\eta_P = 1$, the rule is exactly the Taylor rule defined for the inflation targeting, while $\eta_P = 0$ means pure price-level targeting. For $0 < \eta_P < 1$ the rule is a hybrid one where the central bank is concerned about reaching the inflation target rate but also about the evolution of prices on the way to the inflation target.

Fiscal policy is modelled in a very simple way. The government raises revenues via taxes Tax_t to finance exogenous government spending G_t.

$$P_t G_t = Tax_t + (M_t - M_{t-1})$$

3.5 Equilibrium

Domestic demand and total output are respectively equal to:

$$DD_t = C_t + C_{Nt}^e + C_{Xt}^e + G_t + I_{Nt} + I_{Xt} + \frac{\varphi_N}{2} \left(\pi_t^N - 1 \right)^2 + \frac{\varphi_M}{2} (\pi_t^M - 1)^2$$

$$P_t Y_t = P_t DD_t + (P_{Xt} Y_{Xt} - P_{Mt} Y_{Mt})$$

For the investment sector, the equilibrium condition implies that

$$I_{Mt} + I_{NNt} = I_{Nt} + I_{Xt} = I_t$$

Total debt is the sum of debt hold by households and debt hold by enterprises:

$$B_t = B_t^h + B_{Nt}^e + B_{Xt}^e$$

The evolution of net total debt is defined as follows:

$$\begin{aligned} S_t B_{t+1} &= P_t \left(C_t + C_{Nt}^e + C_{Xt}^e + G_t\right) + P_{It} I_t - \left(\ r_{Nt}^K K_{Nt} + r_{Xt}^K K_{Xt} + W_t H_t\right) - P_{Nt} Y_{Nt} \left(1 - \frac{MC_t}{P_{Nt}}\right) + \\ &\quad + P_t \frac{\varphi_N}{2} \left(\pi_t^N - 1\right)^2 + P_t \frac{\varphi_M}{2} (\pi_t^M - 1)^2 \\ &= R_t^{n*} S_t B_t - P_{Xt} Y_{Xt} + P_{Mt} Y_{Mt} \end{aligned}$$

where the demand of imported goods and the demand of non-traded goods are respectively determined by the following equations:

$$Y_{Mt} = C_{Mt} + I_{Mt} + (1-a)(C_{Nt}^e + C_{Xt}^e + G_t)$$

$$Y_{Nt} = C_{Nt} + I_{NNt} + a(C_{Nt}^e + C_{Xt}^e + G_t)$$

Finally, labour market conditions must be satisfied:

$$H_{Xt} = (1-a) H_t$$

$$H_{Nt} = a H_t$$

so that labour market clearing condition implies:

$$H_t = H_{Xt} + H_{Nt}$$

3.6 Autoregressive shocks

I introduce four exogenous shocks: two productivity shocks, one in the non-traded sector (i.e. an increase in A_N) and the other in the tradable sector (i.e. an increase in A_X), a financial shock (i.e. an increase in the elasticity to the leverage ratio of premia) and a price mark-up shock (i.e. an increase in the elasticity of substitution between varieties of goods)

All the shocks follow a first-order autoregressive process:

$$A_{Nt} = A_N^{1-\rho_{AN}} (A_{Nt-1})^{\rho_{AN}} \exp(\varepsilon_{ANt})$$

$$A_{Xt} = A_X^{1-\rho_{AN}} (A_{Xt-1})^{\rho_{AN}} \exp(\varepsilon_{AXt})$$

$$\vartheta_{pt} = \vartheta_{pt}^{1-\rho_\vartheta} (\vartheta_{pt-1})^{\rho_\vartheta} \exp(\varepsilon_{\vartheta pt})$$

$$\omega_t = (\omega_t)^{1-\rho_\omega} (\omega_{t-1})^{\rho_\omega} \exp(\varepsilon_{\omega t})$$

3.7 Calibration

Following the literature, I set the steady-state rate of depreciation of capital (δ) equal to 0.025 which corresponds to a rate of depreciation equal to 10 per cent annual; the discount factor β equal to 0.99, which corresponds to an annual real rate in steady-state of 4 per cent. The steady-state share of capital in the non-tradable output (α) is equal to 0.3, while the steady-state share of capital in the tradable output, g, is set equal to 0.6. As suggested by Bernanke Gertler and Gilchrist (1998), the adjustment costs χ take a value between 0 and 0.5 (here 0.2), but there is not agreement in the literature on the value of this parameter. The probability ν that entepreneurs will survive for the next period is set equal to 0.9, therefore on average entepreneurs may alive 36 years. Following Gertler Gilchrist and Natalucci (2003), the elasticity of substitution between domestic goods and imported goods in consumption (ρ) is set equal to 1 and the share of non-tradable goods in CPI (a), is set equal to 0.5. Finally, the inverse of elasticity of substitution in real balance (e) is set equal to 2; the elasticity of labor supply (ψ), and the coefficient of labor in utility (η) are both set equal to 1.

I set the steady-state value of the elasticity of substitution between varieties of goods equal to 6, in both non-tradable and import sector. This value delivers a steady-state value for price mark-up equal to 20%. The same calibration applies for wage mark-up.

Price and wage adjustment costs are set so to correspond to a Calvo parameters equal to 0.75[8].

The parameters of the policy rule in the benchmark model are standard: I assume that ρ_π is equal to 1.5, ρ_y is equal to 0.5 and ρ_{RN} is equal to 0.8.

Shock are persistent: the autoregressive parameter is assumed to be equal to 0.9 for all the shocks.

Other parameters come from the literature: the relative risk aversion coefficient (σ) is set equal to 1; the habit persistence parameter (h) is set equal to 0.70.

Finally, for both sectors the elasticity of risk premia to the leverage ratio (ω_N and ω_X) is assumed to be equal to 0.02 and the steady-state value of the leverage ratio equal to 3. The value I choose for the leverage ratio is not consistent with a strand of literature that normally sets this parameter at a value of 2 for US[9]. Nevertheless, as the model I present means to be specialized towards the emerging market environment, it is reasonable to think that these countries are more willing to bear a higher level of debt equity ratio[10].

4 Impulse response functions analysis

In order to investigate the role played by the financial accelerator mechanism (hereafter, FA), I am comparing the IRFs under three models: the model without the FA mechanism ($\frac{Q_t K_{t+1}}{N_{t+1}} = 1$ and $\omega = 0.00$), the model with a weak FA mechanism ($\frac{Q_t K_{t+1}}{N_{t+1}} = 2$ and

[8] For further details on similarities between Clavo and Rotemberg price-setting assumption, see Lombardo and Vestin (2007)

[9] To be precise, BGG define the leverage at time t as $\frac{N_t}{Q_{t-1}K_t}$ and so they choose steady-state value equal to 0.5.

[10] As reported in Gertler, Gilchrist and Natalucci (2003), according to Krueger and Yoo (2001), in in Korea in 1997 the debt-equity ratio was 5.2 for the thirty largest chaebols, 4.8 for the five largest chaebols, 4.6 for the five largest manufacturing firms, and 3.9 for all firms in the manufacturing sector.

$\omega = 0.02$) and the model with a strong FA mechanism ($\frac{Q_t K_{t+1}}{N_{t+1}} = 3$ and $\omega = 0.02$).

4.1 Sectorial productivity shocks

Figures 1-2 plot the responses to a 1% technological shock in the non-tradable sector. Because of the higher productivity, the marginal cost falls down. The CPI inflation and the CPI price level also decrease and hence on impact the interest rate falls. The decline in the interest rate causes an increase in the inflation which closes the steady-state value after almost five periods. As a consequence of the cut in the interest rate, the exchange rate depreciates initially sharply, before slowly appreciating back to its steady-state value. The depreciation of the domestic currency and the deflation are the main source of the increase in the risk premia. An additional effect is coming from the decrease in the price of capital that generates a further increase in premia[11]. Higher premia reduce the firms' net worth and their investment spending. The more the FA mechanism is stressed, the stronger are the effects on premia and the more weakened is the positive effect of the initial productivity shock. In such a way, the FA mechanism dampens the positive effect of the shock, especially in the sector directly affected by the productivity shock. In the non-tradable sector, net worth is decreasing more sharply if the FA mechanism applies. Because of the gain in productivity, investments and output are still increasing but they do not achieve the same level that could be affordable in the absence of financial frictions.

Some variables concerning the tradable sector are sometimes positively affected by the presence of the FA mechanism, at least on impact. This can be due to the stronger initial devaluation of the currency that on one side makes the marginal productivity of capital increase; on the other, it also stimulates the production in the tradable sector because of a gain in competitiveness. As soon as the exchange rate starts to appreciate,

[11] I have calibrated the model so that price of investment goods and CPI price level are modelled in a similar way. The price of capital assets reacts consistently with the price of investment goods:

$$Q_t = \frac{P_{It}}{1 - \chi\left(\frac{I_t}{K_t} - \delta\right)}$$

positive effects in the tradable sector are offset[12].

Figures 3-4 plot the response to a 1% productivity shock in the tradable sector. Following the higher productivity, the price of tradable goods is decreasing, and hence, as the law of one price applies, the national currency revaluates. On the one hand the exchange rate appreciation makes the import goods less expensive, on the other hand the price of non-tradable goods rises due to the higher marginal cost. As the degree of openness is not remarkable, the second effect dominates and then CPI inflation raises. The combined effect of higher inflation and currency appreciation relaxes the real dollarized debt burden and improves on firms' balance sheets through the positive effect on financial premia. For the rest, a productivity shock in the tradable sector yields conclusions that are similar (but inverse) to those that are drawn in the case of a shock in the non-tradable sector.

4.2 Price mark-up shock

A price mark-up shock is introduced as an increase in the elasticity of substitution between the varieties of goods. A gain in competitiveness pushes the mark-up down, from 20% to 15%. The response of the main variables to a price mark-up shock are plotted in Figures 5-6. Inflation is decreasing as well and as the Taylor rule is responding to inflation, interest rate falls down and the national currency devaluates.

Results are similar to those observed for the productivity shock in the non-tradable sector.

[12] The strong increase in the tradable output explains also the increase of output gap. Generally, following a productivity shock, potential output should increase more than effective output and the output gap is expected to decrease. In this set up, the depreciation of the currency makes the import prices raise and leads to an improvement of the trade balance and of total output. In the sticky economy this effect is reiforced by the presence of price adjustment costs in the imported goods sector, so the effective output is pushed above its potential level. This "non standard" increase in the output gap is no longer appearing if the productivity shock is transitory. If the shock presents a low persistence, the depreciation-and hence the gain im competitiveness of export goods-is not so substantial.

4.3 Financial shock

Figure 7-8 depict the effect of a positive risk premium shock. This shock discourages investors and leads to an exchange rate depreciation. Imports goods are becoming more expansive in terms of domestic currency and then CPI inflation increases. In the case of a financial shock, the financial accelerator mechanism is mainly driven by the exchange rate depreciation. The increase in premia, through its effect on firms' balance sheets, is pushing the economy in a recession that is amplified if the economy is affected by financial frictions.

It is worth noting that, in the case of a financial shock, interest rate falls, responding more to the drop in the output gap than to the raise in the inflation.

The more the financial accelerator mechanism is stressed, the more the economy is affected by a financial shock.

In the case of a productivity shock or a price mark-up shock, the debt deflation effect and the depreciation are both pushing premia up. The financial accelerator mechanism is driven by these two effects that are working in the same direction. On the contrary, in the case of a financial shock, these two effects work in opposite direction. The negative effect on premia generated by the currency depreciation results to be dominant, while the debt-deflation effect is negligible. This latter argument is in line with results in Christiano, Motto and Rostagno (2007).

Finally, the IRFs analysis shows that premia-and hence the net worth-are reacting much more to a financial shock than to the other shocks. This results highlights the importance of financial shocks in driving the financial accelerator mechanism.

5 Optimal monetary policy

I consider the case in which the economy is affected by four kinds of shocks at the same time: two sectorial productivity shocks, a price mark-up shock and a financial shock. Then, I compare outcomes under three alternative Taylor rules: a "standard" inflation targeting rule (hereafter, IT), an "augmented" Taylor rule (that is an inflation targeting rule that is responding also to financial variables) and a price-level targeting rule (hereafter, PLT).

The analysis is based on a social loss function that penalizes the deviation of output and inflation from their steady-state values. Moreover, a large floating in the nominal domestic interest rate is also penalized. The monetary authority's loss function is the unconditional expectation of a period loss function of the form[13]:

$Loss_t = \pi_t^2 + \lambda_{ygap} ygap_t^2 + \lambda_i i_t^2$

Hence, after taking expectations, the loss function becomes:

$E[Loss_t] = var(\pi_t) + \lambda_{ygap} var(ygap_t) + \lambda_i var(i_t)$

5.1 Inflation Targeting with a standard Taylor rule

When the FA mechanism is not active (table 1, column 6), all the three variables in the loss function present a lower variability if compared to the model with financial frictions (table 2, column 2). In order to compare results for the optimal monetary policy, I have to consider a scenario without the financial shock because in the model without FA mechanism the financial shock is not active.

The increase in the inflation volatility is particularly remarkable. The presence of the FA mechanism in the model makes not possible to reach a value of the loss function as low as in the model without financial frictions.

When the financial accelerator applies, the optimal simple rule is highly super-inertial. The main advantage of a super-inertial rule is that it is very successful in affecting and controlling expectations, as it is an alternative source of history dependence. In case of a disinflationary (inflationary) disturbance, a higher coefficient of inertia can lower (increase) people's expectation about future nominal interest rate. In such a way, the IT rule introduces history dependence and behaves as a PLT rule, hence the monetary authority controls inflation expectations. If inflation expectations remain around the target, then inflation itself remains stable and the volatility of interest rate remains

[13] In this paper, weights in the loss function are set as follows: $\lambda_y = 1; \lambda_i = 0.05$

small. Through the stabilization of interest rates, the monetary authority minimizes the unexpected changes in the debt-service. Moreover, the stabilization of the interest rate also implies a smoother response in the exchange rate. In such a way, a super-inertial monetary rule is more successful in offsetting the effects from external shocks on business cycles.[14]

This mechanism also explains why there is no room for the optimal policy to be super-inertial in an economy that is not affected by financial frictions. Figures 9-14 compares the IRFs under the optimal rules for the model with and without financial frictions. When the FA mechanism is not working, the economy is not affected by the financial shock. Therefore, figures 15-16 display the reactions to a financial shock under the optimal ruleonly for the model with financial frictions. If the FA mechanism applies, it is optimal to control the inflation through the expectations rather than through an aggressive response to inflation that could lead to a deflation and then to a tightening of the real debt burden. On the contrary, if the financial accelerator does not apply, firms are fully self-financed and the economy is less vulnerable to fluctuations in the interest rate and in the exchange rate.

In a nutshell, the main advantage of a super-inertial rule is that it "smooths" the response of the interest rate to shocks, that, in turns, reduces interest payments volatility and fluctuations in the exchange rate. This beneficial impact is negligible in an economy where firms do not burden with a high level of debt.

Finally, it is worth to note that the gain from super-inertial rule in a model with financial frictions is at least partially linked to the occurrence of financial shocks. As highlighted in paragraph 4.3, the IRFs analysis has showed that premia are significantly affected by the financial shock, rather than by the technology shocks and the price mark-up shock. Therefore, the financial shock is the main source in triggering the financial accelerator mechanism. Table 2 also confirms results from the IRFs analysis: in the

[14] I have double-checked this argument, fixing $\rho_{RN} = 0.7$. The minimization of the loss function yelds the following values for the coefficient in the taylor rule: $\rho_\pi = 1.54$ and $\rho_y = 0.67$.

The variance of $\frac{S_{t+1}}{S_t}$ is increasing by 28%.

absence of the financial shock, the optimal monetary policy displays a stronger reaction to inflation and a lower degree of interest rate smoothing, even if it is still super-inertial. The value of the loss function is consistently decreasing.

5.2 Inflation Targeting with an "augmented" Taylor rule

I investigate whether the trade-off (and the loss) is smaller if monetary policy is allowed to react to financial variables, in this case an aggregate financial premium.

Instead of introducing a response to asset prices, I decide to add the financial premium as a target for the monetary policy. This choice stems from two main reasons. First, financial distortions are closely related to leverage ratio and fluctuations of the exchange rate, then it seems more natural to add in the Taylor rule a financial variable, as premium, that is linked to both leverage ratio and exchange rate. Second, as Quadrini (2007) has pointed out, the main implication of the globalization for emerging countries is that the economy becomes more vulnerable to external asset price shocks. Therefore, the target of monetary policy for stabilization purposes should shift from domestic asset prices to foreign asset prices. In this framework, as the debt is denominated in foreign currency, the financial premia are closely affected by external asset prices (i.e. the exchange rate).

To consider a reaction to financial variables, Cúrdia and Woodford (2008) add a spread adjustment in the standard Taylor rule. In a similar way, here I include in the monetary rule a response to change in the aggregate financial premium. The underlying logic is the following: when, following a shock, premia are increasing, then the central bank should decrease the nominal interest rate to compensate the recessionary effects of the shock, at least partially[15].

[15] In Curdia and Woodford (2008), a spread adjustment would generally represent the right direction of adjustment of policy, relative to a simple Taylor rule. The main open issue is the magnitude of adjustment that would be appropriate, depending on the source of the shock. In some cases it is desirable to lower the policy rate by the full amount of the increase in the spread between the deposit rate and the lending rate; but in a number of cases a much smaller adjustment would lead to a more nearly optimal policy, while in other cases, even an adjustment several times as large as the increase in credit spreads would not be sufficient.

Table 1 (column 3) reports outcomes under an optimal monetary rule that is reacting to the aggregate financial premium. With respect to a benchmark rule[16], the standard IT optimal rule is improving on loss by 6.5%. When the optimal simple rule is also responding to financial variables, the additional gain is less than 1%. This result confirms that an "augmented" Taylor rule is not considerably improving on loss.

Nevertheless, the optimal policy delivers different coefficients in the Taylor rule. It is worth noticing that if the monetary authority is concerned about responding to financial variables, there is no need anymore to set a strongly super-inertial Taylor rule. The negative effect on net worth, investments and output generated by the increase in premia is partially compensated by a decrease in the interest rate itself, rather than through the expectations mechanism.

5.3 Inflation targeting *cum* exchange rate stabilization

I now consider a policy rule that attempts to stabilize a basket composed of CPI inflation,output and exchange rate. Table 1 (column 4) shows that the feedback from the exchange rate is close to zero and results are similar to those obtained under the "standard" inflation target rule. In other words, responding to changes in the exchange rate is not optimal under dollarization of liabilities and in the presence of financial frictions. These two factors play a key role. On the one hand the dollarization of liabilities strengthens the exchange rate channel of monetary policy transmission. On the other side, implications for monetary policy are strongly depending on the presence of the financial shock, as it is the exogenous disturbance that mainly triggers the financial accelerator mechanism. As displayed in table 2 (column 3) when the economy is not affected by the financial shock, adding a small reaction to the fluctuation in the exchange rate can be optimal.

[16] For "benchmark rule", I mean the calibrated rule in which parameters are set as follows:

$\rho_{RN} = 0.8$

$\rho_{\pi} = 1.5$

$\rho_{y} = 0.5$

$\rho_{PR} = 0.0$

The increase in the required premium generates a contraction in the financial account that must be matched with an increase in the current account. The optimal policy requires a depreciation together with an increase in the interest rate, as displays in figure 15. On the domestic economy side, the optimal policy implies an increase in the interest rate in order to discourage borrowing and consumption. On the balance of trade side, the optimal policy implies also a depreciation of the domestic currency. Under a fixed exchange rate system, the burden of adjustment is only on the domestic economy side. The central bank is forced to impose aggressive changes in the interest rate, pushing the economy in a stronger recession.

In brief, reducing the volatility of the exchange rate limits the ability of the central bank to enact stabilizing monetary policy by devaluating the exchange rate, Then , the monetary authority is forced to increase the interest rates exacerbating the contraction in investment spending which in turns affects net worth and output.

5.4 Price-level targeting

Finally, I explore the issue of whether price level is a better target for the monetary policy.

Actually, not only fluctuations in the exchange rate, but also movements in the price level are affecting the real value of the debt denominated in foreign currency. The "deflationary effect" is one of the main sources of the financial accelerator mechanism, as it generates an increase in the premia and it propagates the negative effect of a shock through the balance sheets effect. For these reasons, I investigate whether in the presence of a deflation, it is preferable to increase the percentage of price-stability concern of the monetary authority that take the form of price-level targeting in the Taylor rule. In this exercise I am considering a pure price-level targeting rule.

Table 1 (column 5) reports results under a PLT rule. The variance of all variables in the loss function (especially the inflation) is lower that in the case in which the Central Bank is setting an IT rule. The loss function decreases by 40%. These results seem to confirm the wisdom that a PLT rule produces the best outcomes in terms of the variance of inflation and volatility of nominal interest rates.

The main gain from the optimal PLT rule is that it results in less volatile interest rates. The stabilization of the interest rate reduces the risk faced by both enterprises and households that hold debt in nominal terms. Through the stabilization of return on nominal assets and liabilities, the optimal PLT rule reduces also the variability of consumption, investments and then output. Then, what is interesting here is that the PLT rule is also improving on output variability. Jääksela (2005) find that, in a forward-looking expectations set-up, there is a trade-off between variability of inflation and the output gap. Rules that react to price level overperform the standard inflation targeting rule in terms of variance of inflation, but the downside of these rules is that they generate a higher variability of output gap. In this framework incorporating financial frictions, a PLT rule is also delivering a lower variability of output gap because it helps in minimizing the nominal debt distortions and hence net-worth, investments and output are also improving in terms of volatility.

As pointed out in Dib, Mendicino and Zhang (2008) the advantage of a PLT rule is significantly linked to the occurrence of the financial shock, as it is the main trigger source for the financial accelerator mechanism. Once the financial shock is not hitting the economy, the financial accelerator mechanism is weak. Therefore, there is a less pressing need to stabilize the interest rate and the exchange rate in order to minimize the distortions deriving from the nominal "dollarized" debt. Then, the PLT rule is still improving on inflation variability, but it delivers an higher variability of output gap. The trade-off arising in Jääksela -between output stabilization and inflation variability- is restored. If in this setting, the monetary authority is assigning a high weight to the stabilization of the output gap in the loss function, then the PLT rule generate a higher value of loss. Similar conclusions are drawn if I have evaluate the optimal PLT monetary policy in a model without financial frictions.

The results here obtained are in line with those in Giannoni (2000)[17] who argues that

[17] Among the others: Black, Macklem and Rose (1997); Vestin (2006).

when agents are forward-looking and the monetary authority credibly commits to a PLT rule, such a rule yields lower variability of inflation and of nominal interest rates. Agents' expectation of a future deflation after an inflationary shock dampens the initial increase in inflation, lowers the variability of inflation, and hence stabilizes output and increases welfare.

Nevertheless, many authors have stated that the performance of the price level rule depends critically on the expectation formation process assumed in the model. When expectations are forward-looking (as in this framework), a PLT rule introduces a desirable inertia that affects the private sector's expectation appropriately. The mechanism operates as follows. Assume that a deflationary or disinflationary disturbance leads to a fall in the price level relative to target (e.g. a price mark-up shock). Economic agents observing the shock understand that the central bank will correct the deviation from the target aiming at an above average inflation rate. As a result, inflation expectations increase, which helps to mitigate the initial impact of the deflationary shock. Under a credible price level target, inflation expectations operate as automatic stabilizers. The beneficial impact of a PLT rule on inflation expectations was lacking in the first strand of theoretical analysis based on backward-looking models, as in Lebow, Roberts, and Stockton (1992), Haldane and Salmon (1995), Fillion and Tetlow (1994).

6 Conclusions

The financial crises over the last decade have generated interest in the design of monetary policy for emerging market economies. Many economists have argued that if credit frictions are quantitative important for cyclical fluctuations, models used for monetary policy analysis should take them more seriously in order to offset the propagation of transitory shocks.

I have analyzed how introducing financial frictions in a small open economy with dollarization of liabilities can affect the choice of the optimal monetary policy.

Primarily, I have focused on the trade-off that may arise between output stabilization and price stability both in the model with financial accelerator and in the model without financial accelerator. I have found that in a model with both nominal and financial frictions, a simple policy rule is delivering a higher value of loss than in a model without financial frictions. Moreover, the presence of financial frictions requires more inertia in the optimal rule, in order to stabilize interest rates. In such a way, the monetary rules is successful in minimizing the risk embedded in the repayment of nominal debt. Nevertheless, this argument depends on the source of the shock. It has been showed that the gain from a super-inertial rule is significantly reduced if the economy is not affected by the financial shock.

To this extend, I have investigated whether, in the presence of financial frictions, the optimal outcome can be realized or approached more closely if monetary policy is allowed to react to aggregate financial variables. It is showed that an "augmented" Taylor rule (that is a monetary rule responding to changes in the aggregate financial premium) is not improving on loss, but it needs a lower degree of inertia. The stabilization works through the reaction of interest rate itself to changes in premia, rather than through the expectations' control.

In addition, I find that responding to exchange rate fluctuations it is not optimal when liabilities are denominated in foreign currency and when financial frictions are driven by the financial shock. Indeed, reducing the volatility of the exchange rate forces the central bank to undertake more aggressive change in the interest rate in order to enact stabilizing monetary interventions. Fluctuations in the interest rate induce rise in the cost of capital which in turns affects net worth and output.

Finally, I have explored the issue of whether price level is a better target for the monetary policy. This latter analysis stems from the initial intuition that movements of the price level can play an important role in the propagation of shocks through the so called "deflationary effect" and its effect on firms' balance sheets. I have found that a PLT rule produces the best outcomes in terms of the variance of inflation and volatility of nominal interest rates. This result arises from the fact that a PLT rule introduces a desirable inertia in the monetary rule. In such a way it affects price sector's expectations that operate as automatic stabilizers. As a result, the lower volatility of the interest rates and the exchange rate help in minimizing distortions introduced by the presence of liability defined in nominal terms and in foreign currency.

References

[1] Aoki, K., Proudman J. and G. Vlieghe (2004) "House Prices, Consumption, and Monetary Policy: a Financial Accelerator Approach", Journal of Financial Intermediation 13, pp. 414-435.

[2] Ball, L. (1999) "Policy Rules for Open Economies", in J. Taylor (ed.) Monetary Policy Rules, University of Chicago Press, Chicago.

[3] Batini, N. and E. Nelson (2000) "When the Bubble Bursts: Monetary Policy Rules and Foreign Exchange Market Behavior", Mimeo

[4] Bernanke, B., and M. Gertler (1989) "Agency Costs, Net Worth and Business Fluctuations." American Economic Review 79, pp.14-31.

[5] Bernanke, B., and M. Gertler (1995) "Inside the Black Box: the Credit Channel of Monetary Policy Transmission." Journal of Economic Perspectives 9, pp. 27-48.

[6] Bernanke, B., M. Gertler, and S. Gilchrist (1998) "The Financial Accelerator in a Quantitative Business Cycle Framework." NBER Working Paper No. 6455, March.

[7] Bernanke, B. & Gertler, M. (1999) "Monetary Policy and Asset Market Volatility", Federal Reserve Bank of Kansas Economic Review, 84, 1752.

[8] Bernanke, B. & Gertler, M. (2001) "Should Central Banks Respond to Movements in Asset Prices?", American Economic Review, Papers and Proceedings, 91, Vol. 2, No. 2, pp. 53-257.

[9] Black, R., Macklem, T. and D. Rose (1997) “On policy rules for price stability”, in: Price Stability, Inflation Targets, and Monetary Policy, Proceedings of a conference held by the Bank of Canada, May 1997, pp. 411-461.

[10] Braggion, F. Chhristiano, J. L. and J. Roldos (2007) "Optimal monetary policy in a Sudden-Stop", NBER Working Paper No. 13254.

[11] Carlstrom, C. T. & Fuerst, T. S. (2007) "Asset Prices, Nominal rigidities and Monetary Policy", Review of Economic Dynamics, 10 (2), pp. 256–275.

[12] Cecchetti, S., Genberg, H., Lipsky, J., & Wadhwani, S. (2000) "Asset prices and Central Bank Policy", Report on the world economy 2. Geneva, CEPR and ICMB.

[13] Cespedes, L.F., Chang, R. and A. Velasco (2001), "Dollarization of Liabilities, Net Worth Effect, and Optimal Monetary Policy", mimeo, Harvard University.

[14] Cespedes, L. F., Chang, R. and A. Velasco (2004) "Balance Sheets and Exchange Rate Policy" NBER Working Paper No. 7840, Cambridge MA

[15] Christiano, J. L., Motto, R. and M. Rostagno (2006) "Shocks, structures or Policies? A Comparison of the EA and the US" Mimeo, European Central Bank.

[16] Christiano, J. L., Motto, R. and M. Rostagno (2007) "Financial Factors in Business Cycles", manuscript.

[17] Cúrdia, V. (2008) "Optimal Monetary Policy Under Sudden Stops", Staff Report Federal Reserve of New York, 323.

[18] Cúrdia, V. and M. Woodford (2008) "Credit Frictions and Optimal Monetary Policy", prepared for presentation at the BIS annual conference "Whither Monetary Policy?" Lucerne, Switzerland, June 26-27, 2008.

[19] De Fiore, F. and H. Uhlig (2005) "Bank Finance versus Bond Finance: What Explains the Difference Between the US and Europe?", CEPR Working Paper No. 5213.

[20] Devereux, M., Lane, P. and J. Xu (2004) "Exchange Rates and Monetary Policy in Emerging Market Economies", CEPR Working Paper No. 36, August 2004.

[21] Dib, A., Mendicino, C. and Y. Zhang (2008) "Price Level Targeting in a Small Open Economy with Financial Frictions: Welfare Analysis", Bank of Canada Working Paper No. 2008-40.

[22] Dupor, W. (2001) "Nominal Price Versus Asset Price Stabilization", Working Paper. The Wharton School, Pennsylvania.

[23] Faia, E. and T. Monacelli (2005), "Optimal Monetary Policy Rules, Asset Prices and Credit Frictions", CEPR Discussion Paper no 4880.

[24] Fillion, J.-F. and R. Tetlow (1994) "Zero-Inflation or Price-Level Targeting? Some Answers from Stochastic Simulations on a Small Open-Economy Macro Model". Proceedings of a conference held by the Bank of Canada, October 1993. Ottawa: Bank of Canada.

[25] Gertler, M., Gilchrist, S. and F. Natalucci (2003) " External Constraints on Monetary Policy and the Financial Accelerator", NBER Working Paper No.10128.

[26] Giannoni, M.P. (2000) "Optimal Interest Rate Rules in a Forward-Looking Model, and Inflation Stabilization versus Price-Level Stabilization", Unpublished, Princeton University.

[27] Gilchrist, S., Hairault, J.O. and H. Kempf (2002) "Monetary Policy and the Financial Accelerator in a Monetary Union" European Central Bank Working Paper No.175, Frankfurt.

[28] Haldane, A.G. and C.K. Salmon (1995) "Three Issues on Inflation Targets." In Targeting Inflation, edited by A.G. Haldane, 170–201. London: Bank of England.

[29] Iacoviello, M. (2005) "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle", American Economic Review,Vol. 95, No. 3, pp. 739-764.

[30] Jääskelä, J.P. (2005) " Inflation, Price Level and Hybrid Rules under Inflation Uncertainty", Scandinavian Journal of Economics, Vol 107, No. 1, pp. 141-156.

[31] Lebow, D.E., J.M. Roberts, and D.J. Stockton (1992) "Economic Performance Under Price Stability."U.S. Board of Governors of the Federal Reserve System Working Paper No. 125.

[32] Levin, A., Natalucci, F. and E. Zakrajsek (2004) "The Magnitude and Cyclical Behavior of Financial Market Frictions", Staff Working Paper 2004-70, Board of Governors of the Federal Reserve System.

[33] Lombardo, G. and D. Vestin (2007) "Welfare implication of Calvo vs Rotemberg pricing assumption", European Central Bank Working Paper No. 770, Frankfurt.

[34] Meier, A. and G. Mueller (2006) "Fleshing out the Monetary Transmission Mechanism - Output Composition and the Role of Financial Frictions", Journal of Money, Credit, and Banking, 38(8), December 2006, pp. 2099-2134.

[35] Quadrini, V. (2007) "Asset-price driven business cycle and monetary policy", manuscript.

[36] Queijo, V. (2005) "How Important are Financial Frictions in the US and the Euro Area?", Seminar Paper n. 738, Institute for International Economic Studies, Stockholm.

[37] Siklos, P., Werner, T. and M. T. Bohl (2004) "Asset Prices in Taylor Rules: Specification, Estimation, and Policy Implications for the ECB", Deutsche Bundesbank Discussion Paper Series 1: Studies of the Economic Research Centre No. 22/2004.

[38] Smets, F. (1997) "Financial Asset Prices and Monetary Policy: Theory and Evidence", CEPR Discussion Paper No. 1751, November 1997.

[39] Svensson, L.E.O.(1999) "Price-Level Targeting vs. Inflation Targeting: A Free Lunch?"Journal of Money, Credit and Banking No. 31, August 1999, pp. 277-293.

[40] Vestin, D. (2006) "Inflation versus price-level targeting", Journal of Monetary Economics, Vol. 53 No. 7, pp. 1361-1376.

A The steady-state equilibrium

$$A_N = 1$$
$$A_X = 1$$
$$P_M^* = 1$$
$$P_M = 1$$
$$P_N = 1$$
$$P = 1$$
$$P_I = 1$$
$$S = 1$$
$$\varepsilon_{AN} = 0$$
$$\varepsilon_{AX} = 0$$
$$\varepsilon_{PM} = 0$$
$$\varepsilon_{PX} = 0$$
$$\varepsilon_{RN} = 0$$
$$\varepsilon_{RN^*} = 0$$
$$\varepsilon_G = 0$$
$$\pi = 1$$
$$\pi^N = 1$$
$$\pi^M = 1$$
$$\pi^W = 1$$
$$\Delta S = 1$$
$$\mu = 1$$
$$G = 0.1$$
$$tax = G$$
$$R^n = \frac{1}{\beta}$$
$$R = R^n$$
$$R^{*n} = R^n$$

$$MC = \frac{\vartheta^P - 1}{\vartheta^P} P_N$$
$$P_M^* S = \frac{\vartheta^P - 1}{\vartheta^P} P_M$$
$$Q_N = P_I$$
$$Q_X = P_I$$
$$F_N = \left(1 + \frac{N_N}{B_N^e}\right)^{-\omega_N} R^{*n}$$
$$F_X = \left(1 + \frac{N_X}{B_X^e}\right)^{-\omega_X} R^{*n}$$
where for $j = N, X \quad \left(1 + \frac{N_j}{B_j^e}\right) = \frac{K_j Q_j}{N_j} = leverage$
$$E(F_N) = F_N$$
$$E(F_X) = F_X$$
$$premium_N = \frac{E(F_N)}{R^{*n}}$$
$$premium_X = \frac{E(F_X)}{R^{*n}}$$
$$r_N^K = \left[\left(1 + \frac{N_N}{B_N^e}\right)^{-\omega_N} R^{*n} - (1-\delta) Q_N\right]$$
$$r_X^K = \left[\left(1 + \frac{N_X}{B_X^e}\right)^{-\omega_X} R^{*n} - (1-\delta) Q_X\right]$$

$$\frac{K_N}{Y_N} = \frac{MC(\alpha)}{r_N^K}$$
$$\frac{H_N}{Y_N} = \left[A_N \left(\frac{K_N}{Y_N}\right)^{\alpha}\right]^{-\frac{1}{1-\alpha}}$$

$$W_N = MC(1-\alpha) \frac{Y_N}{H_N}$$
$$W = \frac{W_N}{P}$$
$$W_X = W_N$$
$$\frac{M}{P} = \zeta^{1/\varepsilon [} (1-h) C]^{\sigma/\varepsilon} \left(\frac{R^n}{R^n - 1}\right)^{1/\varepsilon}$$

$$P_X = \frac{W_X^{1-\gamma} (r_X^K)^{\gamma}}{(1-\gamma)^{1-\gamma} A_X \gamma^{\gamma}}$$

$$\frac{K_X}{Y_X} = \frac{\gamma P_X}{r_X^K}$$

$$\frac{H_X}{Y_X} = \left[A_X \left(\frac{K_X}{Y_X}\right)^{\gamma}\right]^{-\frac{1}{1-\gamma}}$$
$$P_X^* = \frac{P_X}{S}$$
$$Y_N = 0.7$$
$$Y_M = 0.3$$
$$Y = Y_N + Y_M$$
$$Y_X = \frac{P_M Y_M}{P_X}$$
$$K_N = \frac{K_N}{Y_N} Y_N$$
$$K_X = \frac{K_X}{Y_X} Y_X$$
$$H_N = \frac{H_N}{Y_N} Y_N$$
$$H_X = \frac{H_X}{Y_X} Y_X$$
$$H = H_N + H_X$$
$$I_N = \delta K_N$$
$$I_X = \delta K_X$$
$$N_N = \frac{K_N Q_N}{leverage}$$
$$N_N = \frac{K_X Q_X}{leverage}$$
$$Z_N = \frac{N_N}{\nu}$$
$$Z_X = \frac{N_X}{\nu}$$
$$B_N^e = Q_N K_N - N_N$$
$$B_X^e = Q_X K_X - N_X$$
$$C_N^e = (1 - \nu) Z_N$$
$$C_X^e = (1 - \nu) Z_X$$
$$C = Y - (P_X Y_X - P_M Y_M) - (I_N + I_X) - (C_N^e + C_X^e) - G$$
$$I_{NN} = a_I (I_N + I_X)$$
$$I_M = (1 - a_I)(I_N + I_X)$$
$$C_N = a_c C$$

$$C_M = (1 - a_c)C$$

$$DD = C + C_N^e + C_X^e + I_N + I_X + G$$

$$Y = DD + (P_X Y_X - P_M Y_M)$$

$$B = \frac{P_X Y_X - P_M Y_M}{1 - R^{n*}}$$

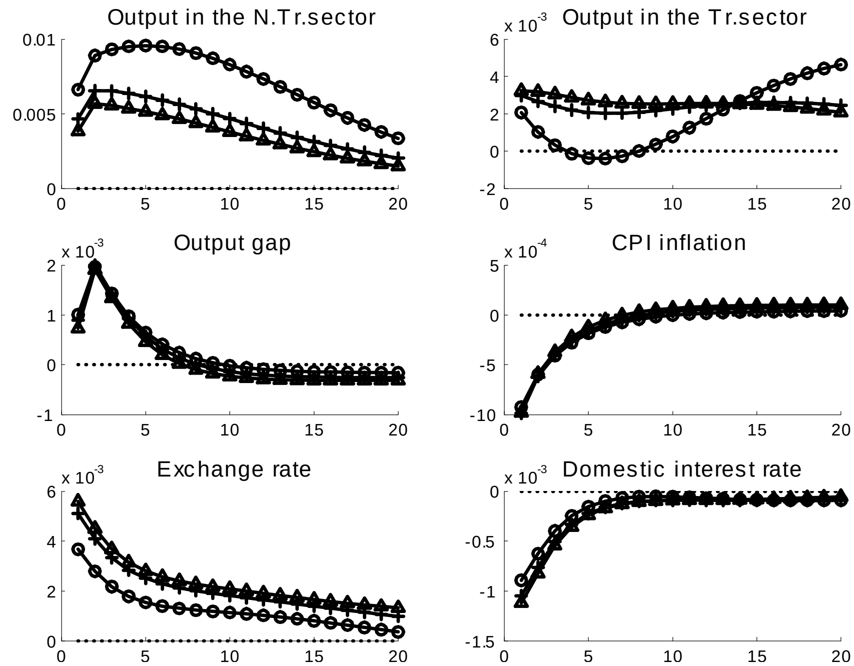

Figure1: IRFs-Productivity shock in the non tradable sector

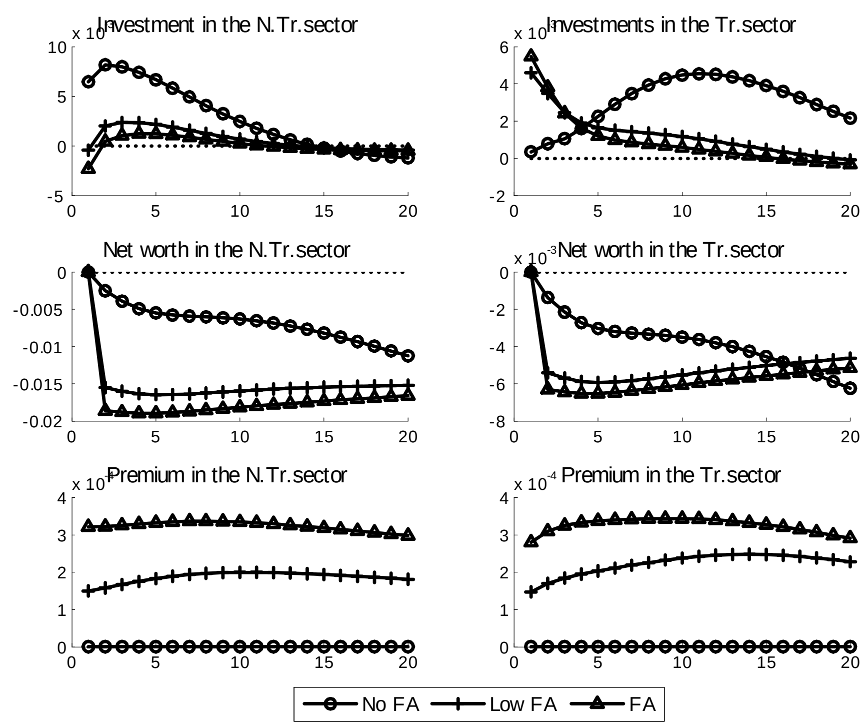

Figure2: IRFs-Productivity shock in the non tradable sector *bis*

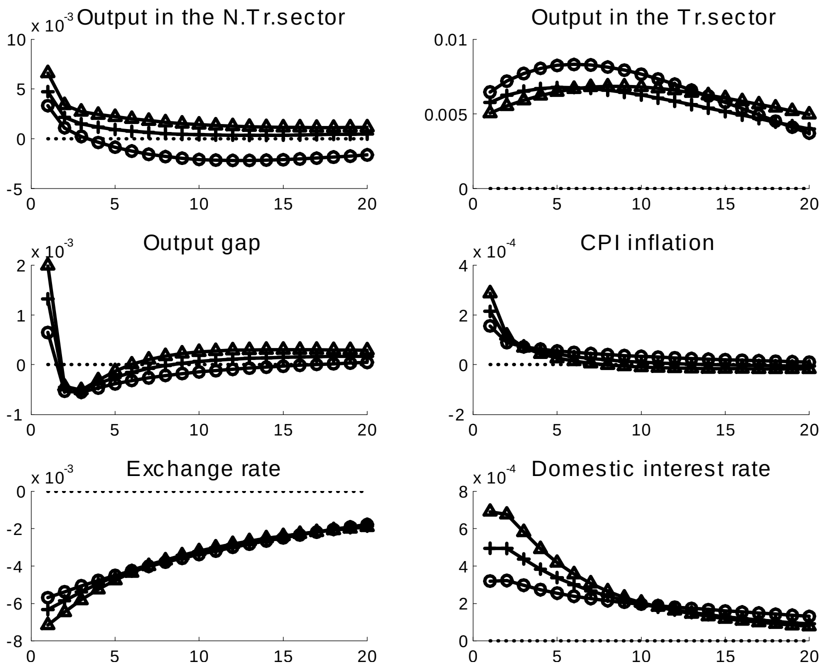

Figure3: IRFs-Productivity shock in the tradable sector

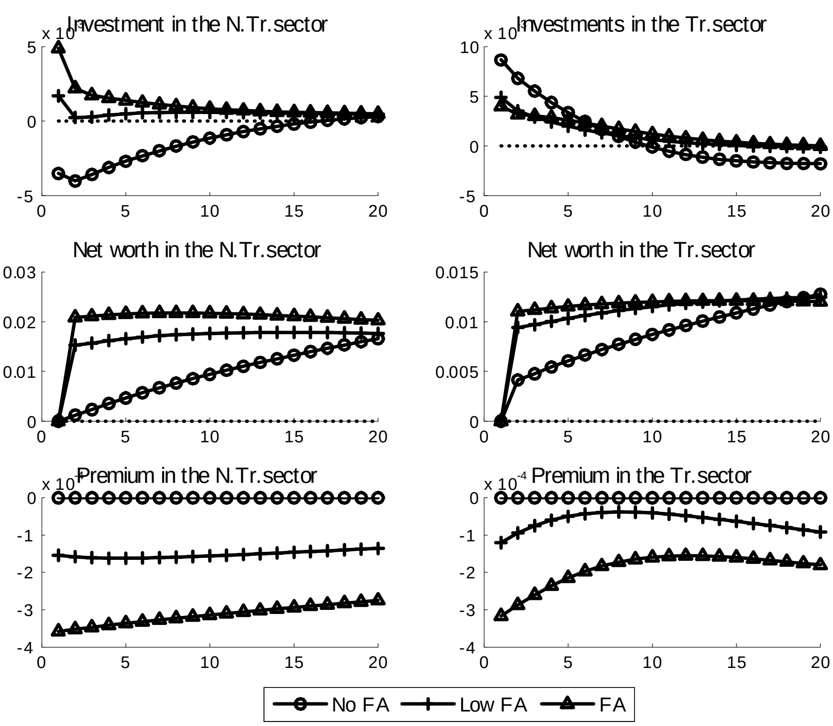

Figure4: IRFs-Productivity shock in the tradable sector *bis*

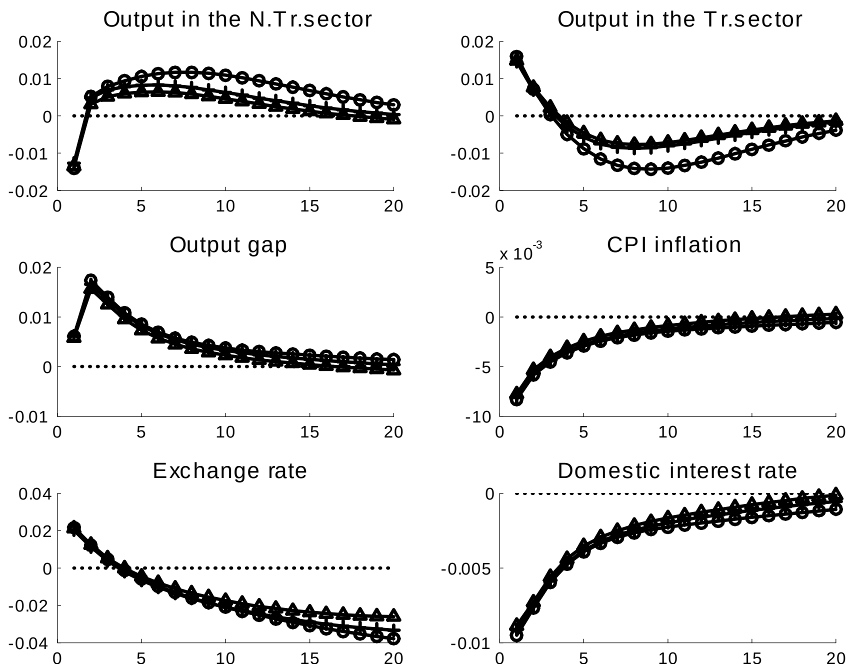

Figure 5: IRFs-Price mark-up shock

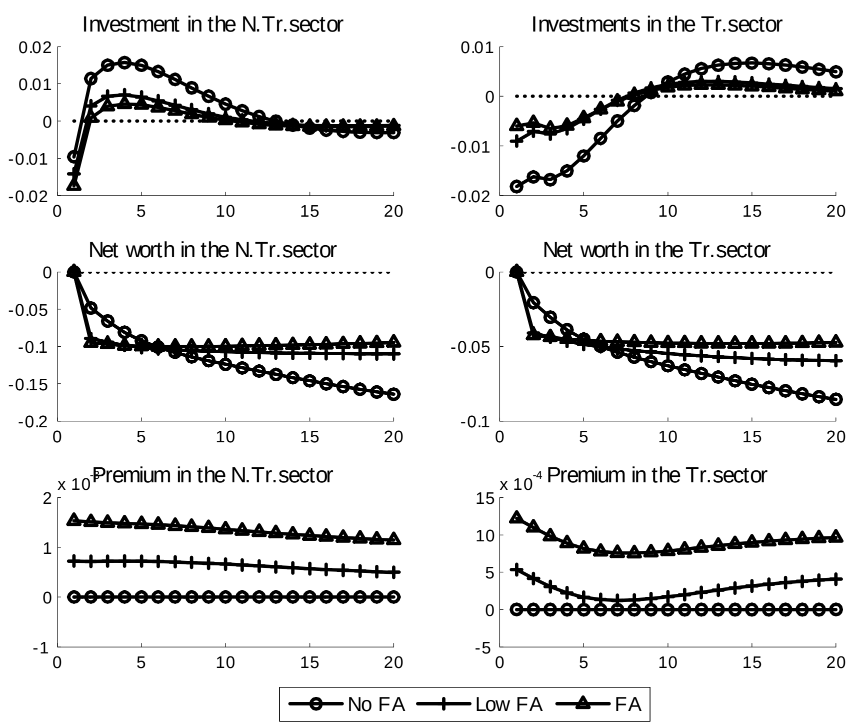

Figure 6: IRFs-Price mark-up shock *bis*

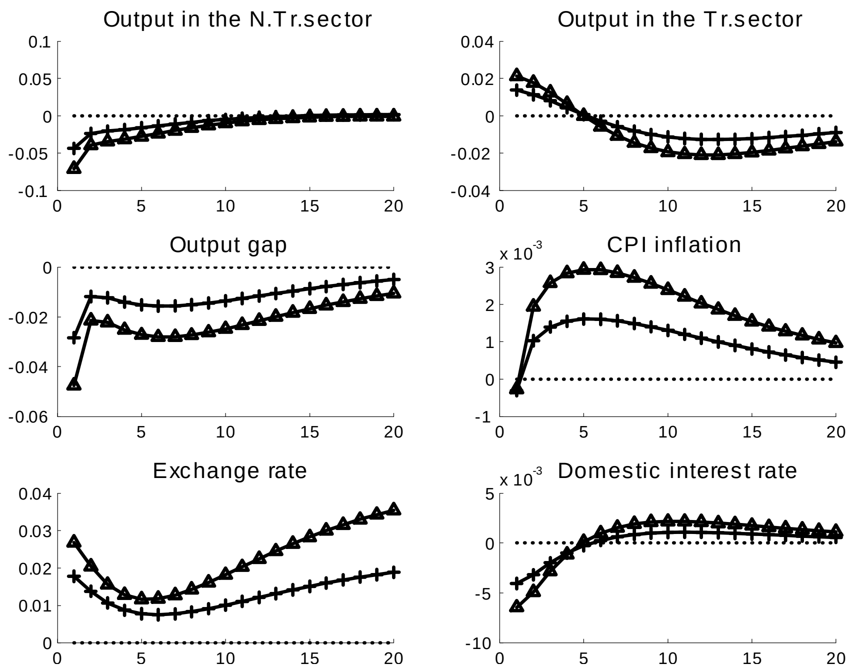

Figure 7: IRFs-Financial shock

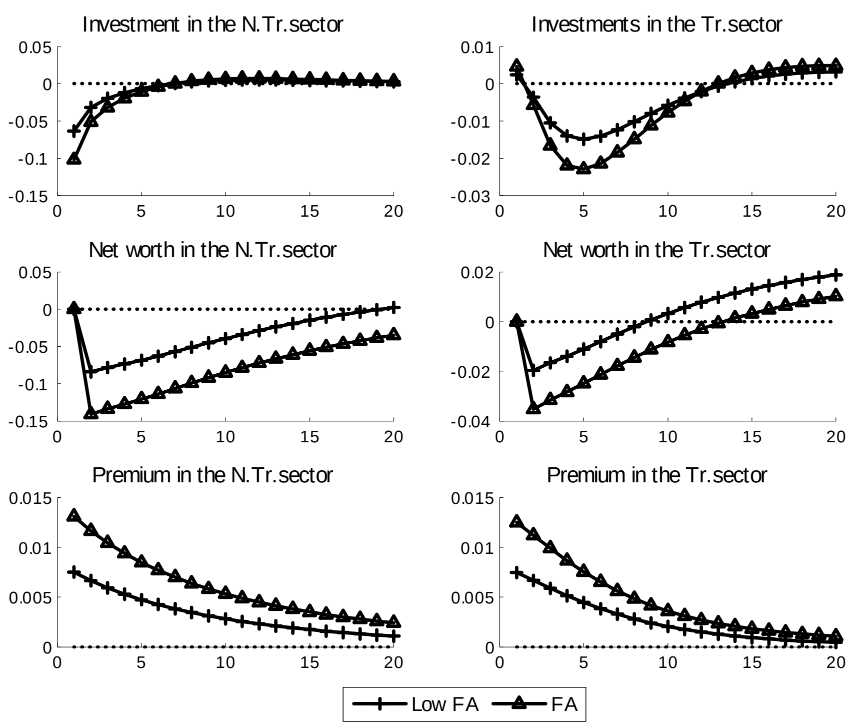

Figure 8: IRFs-Financial shock *bis*

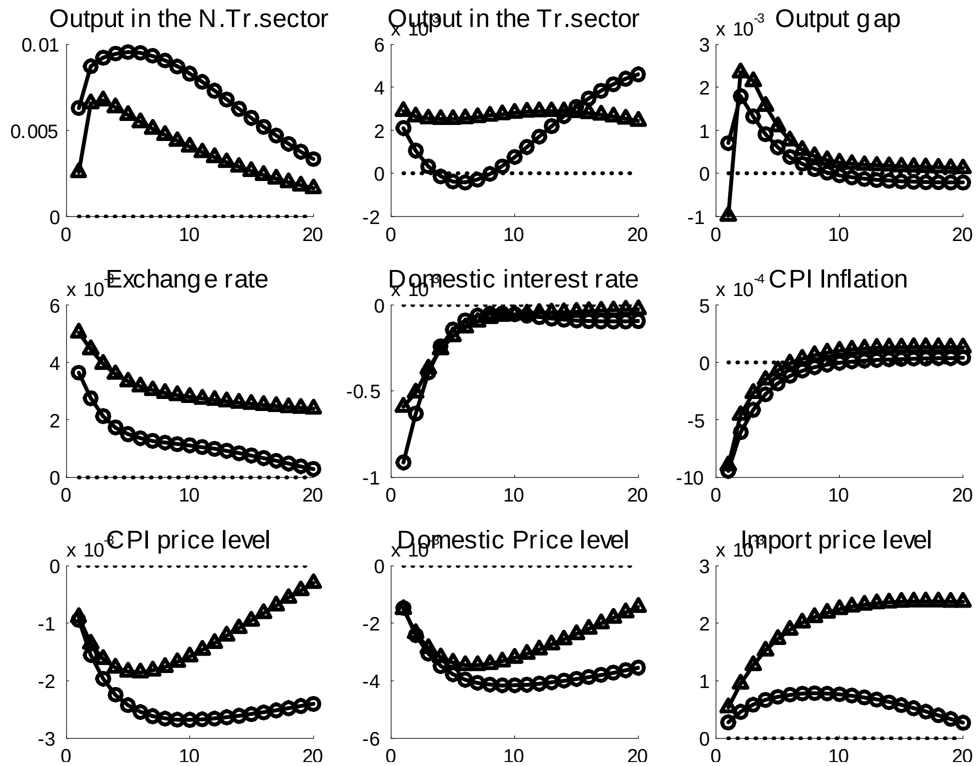

Figure 9: IRFs, optimal rule- Productivity shock in the non tradable sector

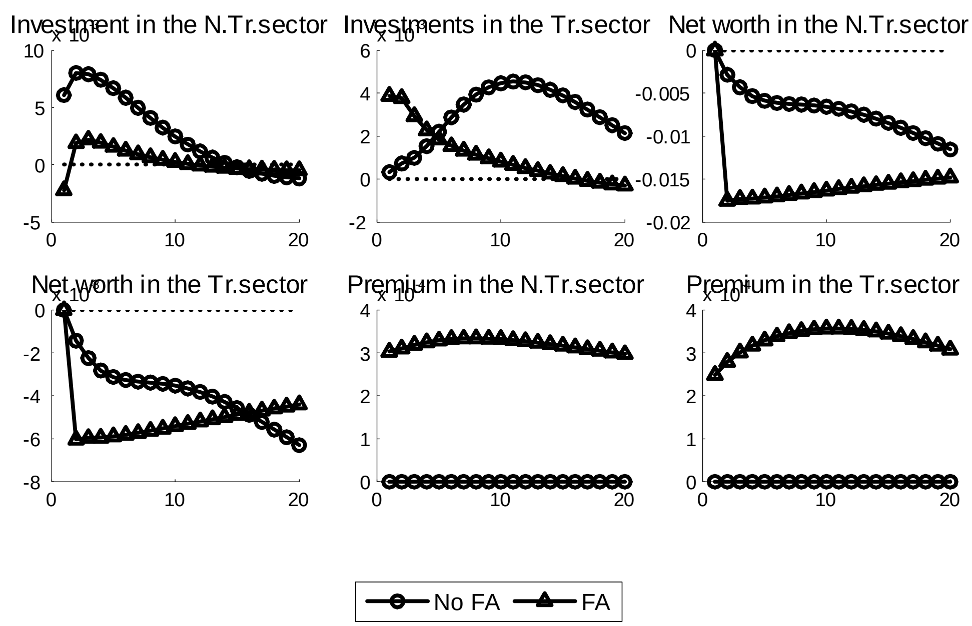

Figure10: IRFs, optimal rule- Productivity shock in the non tradable sector *bis*

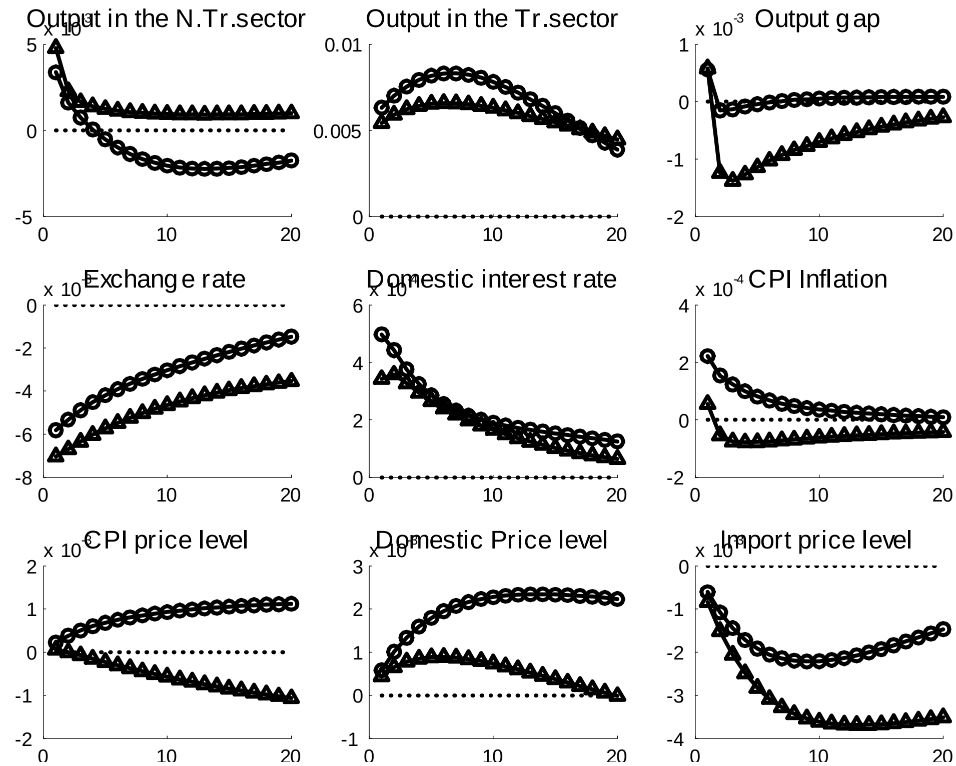

Figure11: IRFs, optimal rule- Productivity shock in the tradable sector

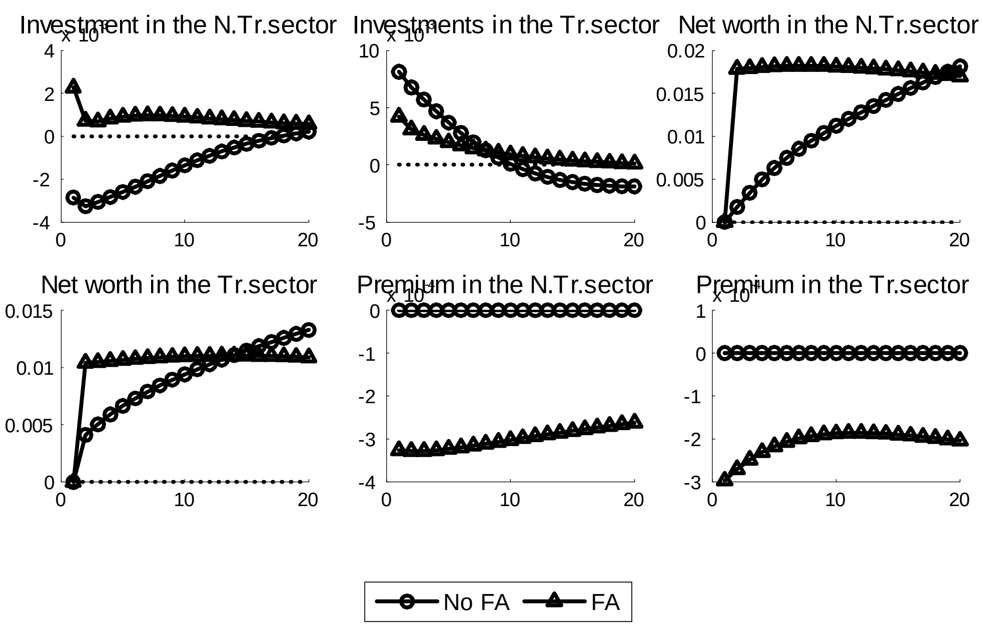

Figure12: IRFs, optimal rule- Productivity shock in the tradable sector *bis*

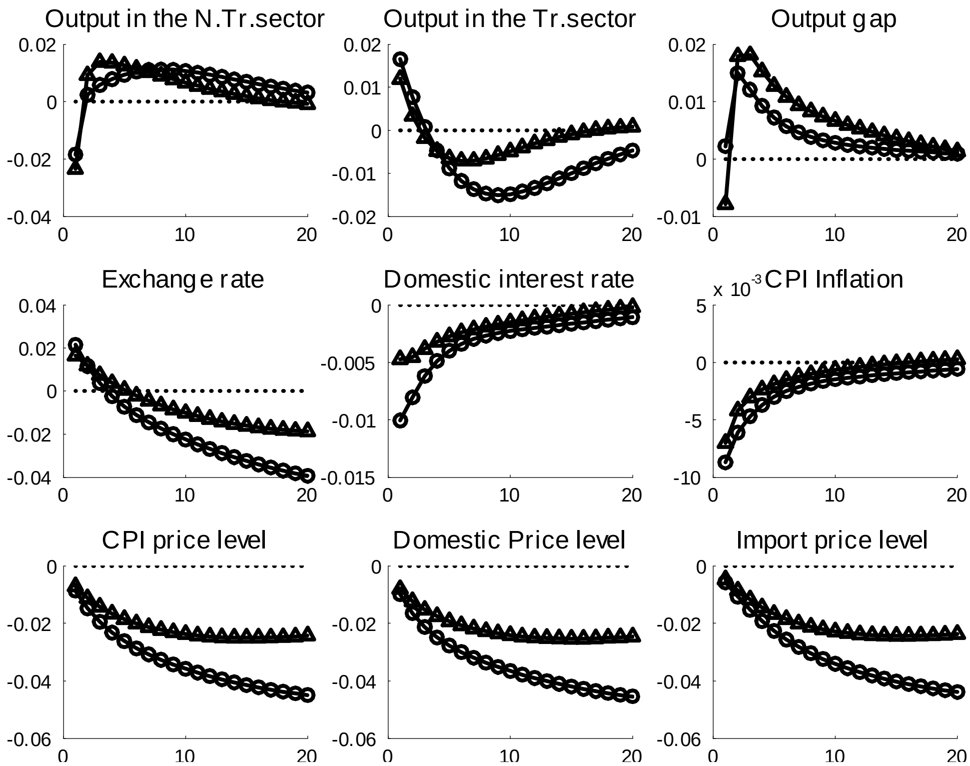

Figure13: IRFs, optimal rule- Price mark-up shock

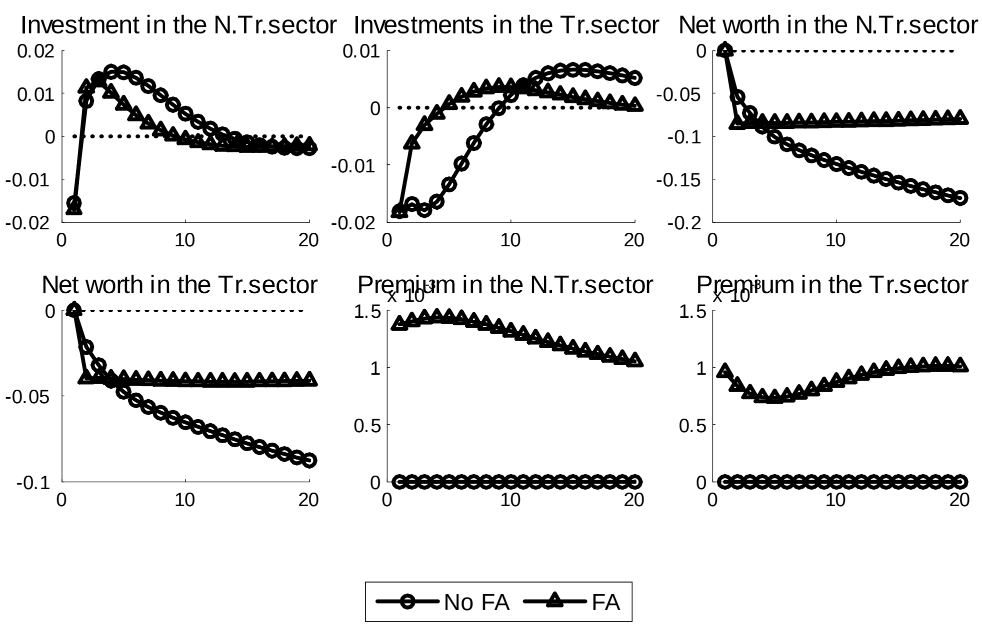

Figure14: IRFs, optimal rule- Price mark-up shock *bis*

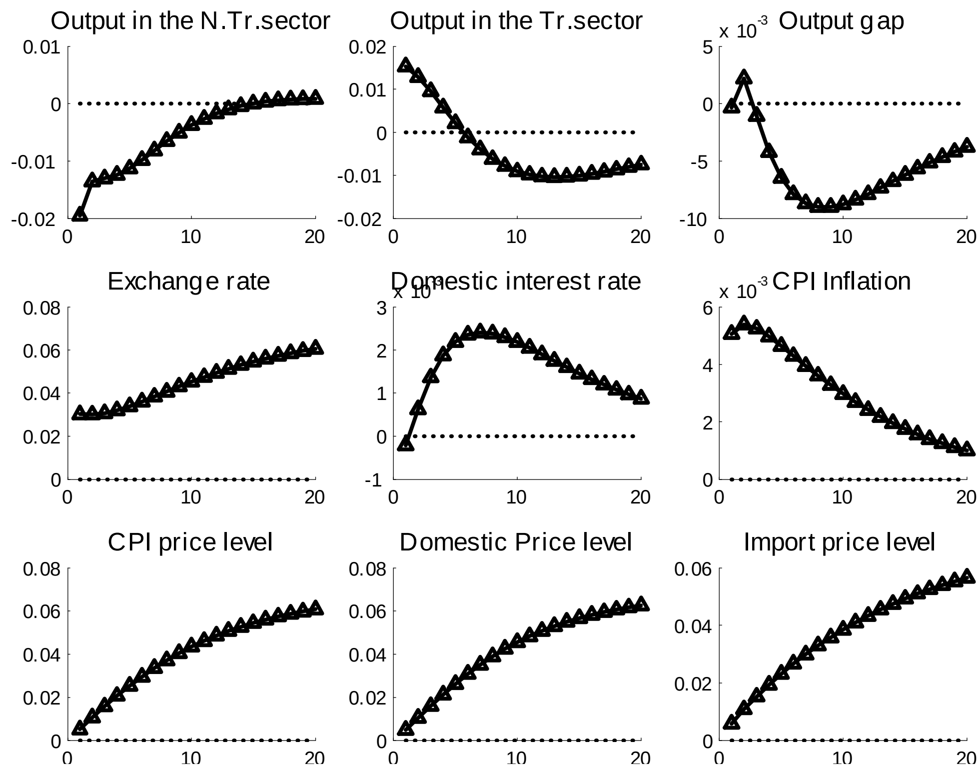

Figure15: IRFs, optimal rule- Financial shock

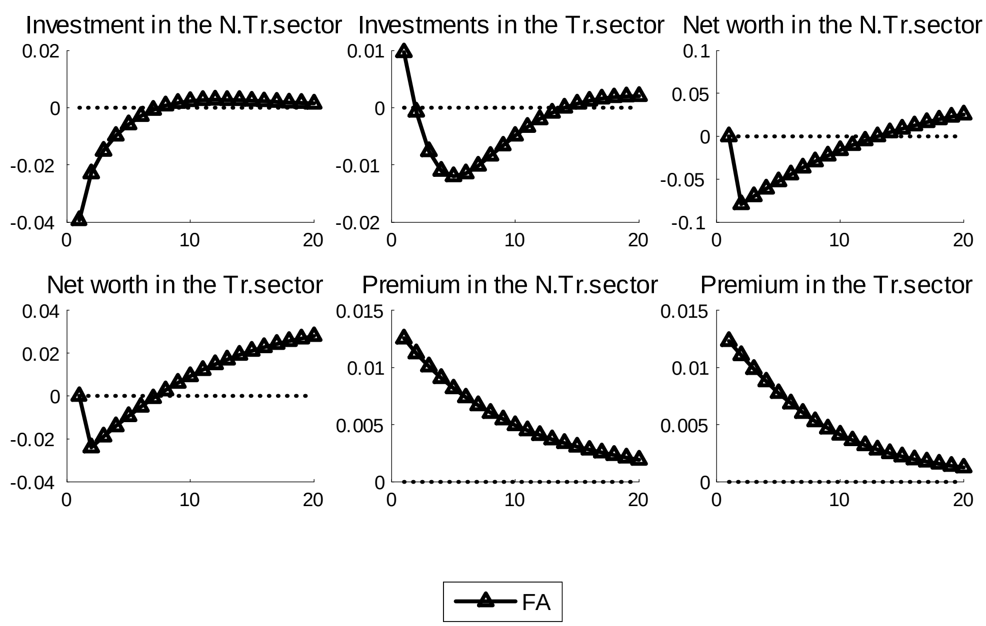

Figure16: IRFs, optimal rule- Financial shock *bis*

Parameters	IT rule	Augmented Taylor rule	IT *cum* exchange rate	PLT rule	IT rule-No FA
ρ_π	0.000	0.263	0.000	-	1.238
ρ_P	-	-	-	0.001	-
ρ_{RN}	3.227	1.678	3.228	1.547	0.620
ρ_S	-	-	0.000	-	-
ρ_y	0.589	0.252	0.589	0.095	0.385
ρ_{PR}	-	0.488	-	-	-
σ_π	0.00072	0.00069	0.00072	0.00041	0,00018
σ_{RN}	0.00056	0.00056	0.00056	0.00020	0.00031
σ_y	0.00808	0.00826	0.00808	0.00535	0.00061
Loss	0.2002	0.19842	0.2002	0.01212	0.00377

Table 1: Optimal monetary policy, all shocks

Parameters	IT rule	IT *cum* exchange rate stabilization	PLT rule
ρ_π	0.302	0.346	-
ρ_P	-	-	0.644
ρ_{RN}	1.848	2.080	0.000
ρ_S	-	0.051	-
ρ_y	0.255	0.326	0.391
σ_π	0.00016	0.00016	0.00005
σ_{RN}	0.00016	0.00016	0.00002
σ_y	0.00324	0.00323	0.00062
Loss	0.00591	0.00591	0.00764

Table 2: Optimal monetary policy without the financial shock