A COMPARISON OF MONETARY POLICY RULES FOR TURKEY

by

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Abstract

In this thesis a dynamic general equilibrium (DGE) model with monopolistic competition and price stickiness is constructed in order to compare the macroeconomic implications of four alternative monetary policy rules for Turkey. The analyzed policy rules are non-tradable inflation targeting, money peg, exchange rate peg and a Taylor rule. The equilibrium dynamics of small open economy are generated through exogenous shocks to domestic productivity level, government expenditures, foreign interest rate and foreign price level. I find that significantly different dynamics in terms of magnitude are observed in the first periods after the shocks. Against foreign shocks, the non-tradable inflation targeting rule generates the smallest response in the main macroeconomic variables. In terms of domestic shocks, the dynamics that the policy rules entail differ. Under the Taylor rule and the money peg, intermediate level responses are obtained for all shocks except tradable productivity shock.

Keywords: DGE, Monetary Policy Rules, Turkey

TÜRKİYE İÇİN PARA POLİTİKALARI KARŞILAŞTIRMASI

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Özet

Bu tezde alternatif para politikalarının makroekonomik sonuçlarını Türkiye açısından karşılaştırmak için tekelci rekabet ve Calvo fiyat esneksizliği durumunda dinamik genel denge (DGD) modeli kurulmuştur. Analiz edilen dört politika kuralı şöyledir: ticarete konu olmayan malların enflasyon hedeflemesi, sabit para arzı, sabit döviz kuru ve Taylor kuralı. Küçük ölçekli açık ekonominin denge dinamikleri yurtiçi verimlilik seviyesi, hükümet harcamaları, yabancı faiz haddi ve yabancı fiyat seviyesindeki ekzojen şoklarla yaratılmıştır. Nicelik açısından kayda değer dinamik farklılıkları şoktan sonraki ilk dönemde gözlemlenmiştir. Ticarete konu olmayan mallar enflasyon hedeflemesi tüm dış şoklara karşı temel makroekonomik değişkenlerde en az tepkiyi yaratmıştır. Yurtiçi şoklar bakımından politika kurallarının oluşturduğu dinamikler farklılık gösterir. Taylor kuralı ve sabit para arzı uygulamasında ticarete konu olan mallar verimlilik şoku hariç her şokta orta seviyede tepkiler elde edilmektedir.

Anahtar Sözcükler: DGD, Para Politikaları Kuralları, Türkiye

to my parents

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Introduction

Monetary policy rules have been analyzed in the framework of closed economy models until the mid-90's[1]. However, economic and financial crises that emerging markets have experienced since the nineties and the formation of the European Monetary Union have proved that even large scale economies are not independent of external shocks. Hereby, there emerges a necessity of studying monetary policies for an open economy for which has interactions with the rest of the world. In this paper, I analyze four alternative monetary policy rules using a small open economy model which is calibrated to Turkey. The implications of main macroeconomic variables under alternative monetary policy rules are analyzed.

In this thesis the benchmark model of Lama and Medina (2004a) is followed to analyze different monetary policy rules[2]. There are two sectors:

[1] Rotemberg and Woodford (1997), McCallum and Nelson (1998), Chari, Kehoe and McGrathan (1998), King and Wolman (1996)

[2] This model is a variant of the models set up by Rebelo and Vegh (1995) and Schmitt-Grohe and Uribe (2001).

tradable and non-tradable. The non-tradable sector is characterized by monopolistic competition. Tradable sector is perfectly competitive and the price level of tradables are determined by law of one price, that is, it is set at the same level as the foreign price level. In the determination of the non-tradable price level Calvo price stickiness is assumed[3]. In price stickiness *a la* Calvo, each period there is a constant probability that the firm can adjust its price level. The dynamics of macroeconomic variables that are analyzed in the model are generated via domestic and foreign shocks. The domestic shocks are productivity and government expenditure shocks for both sectors. The foreign shocks are foreign interest rate shock and, differently from Lama and Medina (2004a), foreign price level shock. The monetary policy rules that are considered are non-tradable inflation targeting, money peg, exchange rate peg and a Taylor rule. In order to evaluate the performance of these monetary policy rules in a small open economy seting, the model is solved using Turkish data[4]. Finally, the macroeconomic implications of these four monetary policies are analyzed in terms of equilibrium dynamics that they entail. Against each exogenous shock, the impulse responses of the main macroeconomic variables that are generated by each monetary policy rule are compared. Furthermore, the evaluation of monetary policy rules are provided in terms of volatility of real macroeconomic variables in both sectors under each rule that are obtained by simulation of the model.

The findings of the evaluation of equilibrium dynamics of the model against each shock are as the following. Under all policies the direction of

[3]Rotemberg price stickiness is assumed in Lama and Medina (2004b).

[4]Lama and Medina (2004a) calibrate their model to Chile. Ghironi and Rebucci (2001) calibrate their model to Argentina.

responses of macroeconomic variables such as consumption, labor and output is the same against all shocks except tradable productivity shock. However, significantly different responses in terms of magnitude among policies are observed approximately in the first 8 periods which mainly stems from the price stickiness assumption in the non-tradable sector. Response levels under each policy converge to each other after those initial 8 periods as prices in the non-tradable sector adjust.

Against foreign shocks, i.e. foreign price level and foreign interest rate shocks, non-tradable inflation targeting creates smaller responses than the other policies since exchange rate flexibility absorbs the foreign shocks so that the real economy is affected less, whereas, exchange rate peg regime generates the largest responses which is consistent with the results in Lama and Medina (2004a).

Considering domestic shocks, the dynamics that the monetary policy rules create differ. For instance, against non-tradable productivity and government expenditure shocks non-tradable inflation targeting regime provides the most responsive dynamics in consumption level for both sectors which causes the smallest response in labor level for both sectors. However, against shocks from non-tradable sector, under exchange rate peg the response level in consumption for both sectors is the smallest, yielding largest response in labor level and then output level for both sectors. In terms of tradable government expenditure shock, the least responsive monetary policy rule is non-tradable inflation targeting regarding consumption of non-tradables, labor and output for both sectors. Against all shocks except tradable productivity shock, money peg and Taylor rule generate intermediate response level. For tradable productivity shock, a Taylor rule is the most responsive policy except for non-tradable and total labor supply.

Regarding the simulation results, the non-tradable inflation targeting smooths both aggregate consumption and non-tradable consumption better than the other policies but generates more volatile labor. Even though the consumption of tradables is least volatile under exchange rate pegging, this policy generates the most volatile aggregate consumption among all policies. In terms of the volatility of labor, the ranking of the policies is reversed with the exchange rate peg leading to the least volatile labor supply and the non-tradable inflation targeting generating the highest volatility. This result indicates a trade-off between the volatilities of consumption and labor, which is consistent with Lama and Medina (2004a).

The New Open Economy Macroeconomics literature which has been developed since the publication of Obstfeld and Rogoff's Redux model (1995) presents dynamic general equilibrium models with nominal rigidities and market imperfections[5]. The new features of the models with monopoly power facilitate precise analysis of pricing decisions and monetary policy rules in a socially suboptimal environment. Furthermore, it provides welfare analysis due to introducing utility and profit maximization problems[6].

In the NOEM literature, small scale economies have been studied recently[7]. Gali and Monacelli (2002), Devereux (2001), Lama and Medina (2004a/b) are some of the sample articles analyzing alternative policy rules

[5] Betts and Devereux (1997), Benigno and Benigno (2001), Chari et al. (2000), Corsetti and Pesenti (2000/2001)

[6] See Lane (2000) for an extensive literature review.

[7] Cespedes, Chang and Velasco (2001) McCallum and Nelson (1999)

for small economies. Gali and Monacelli (2002) aim to analyze the monetary rules in terms of exchange rate volatility in an incomplete exchange rate pass-through environment. They conclude that domestic inflation targeting which simultaneously stabilizes both domestic prices and output gap entails a considerably larger volatility of exchange rate.Under their assumptions domestic inflation targeting arises as the optimal policy regime. In this thesis, despite of the fact that monetary policy rules are analyzed by means of volatility of main variables, a similar result that the non-tradable inflation targeting is the best in terms of generating the least volatile aggregate consumption.

Devereux (2001) compares monetary policy rules in terms of existence of complete exchange rate pass-through. Similar to this thesis, impulse responses of macroeconomic variables are analyzed. The main result of the paper is that strict inflation targeting is much easier to implement in an economy with lagged pass-through. Moreover, it is concluded that stabilizing non-traded goods price level is a simple and efficient monetary policy rule for an open economy. However, in Lama and Medina (2004a), the monetary policy rules are compared in terms of welfare level, using a similar method that is implemented by Lucas (1987). Like this paper, it is concluded that the implications of monetary policy rules are dependent on the shocks. However, since the comparison is done by welfare cost analysis, the results differ from my thesis in terms of foreign shocks. Against foreign interest rate shock, productivity shock of non-tradables and tradable government expenditure shock, exchange rate pegging is the best response whereas, in this paper the exchange rate peg is the most responsive policy for foreign interest rate shock. Yet, for tradable productivity shock and non-tradable government expenditure shock, non-tradable inflation targeting is the best one in terms of welfare level. In Lama and Medina (2004b), as a limitation in the financial markets the asset market segmentation is added to the previous model. However, the comparison of monetary rules are done in terms of how well the policy rules resemble the optimal monetary policy regarding impulse responses. In the paper, it is concluded that the optimal policy largely stabilizes the non-tradable price level. Furthermore, for any degree of market segmentation, non-tradable inflation targeting is the optimal policy rule.

The thesis is organized as the following. Chapter 2 presents the benchmark model which is calibrated to Turkey. Also the shocks and the monetary policy rules are explained. Chapter 4 provides a comparison of monetary policy rules in terms of impulse responses and volatility of simulated variables. Chapter 5 concludes.

Chapter 2

Model

2.1 Households

There are infinitely many identical consumers. Each representative consumer aims to maximize her expected discounted utility. The utility function of the consumer depends on tradable consumption, C^T, non-tradable consumption, C^N, labor services, L and real money balances, M/P^T.

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t^T, C_t^N, L_t, M_t/P_t^T)$$

The budget constraint and borrowing constraints of the optimization problem are as follows:

$$P_t^T C_t^T + P_t^N C_t^N + S_t B_t^* + M_t + E_t Q_{t,t+1} B_{t+1} \leqslant W_t L_t + M_{t-1} + S_t B_{t-1}^* R_{t-1}^* + B_t + \Pi_t^T + \Pi_t^N - T_t$$

$$B \leqslant B_t$$

$$B \leqslant B_t^*$$

where P_t^T are P_t^N are the price levels of tradable and non-tradable goods, S_t is the nominal exchange rate, B_t^* is the amount of foreign bonds, M_t is the nominal money holdings that is held for period $t+1$, W_t is the nominal wage rate, R_t^* is the gross foreign interest rate, B_t is the amount of domestic bonds, $Q_{t,t+1}$ is the state contingent price of domestic bonds, Π_t^T and Π_t^N are the profits from tradable and non-tradable sectors, and T_t is the lump sum tax. B is a large negative number such that the constraints are not binding (see Lama and Medina 2004)

The first order conditions from the household's problem are as follows:

$$\frac{U_{C^N,t}}{U_{C^T,t}} = \frac{P_t^N}{P_t^T} \tag{2.1}$$

$$\frac{U_{L,t}}{U_{C^T,t}} = \frac{W_t}{P_t^T} \tag{2.2}$$

$$U_{C^T,t} = \beta R_t^* E_t U_{C^T,t+1} \tag{2.3}$$

$$U_{M/P^T,t} = E_t \beta U_{C^T,t+1} \frac{P_t^T}{P_{t+1}^T} - U_{C^T,t} \tag{2.4}$$

$$Q_{t,t+1} = \beta E_t \frac{U_{C^T,t+1}}{U_{C^T,t}} \frac{P_t^T}{P_{t+1}^T} \tag{2.5}$$

In equation (1), consumer's relative demand of non-tradable and tradable goods are achieved as a function of relative prices. Equation (2) gives the labor supply equation, equating the marginal rate of substitution between leisure and tradable goods to the real wage rate. Equation (3) is the Euler equation. Equation (4) gives the demand for real money balances. In equation (5), the nominal price of state contingent domestic bonds is determined.

2.2 Firms

2.2.1 Tradable Sector

Tradable sector is perfectly competitive. Only labor is used as a factor of production[1]. Each firm aims to maximize its profit:

$$P_t^T Y_t^T - W_t L_t^T$$

subject to

$$Y_t^T = \exp z_t^T F^T(L_t^T)$$

Thus the first order condition that gives labor demand in the tradable sector is

$$\frac{W_t}{P_t^T} = \exp z_t^T F_L^T(L_t^T) \tag{2.6}$$

where z^T is tradable productivity shock which is assumed to follow AR(1) process. Under the law of one price assumption, the tradable price level is

[1]For tractability capital is ignored. McCallum and Nelson (1999), Cogley and Nason (1995) show evidences that ignorance of capital will cause little cost in the analysis of inflation. For counter arguments see Dotsey and King (2001),and Christiano, Eichenbaum and Evans (2001).

set as follows[2]:

$$P_t^T = S_t P_t^* \tag{2.7}$$

where

$$P_t^* = P^* \exp u_t$$

where u_t is foreign price level shock , assumed to be AR(1). For simplicity P^* is assumed to be unity.

2.2.2 Non-tradable Sector

There are two stages in the production of non-tradables. In the first stage which is characterized by imperfect competition and price stickiness a continuum of monopolistically competitive firms produce a differentiated intermediate non-tradable good. As a factor of production only labor is used. Each firm i sets its price over marginal cost *a la* Calvo price stickiness. In the second stage these intermediate non-tradable goods are aggregated and a final non-tradable good is produced by perfectly competitive firms.

The firms that produce the final non-tradable good determine their demand for each intermediate non-tradable good i, $Y_t^N(i)$, by maximizing their profit

$$P_t^N Y_t^N - \int_0^1 P_t^N(i) Y_t^N(i) di$$

subject to

[2]For incomplete exchange rate pass-through analysis see Monacelli (2003), Adolfson (2001) and Smets and Wouters (2002)

$$Y_t^N = \left(\int_0^1 Y_t^N(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}$$

where ε is the elasticity of substitution parameter. The demand for each intermediate good i and the aggregate price level for non-tradable goods, then, are given by:

$$Y_t^N(i) = \left(\frac{P_t^N(i)}{P_t^N}\right)^{-\varepsilon} Y_t^N \tag{2.8}$$

$$P_t^N = \left(\int_0^1 P_t^N(i)^{1-\varepsilon} di\right)^{1/(1-\varepsilon)} \tag{2.9}$$

All intermediate good producers have the same production function and therefore have the same cost minimization problem given by

$$\min \frac{W_t}{P_t^N} L_t^N(i)$$

subject to

$$Y_t^N(i) = \exp z_t^N F_t^N(L_t^N(i))$$

where z^N is non-tradable productivity shock which is assumed to follow AR(1) process. Then the labor demand of each firm is obtained as a function of real marginal cost MC_t:

$$MC_t = \frac{W_t}{P_t^N \exp z_t^N F_{L^N}^N(L_t^N)} \tag{2.10}$$

The firms in both sectors face same wage rate. Combining equations (6) and (10), we obtain:

$$P_t^T \exp z_t^T F_{L^T}^T(L_t^T) = MC_t P_t^N \exp z_t^N F_{L^N}^N(L_t^N) \tag{2.11}$$

The price setting behavior in the intermediate goods market follows the staggered price setting assumption of Calvo (1983). The intermediate good producers adjust the price level with a constant probability $(1-\eta)$ in each period[3].Then the profit maximization problem of firm i becomes

$$\max E_t \sum_{k=0}^{\infty} Q_{t,t+k}\eta^k \left(P_t^N(i) - MC_{t+k}P_{t+k}^N\right) Y_{t+k}^N(i)$$

subject to the demand from final non-tradable goods producers, i.e. equation (8).

$Q_{t,t+k}$ is the relevant stochastic discount factor. In this setup, it is the nominal price of state contingent domestic bonds, which is given by equation (5)[4]. η^k denotes the probability that the firm does not change the optimal price level for k periods after setting it. Then the optimal price level for firm i is obtained as:

$$P_t^{N*}(i) = \frac{\varepsilon}{(\varepsilon-1)} \frac{E_t \sum_{k=0}^{\infty} \eta^k Q_{t,t+k} Y_{t+k}^N MC_{t+k} {P_{t+k}^N}^{\varepsilon+1}}{E_t \sum_{k=0}^{\infty} \eta^k Q_{t,t+k} Y_{t+k}^N {P_{t+k}^N}^{\varepsilon}} \tag{2.12}$$

From equation (9), the aggregate price level of non-tradable goods evolves

[3]Firms' adjusting price level is an exogenous Poisson process. The firm adjust its price with a constant probability $(1-\eta)$ each period, thus the frequency is $1/(1-\eta)$ (see Walsh (2003))

[4]Stochastic discount factor is necessary to have stationary steady state values, ie. independent of initial values.(Schmitt-Grohe and Uribe (2001)). Smets and Wouters (2002) use OLG models to undo non-stationary steady state.

according to[5]:

$$P_t^N = \left((1-\eta) \left(P_t^{N*}\right)^{1-\varepsilon} + \eta \left(P_{t-1}^N\right)^{1-\varepsilon} \right)^{1/(1-\varepsilon)} \tag{2.13}$$

Log-linearization of (12) and (13) around zero inflation steady state gives the new Keynesian Phillips curve:

$$\pi_t^N = \beta E_t \pi_{t+1}^N + \lambda mc_t$$

where mc_t is the real marginal cost as a percentage deviation around its steady state value $\frac{\varepsilon-1}{\varepsilon}$ and

$$\lambda = \frac{(1-\beta\eta)(1-\eta)}{\eta}$$

2.3 Government

The government has a balanced budget, i.e., total revenue from lump-sum taxes and seigniorage equals to total government expenditures on both types of goods.

$$T_t + M_t^S = P_t^T G_t^T + P_t^N G_t^N + M_{t-1}^S$$

Furthermore, government expenditures evolve as the following:

[5] Since monopolistic firms face same production technology, constant demand elasticity, they are identical except they produce differentiated goods. Thus they set the same optimal price but at different time (Walsh (2003)).

$$G_t^T = G^T \exp \varepsilon_t^{G_T}$$

$$G_t^N = G^N \exp \varepsilon_t^{G_N}$$

where G^T, G^N are constant government expenditure levels and ε^{G_T}, ε^{G_N} are government expenditure shock disturbance terms for tradable and non-tradable sector respectively.

2.4 Foreign Bond Market

Following the benchmark model of Lama and Medina (2004a), in this study, positively sloped supply of international bonds is assumed in order to have stationary level of foreign bond holdings (Schmitt-Grohe and Uribe(2003)) [6]

$$R_t^* = R^* \left(\frac{B_t^*}{B^*} \right)^{\upsilon} \exp \epsilon_t^*$$

Moreover, under the assumption of complete international financial market, uncovered interest rate parity holds. In fact, equality of returns on domestic and foreign bonds are also obtained from equations (3) and (5).

$$r_t = r_t^* + E_t \Delta s_{t+1} \tag{2.14}$$

[6] Method of log-linearization around steady state is not reasonable with a unit root, non-stationary variable. Schmitt-Grohe and Uribe (2003) state that assuming upward sloping supply of bonds will solve the unit root property of supply of bonds in small economy analysis (Lama and Medina (2004)).

2.5 General Equilibrium

The market clearing condition for the non-tradable sector is given by:

$$\left(\int_0^1 \left(\exp z_t^N f^N(L_t^N(i))\right)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\varepsilon/(\varepsilon-1)} = Y_t^N = G_t^N + C_t^N \tag{2.15}$$

Since all households are identical, the domestic bond market clearing condition in equilibrium is as follows:

$$B_t = 0 \tag{2.16}$$

Additionally the market clearing condition for foreign bonds which also gives the net exports is as follows:

$$B_t^* - B_{t-1}^* R_{t-1}^* = Y_t^T - C_t^T - G_t^T \tag{2.17}$$

The labor market equilibrium condition is given by:

$$L_t = L_t^T + \int_0^1 L_t^N(i)di \tag{2.18}$$

The money market clearing condition is as follows:

$$M_t^S = M_t \tag{2.19}$$

2.6 Calibration

For the numerical solution of the model, some of the model parameters are calibrated to match Turkish data, while some are based on other developing country studies, depending on data availability. The specific utility and production functions used for the numerical analysis are[7]:

$$U(C_t^T, C_t^N, L_t, M_t/P_t^T) = \frac{C_t^{1-\sigma}}{1-\sigma} + \psi \frac{(1-L_t)^{1-\gamma}}{1-\gamma} + \omega \frac{\left(M_t/P_t^T\right)^{1-\phi}}{1-\phi}$$

where C_t is a CES composite consumption index which is defined as the following:

$$C_t^{\rho} = \theta \left(C_t^T\right)^{\rho} + (1-\theta)(C_t^N)^{\rho}$$

I set all elasticity parameters equal to σ thus it leads the utility functional form same as Lama and Medina (2004a). Both sectors use only labor as a factor of production.

$$Y_t^T = \exp z_t^T f^T(L_t) = \exp z_t^T A^T L_t^{\alpha^T}$$

$$Y_t^N = \exp z_t^N f^N(L_t) = \exp z_t^N A^N L_t^{\alpha^N}$$

The parameter values are listed in Table 1. Most of the utility parameters are standard and set according to the studies on developing countries. $(1/\sigma)$,

[7] Gali and Monacelli (2002) state that inspite of explicitly including money in both utility function and budget constraint , introducing it in interest rate rule as a monetary policy is sufficient.

which is the intertemporal elasticity of consumption substitution is set to 0.19 based on Reinhart and Vegh (1995). Real money balance coefficient ω is set to 1 as in Lama and Medina (2004a). Share of tradable goods in composite consumption θ is taken as 0.5 based on Devereux (2001)[8]. Elasticity of substitution between tradable and non-tradable goods, $1-1/\rho$, is 0.48 based on Arellano (2003).

The production parameters α^T and α^N are set to 0.4 and 0.63 respectively relying on Lama and Medina (2004a). Elasticity of substitution between differentiated intermediate non-tradable goods ε is assumed to be 6 depending on Gali and Monacelli (2002). It is assumed that the price level completely adjusts four periods after the exogenous shocks, that is, Calvo price stickiness parameter is 0.75. According to Lama and Medina (2004b), ν is set to 0.00001[9]. The gross growth rate of M1 is calibrated from Turkish data as 1.12.

For computation of the parameters related to tradable and non-tradable sectors, agricultural, manufacturing and energy sectors are classified as tradable, while construction and service sectors are classified as non-tradable based on the classification of Arellano(2004). Dynamics of the economy are generated by exogenous shocks to technology and government expenditure in both sectors, foreign interest rate and foreign price level. All shocks are assumed to follow AR(1) processes. Data from 1973:1-2007:1 is used in com-

[8] For Malaysia and Thailand it is estimated 0.55 and 0.54 by Devereux and Cook (2000) and Devereux and Lana (2000). For Mexico it is estimated as 0.56 by Schmitt-Grohe and Uribe (2000) (Devereux (2001))

[9] Small value of ν will result in less modifications in the short-run properties of the model (Schmitt-Grohe and Uribe (2001)).

putation of all parameters specific to Turkey, except technology shock persistency parameters because of inavailability of data for independent estimation of ρ^T and ρ^N. Aggregate data for output and labor from 2000:1-2007:1 is used for both persistency parameters. Similarly there is no distinction for government expenditure fluctuations in each sector. Thus in the calibration same coefficient is used for each sector. For international interest rate and price level shock parameters, US interest rates and producer price index are used[10].

$$e_t^* = \rho^r e_{t-1}^* + \varepsilon_t^r \qquad \varepsilon_t^r \sim N(0, \sigma_r)$$

$$z_t^i = \rho^i z_{t-1} + \varepsilon_t^{zi} \qquad \varepsilon_t^{zi} \sim N(0, \sigma_{zi})$$

$$g_t^i = \rho^{Gi} g_{t-1} + \varepsilon_t^{Gi} \qquad \varepsilon_t^{Gi} \sim N(0, \sigma_{Gi}) \qquad \text{for } i = T, N$$

$$u_t = \rho^u u_{t-1} + \varepsilon_t^u \qquad \varepsilon_t^u \sim N(0, \sigma_u)$$

2.7 Monetary Policy Rules

Four alternative policy rules are analyzed for a small open economy. First policy is non-tradable inflation targeting (NIT), which aims to stabilize the

[10] Turkey data is collected from Electronic Data Delivery System of CBRT at http://evds.tcmb.gov.tr/yeni/cbt-uk.html. While US data is collected from International Financial Statistics.

non-tradable price level. Second policy is a money peg, which aims to stabilize the money supply defined by M1 and third policy is an exchange rate peg (ER Peg), which aims to fix the nominal exchange rate. Money and exchange rate pegging policies include intervention of the monetary authority in the money market. The former aims to stabilize the quantity of money in the market while allowing exchange rate volatility whereas the latter aims to fix the exchange rate. Finally in the fourth policy rule, monetary authority responds to both aggregate inflation rate and output level via interest rate channel, that is a Taylor rule is followed in order to stabilize the inflation rate. The equations of the policy rules are as follows:

$$p_t^N - p_{t-1}^N = \pi_t^N = 0 \tag{2.20}$$

$$m_t - m_{t-1} = 0 \tag{2.21}$$

$$s_t - s_{t-1} = 0 \tag{2.22}$$

$$r_t = \phi_\pi(\theta\pi_t^T + (1-\theta)\pi_t^N) + \phi_y(\theta y_t^T + (1-\theta)y_t^N) \tag{2.23}$$

where all the terms are logarithmic. For the Taylor rule, the policy parameters ϕ_π, $\phi_y$are set as 1.19 and 0.3 respectively according to Ortega and Rebei (2006). The coefficients indicate the strictness of the monetary authority about conducting inflation targeting.

Chapter 3

Comparison of Monetary Policy Rules

In this section, monetary policy rules are analyzed in terms of their effects on the selected variables such as consumption, labor, output for each sector[1]. Initially for each exogenous disturbance, impulse responses of variables for 32 periods are examined under each policy rule. Next a comparison of policy rules is conducted by means of standard deviations of each simulated variable under each policy rule.

[1] For comparision of simple monetary rules in terms of resembling optimal policy see Lama and Medina (2004a)

3.1 Impulse Responses for Tradable Productivity Shock

In figure 3.1, impulse responses for a tradable productivity shock are graphed. A positive productivity shock increases the marginal productivity of labor in the tradable sector. In the labor market, demand for tradable labor becomes higher. Tradable labor level increases so non-tradable labor becomes lower. Thus, tradable output expands and non-tradable output contracts. Under any policy rule that allows to some extent price level flexibility, the relative price of tradables decreases. Under three alternative rules except the non-tradable inflation targeting (NIT), impulse responses are hump-shaped or reverse hump-shaped. The underlying reason for these shapes is price stickiness in the non-tradable sector. The relative price of non-tradables rises but not immediately under the sticky price assumption in all three policies. As non-tradable price adjustments realize, the relative price of non-tradables increases more and the reactions of other variables enlarge for all policies except the NIT.

Under the NIT regime, the relative price level increase is higher than under the ER peg and the money peg so that the decrease in non-tradable consumption demand is larger under the NIT as non-tradable goods become relatively more expensive. Also, the tradable consumption level goes up more under the NIT.

Moreover, that the Taylor rule follows a hump-shape different from the ER peg and the money peg deserves an explanation. Conducting a Taylor rule, the monetary authority responds to both aggregate inflation and output changes by means of changing the nominal interest rate. Under the Taylor rule, there is no separate inflation targeting level or output level for each sector but a convex combination of inflation rate and output level is targeted. Thus, in the event of a tradable productivity shock, firstly the monetary authority loosens the nominal interest rate against an initial fall in the tradable price level and non-tradable price stickiness, which explains why the Taylor rule gives the same responses with fixing the price of non-tradables (NIT) in the first period. Yet, as monopolistic firms adjust non-tradable prices, the monetary authority starts to increase the nominal interest rate as part of a tighter policy (see the nominal interest rate panel in figure 3.1). Also, after price adjustment, the relative price of non-tradable goods becomes higher than the case under other three regimes since the rise in the relative price of non-tradables is caused by both an increase in the price of non-tradables and a decrease in the price of tradables. Hence the responses of real economic variables such as labor, output and consumption are significantly larger under the Taylor rule.

3.2 Impulse Responses for Non-tradable Productivity Shock

In figure 3.2, impulse responses under non-tradable productivity shock are graphed. Under the NIT regime, stabilizing the non-tradable price level makes the relative price of non-tradables decrease the most compared to the other regimes. Therefore, the tradable consumption level goes down and the non-tradable consumption level goes up more. In the labor market, tradable labor supply increases, resulting in an expansion of the tradable output.

Considering ER peg policy, monopolistic non-tradable firms are able to gradually decrease the price level against a positive productivity shock but price level in the tradable sector is determined by law of one price channel (equation (2.7)). This is the reason of a smaller response of the relative non-tradable price level under a fixed exchange rate policy. However, in terms of labor level, the most responsive policy is ER peg for both sectors.

Taylor rule and money peg regimes mimic ER peg. This is because of the asymmetric price changes which are embedded in the model by means of price stickiness and monetary policy rules. Although all economic variables respond in the same direction under each policy rule, Taylor and money peg rules generate intermediate responses since these policies do not directly restrict price level for each sector which influences real economy straightforwardly. On the other hand, extreme behavior of variables are obtained under NIT and ER peg regimes which directly determine the price level in corresponding sector.

3.3 Impulse Responses for Tradable Government Expenditure Shock

Figure 3.3 shows the impulse responses for a fiscal shock in tradable sector. With a tradable expenditure shock, the tradable firms which produce more to meet the rising demand from government side increase demand for labor.

Therefore, tradable fiscal shock yields an expansion in the tradable sector. However, since labor resources of households are shifted from non-tradable to tradable sector, non-tradable labor declines, resulting a fall in non-tradable output and consumption levels.

Analyzing the plotted responses indicate that, under any policy rule, the increase in the tradable government expenditure does not generate significant changes in real variables, especially in the non-tradable sector. Moreover, the variables converge approximately to the same level 12 periods after the shock, which stems from the sticky price assumption. Under the ER peg, all variables respond significantly more, except the tradable consumption level. On the other hand, fixing the non-tradable price results in a bigger decline in the tradable consumption due to the fact that relative price falls more, and therefore, tradable goods become more expensive under the NIT policy compared to the other policies. This is because demand from the government side increases the tradable price level immediately since there is no restriction on tradable prices.

3.4 Impulse Responses for Non-tradable Government Expenditure Shock

In figure 3.4 impulse responses for a non-tradable government expenditure shock are demonstrated. Similar to fiscal shock in tradable sector, rise in the demand of government for non-tradable goods shifts resources from tradable sector to non-tradable sector. Thus, the non-tradable labor increase yields an expansion in the non-tradable output, whereas the tradable labor decrease leads to shrinking tradable output level. Resembling the previous shock, impulse responses under each policy rules converge to nearly the same level 12 periods after the shock.

Regarding the NIT policy, consumption level is the most responsive variable to the fiscal shock. The non-tradable consumption level decreases, causing overall consumption level to fall while tradable consumption rises. On the other hand, under an ER peg, labor market responds more to the shock. As changes in resource allocation emerge, that is tradable labor falls while non-tradable labor rises, relative marginal productivity of tradable labor increases (equation (2.11)). Fixing the exchange rate implies a gradual rise in the non-tradable price level which leads to an increase in the relative price in favor of the tradable sector in line with equation (2.11). Thus, demand for relatively cheaper tradable goods goes up and demand for relatively expensive non-tradable goods goes down.

In case of exchange rate pegging, the economy faces a fixed tradable price level and a gradually adjusting non-tradable price level. Thus, the relative price or non-tradables slowly rises with the increased demand for non-tradable goods, which is the cause of small responses of tradable and non-tradable consumption relative to the NIT policy.

3.5 Impulse Responses for Foreign Price Level Shock

In figure 3.5, the effects of a foreign price level shock on deviations of variables from steady state values are plotted. This external shock influences the economy through the law of one price equation (equation (2.7)) and under any policy rule that manipulates this transmission channel, impulse responses become dependent on the degree of that manipulation. Initially, considering the ER peg regime, an increase in the foreign price level causes a complete pass-through to the tradable price level, which results in a fall in the demand for tradable goods and an increase in the demand for non-tradable goods. Therefore, the firms in the tradable sector reduce labor demand and production level. Labor shift to the non-tradable sector increases the non-tradable output level. Thus, the relative non-tradable price level goes down and consequently non-tradable consumption level goes up.

Regarding the NIT regime, any fluctuations in the foreign price level are absorbed by movements in the exchange rate due to exchange rate flexibility (see the last panel of figure 3.5). Thus, under a flexible exchange rate, an increase in the foreign price level influences real economic variables to a lower degree considering that it affects the tradable price level less. In fact, conducting a policy of non-tradable price stabilization keeps real economic variables from fluctuating much against an external shock, here a foreign price level shock. This is the reason for impulse responses being larger under the ER peg than under the NIT regime.

Impulse responses under the Taylor rule and the money peg differ to the extent of their effects on the exchange rate. The Taylor rule, under which exchange rate volatility is allowed, shows similar movements to the NIT regime because for both policies the price level of tradables is a free variable. So under a Taylor rule, the economy does not react much to a foreign price level shock as the NIT.

The foreign price shock has smaller effects on the economy under the money peg relative to the ER peg. The difference stems from the fact that under an ER peg, the monetary authority directly fixes the exchange rate level and the quantity of foreign currency is determined in the market while under a money peg, it lets the exchange rate float, setting the quantity of monetary aggregate and letting the money market clear. Therefore, the passthrough of a rise in the foreign price level to the domestic tradable price is lower under the money peg regime, leading to smaller effects on the economy relative to the ER peg.

3.6 Impulse Response for Foreign Interest Rate Shock

Figure 3.6 demonstrates the deviations of selected variables from their steady state values for a foreign interest rate shock. To begin with, notice that the reactions of real economic variables, except tradable consumption, are considerably high under the exchange rate peg where foreign interest rate movements pass to the economy via domestic nominal interest rate in line with uncovered interest rate parity (UIP) (equation (2.14)). Furthermore, fixing the exchange rate ensures stabilizing the tradable price level (equation (2.7)). The increase in the foreign interest rate results in a rise in the domestic nominal interest rate which decreases consumption demand of households for both sectors since saving yields more (equation (2.3)). Separately analyzing each sector's consumption level, it is concluded that the non-tradable consumption level decreases the most under the ER peg. However, under the NIT, the tradable consumption level responds more. In terms of labor supply, the foreign interest rate shock causes tradable labor to rise and non-tradable labor to fall to a great extent, especially under the ER peg. Thus, the tradable output level rises and the non-tradable output level falls the most under the ER peg regime.

However, under the policies other than the ER peg, foreign interest rate shocks can be to some extent absorbed via exchange rate movements (UIP). In our case, among alternative policies, the NIT is the policy which enables the shock effects pass to the exchange rate the most. By this means, under the NIT policy, economic variables except the tradable consumption level responds the least. The reason of the high reaction of the tradable consumption level under the NIT is the following: Fixing the non-tradable price level while letting the tradable price level instantly increase due to a rise in the nominal exchange rate will decrease the relative non-tradable price level. On the other hand, fixing the exchange rate stabilizes the tradable price level but the non-tradable price falls gradually under the sticky price assumption. Thus, the initial fall of the relative price of non-tradables will be higher under the NIT regime compared to the ER peg, which means that tradable goods are relatively more expensive under stabilizing the non-tradable inflation. After near 8 periods, however, they converge approximately to the same level. The money peg and the Taylor rule follow intermediate responses in terms of real variables.

3.7 Simulation Results

In this section, monetary policy rules are analyzed in terms of standard deviations of variables that are obtained by simulating the model for 200 times for a time length of 100 periods. By means of simulation, effects of each monetary policy rule on volatility of variables can be evaluated. Table 2 shows standard deviations under each policy rule. First of all, regarding real economic effects, NIT policy generates the least volatile total consumption. On the other hand similar to the findings of Lama and Medina (2004a), the cost of smoother consumption is more volatile leisure at the aggregate level. In terms of each sector, pegging the exchange rate generates less volatile consumption in the tradable sector while under the NIT regime, the non-tradable consumption level is more stable. Furthermore, for both sectors, targeting the non-tradable inflation yields the least volatile output levels. Like the results in the impulse response section, under the money peg and the Taylor rule volatility levels of variables are in between the ones under the NIT and the ER peg. Overall, a policy rule stabilizing price level in a sector generates the least volatile consumption in the corresponding sector.

Chapter 4

Conclusion

In this thesis, in the framework of the new open economics macroeconomics I analyze four monetary policy rules for a small open economy model which is calibrated to Turkey. I set the benchmark model same as the one in Lama and Medina (2004a). Differently from welfare cost analysis and comparison to optimal monetary policy done by Lama and Medina (2004a/b), in this study, the dynamics of main macroeconomic variables under non-tradable inflation targeting, money peg, exchange rate peg and Taylor rule have been evaluated against exogenous shocks to domestic productivity, government expenditure for both sectors, foreign price level and foreign interest rate.

To summarize, under all policies economic the analyzed variables respond in the same direction considering all shocks except the tradable productivity shock. Unlike the NIT regime and the Taylor rule, under the ER peg and the money peg consumption, labor and output of non-tradables indicate positive response to the tradable productivity shock in the first periods. Furthermore, it is observed that magnitude of impulse responses differ significantly in the first 8 periods. After the price adjustment in the non-tradable sector occurs, responses under each policy converge to each other.

Considering foreign price level and foreign interest rate shocks, most responsive case is under the exchange rate peg regime. It is due to the fact that there is no exchange rate channel to absorb the external shocks. Stabilizing the exchange rate will result in a rise in the volatility of real economic variables. However while stabilizing the non-tradable price level, exchange rate flexibility does not let the disturbances pass through to the real economy, thus the NIT generates the smallest responses for foreign shocks.

In terms of domestic shocks, the monetary policy rules generate different dynamics. For productivity and government expenditure shocks of non-tradables, stabilizing the non-tradable inflation generates the least responsive dynamics in labor for both sectors, while it forms the most responsive dynamics in consumption for both sectors. For the shocks in the non-tradable sector, the ER peg creates the largest response in the labor level of both sectors, while generating the smallest response in the consumption level for both sectors. NIT regime responds least to the tradable government expenditure shock in terms of all real variables except consumption of tradables. Except tradable productivity shock under Taylor rule, intermediate response levels are formed.

In order to be tractable and instructive the benchmark model is kept considerably simple. Therefore, there are many aspects that can be extended. Introducing a new channel that exchange rate and foreign price level changes pass to the economy also through the non-tradable sector may present different responses under NIT policy. For instance, a model including tradable intermediate goods that are used in the non-tradable production can be analyzed. Moreover, asymmetric price rigidty for sectors that causes differences on convergence time across policies may be removed by adding imperfect competition and price stcikiness to the tradable sector.

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Appendix

Table 1: Calibration of model

Parameter	Value	Description
β	0.99	Discount Factor
$1/\sigma$	0.19	Intertemporal elasticity of substitution
ω	1	Real money balance coefficient
θ	0.5	Real money balance coefficient
$1 - 1/\rho$	0.48	Elasticity of substitution
α^T	0.4	Labor share in tradable sector
α^N	0.63	Labor share in non-tradable sector
ε	6	Elasticity of intermediate non-tradable goods
η	0.75	Price stickiness parameter
y^T/y	0.42	Tradable output share out of total output
g/y	0.124	Government expenditure share out of GDP
nx/y	0.039	Net-export share out of GDP
l	0.20	Labor supply
ν	0.00001	Foreign interest rate elasticity
μ	1.12	Gross growth rate of money balances

Table 1 (cont.): Calibration of model

Parameters	Value	Description
ρ^r	0.99	Persistency of foreign interest rate shock
$\rho^{zt} = \rho^{zn}$	0.94	Persistency of productivity shock in both sectors
$\rho^{Gt} = \rho^{Gn}$	0.97	Persistency of government expenditure shocks
ρ^u	0.972	Persistency of foreign price level shock
σ_r	0.151	MSE of AR(1) process of foreign interest rate
$\sigma_{zt} = \sigma_{zn}$	1.76	MSE of AR(1) process of productivity
$\sigma_{Gt} = \sigma_{Gn}$	5.22	MSE of AR(1) process of government expenditures
σ_u	0.0474	MSE of AR(1) process of foreign price level shock

Table 2: Standard deviations

	NIT	Money peg	ER peg	Taylor rule
P^T	28.28	16.39	0.27	19.09
P^N	0	8.01	17.74	4.16
S	28.28	16.39	0	19.09
C^T	14.82	13.84	12.20	13.47
C^N	1.56	3.34	6.31	4.41
C	5.20	6.14	7.18	6.21
L^T	45.87	49.64	50.67	48.15
L^N	2.33	5.02	8.99	6.37
L	15.07	14.02	13.11	13.99
Y^T	18.46	19.94	20.38	19.39
Y^N	1.39	2.93	5.54	3.88
M	3.17	0	60.44	92.49

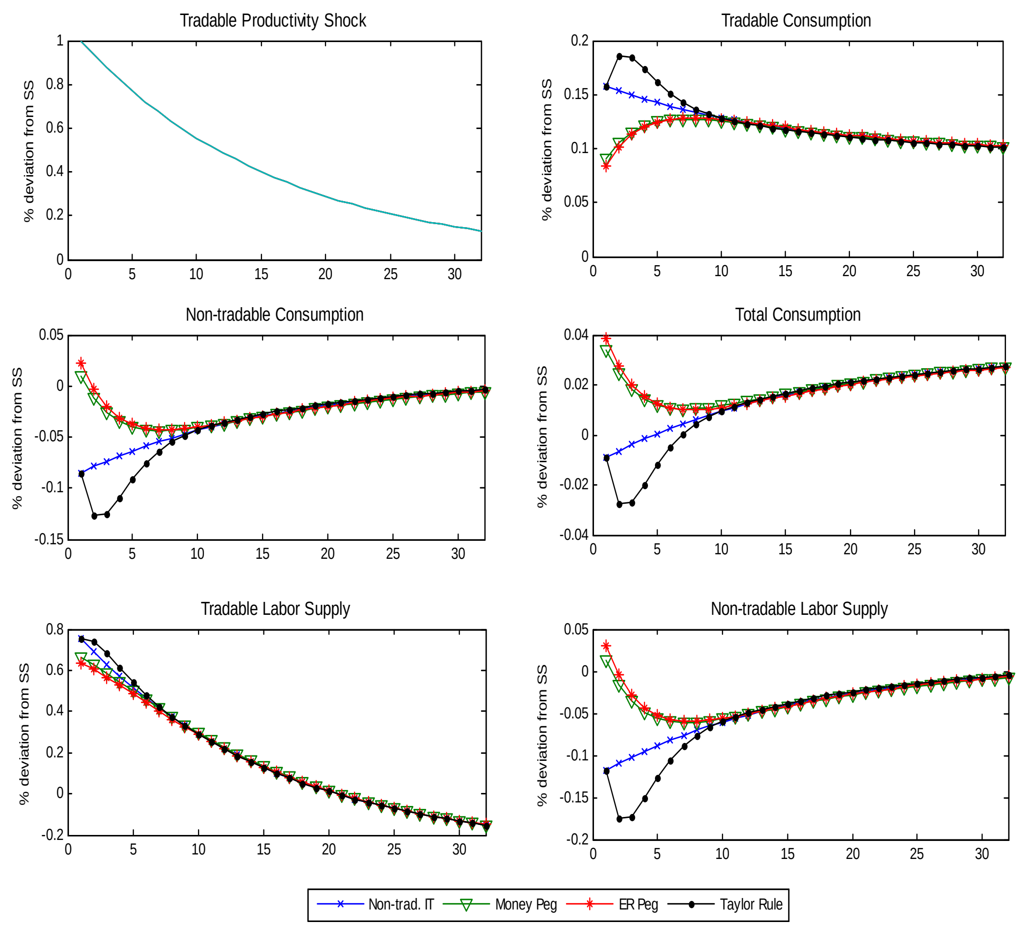

Figure 3.1 : Impulse responses for tradable productivity shock

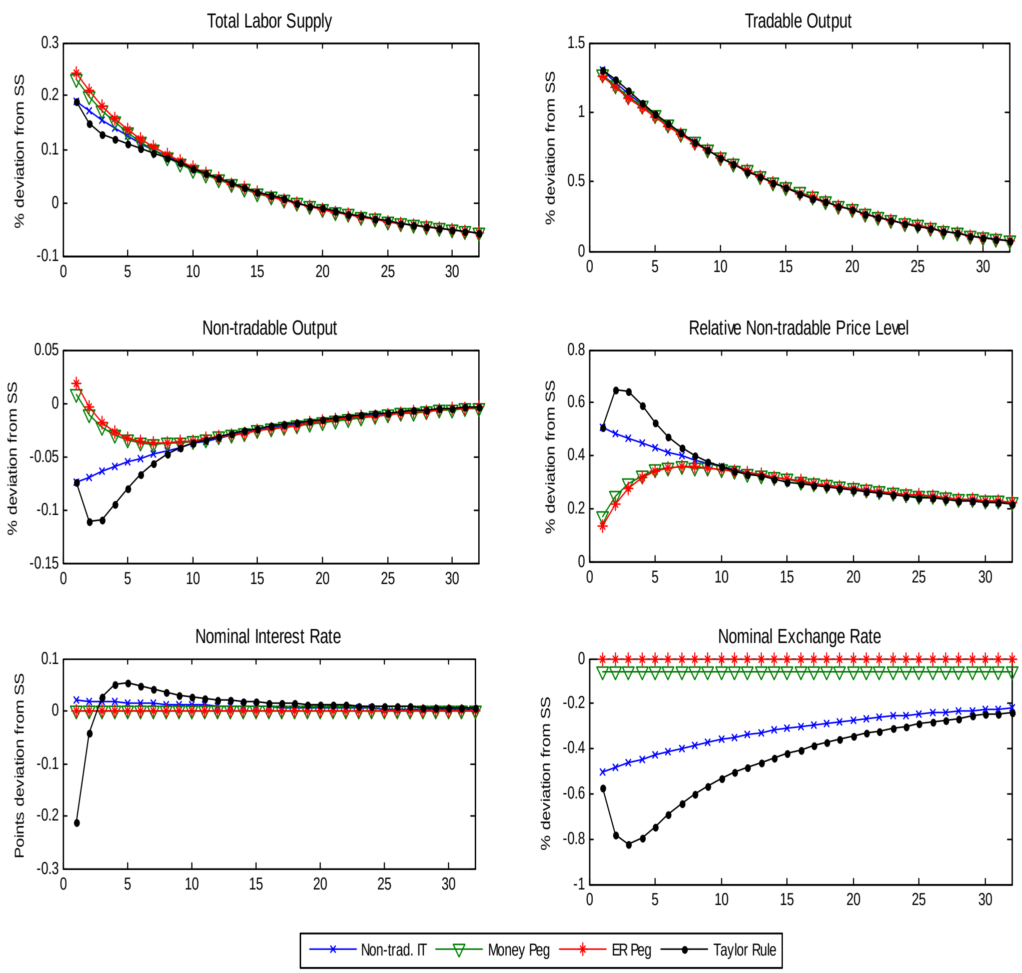

Figure 3.1 (cont.): Impulse responses for tradable productivity shock

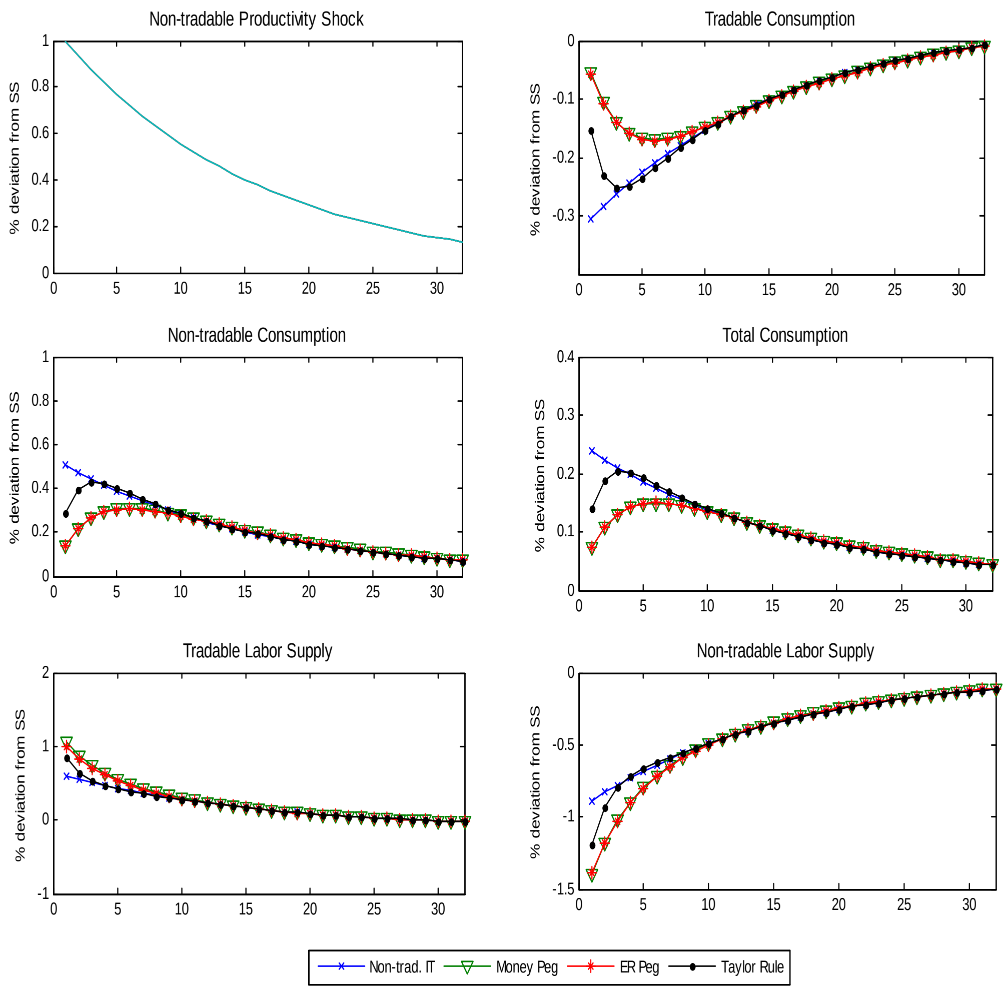

Figure 3.2: Impulse responses for non-tradable productivity shock

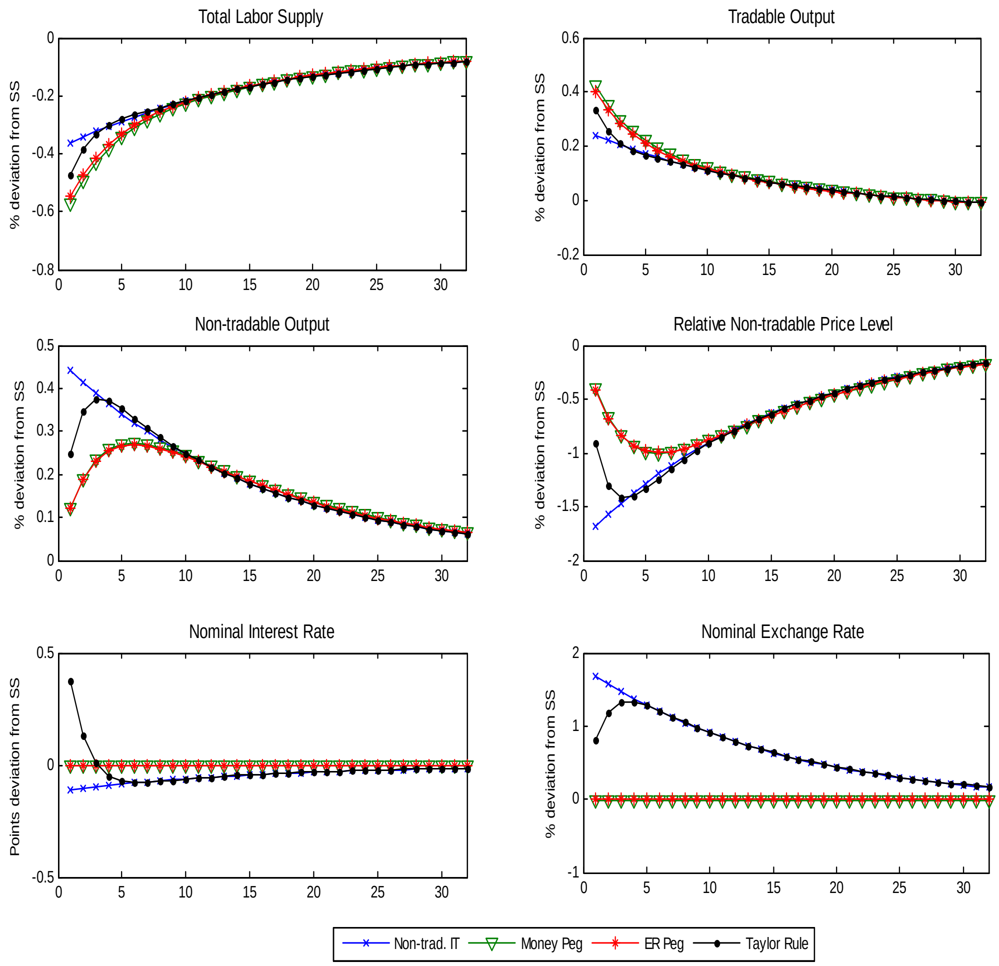

Figure 3.2 (cont.): Impulse responses for non-tradable productivity shock

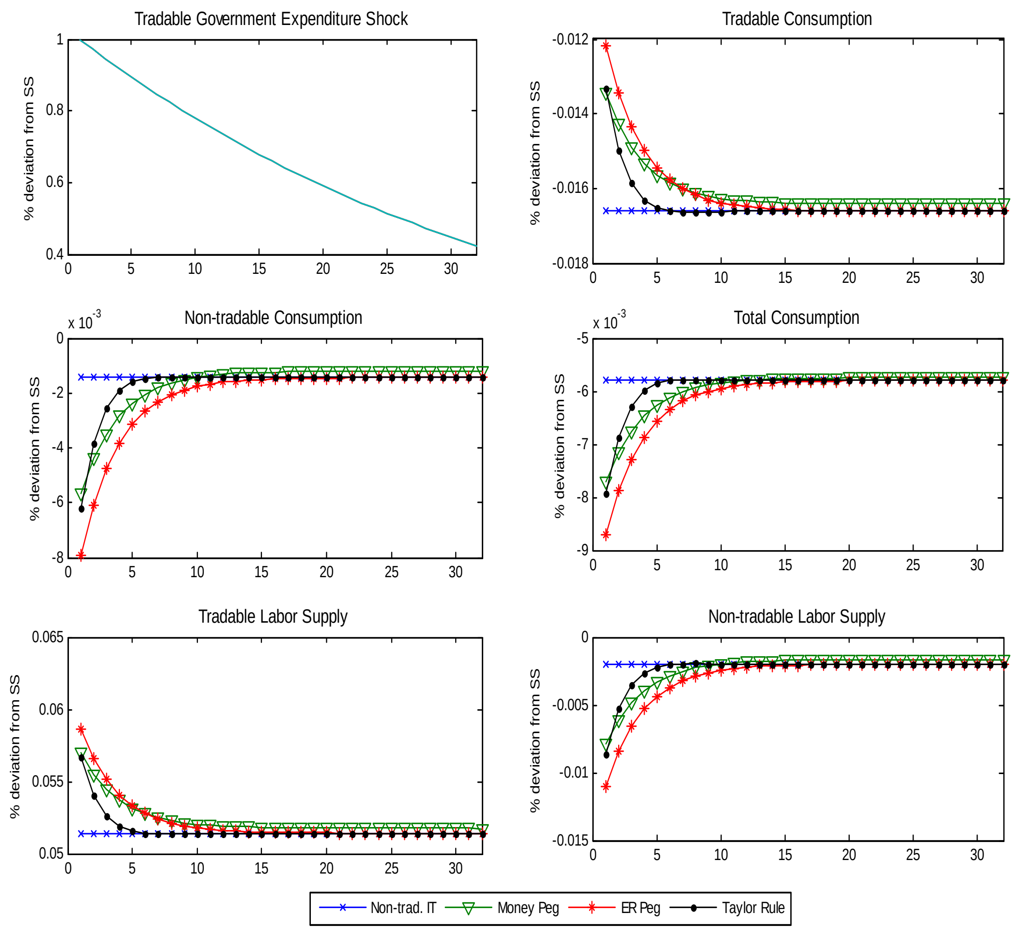

Figure 3.3: Impulse responses for tradable government expenditure shock

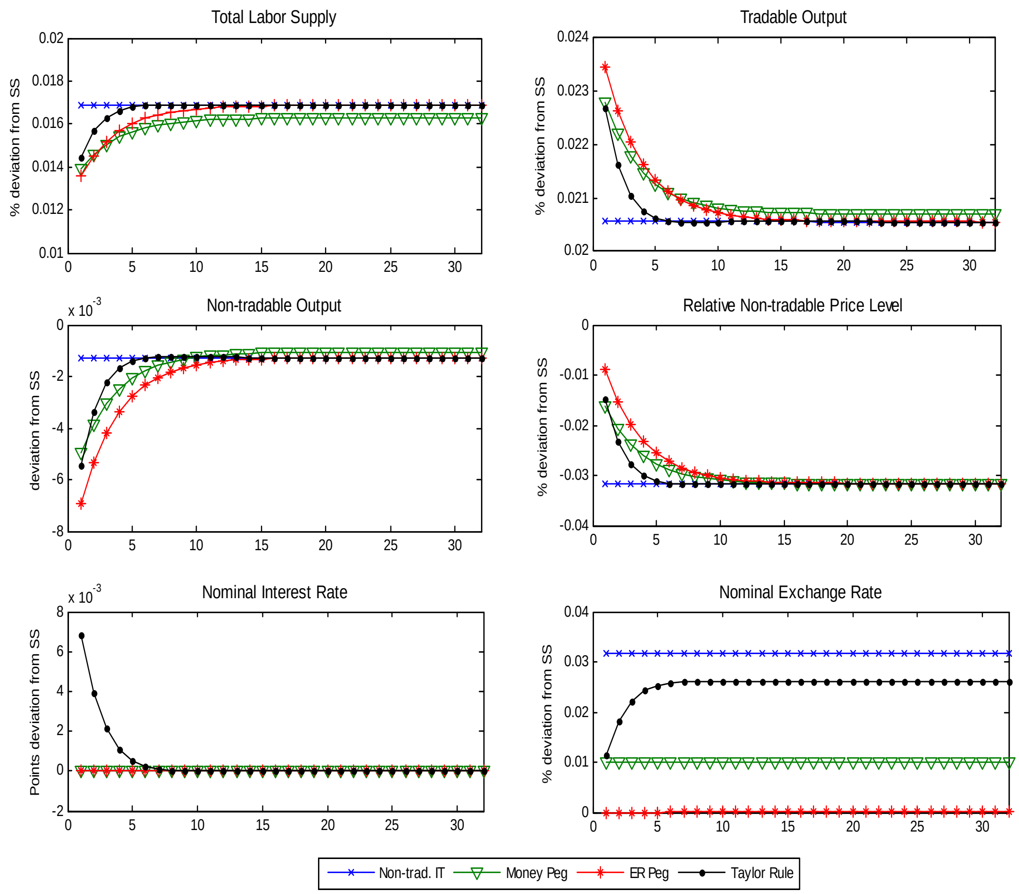

Figure 3.3 (cont.): Impulse responses for tradable government expenditure shock

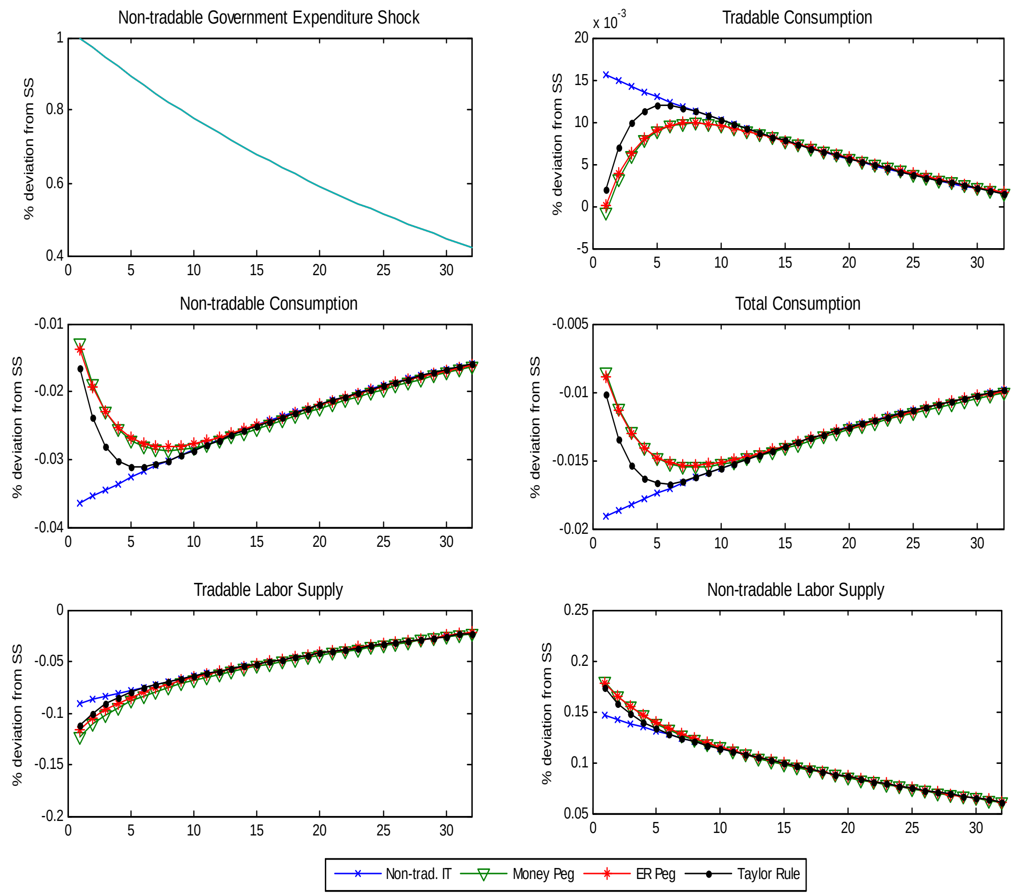

Figure 3.4: Impulse responses for non-tradable government expenditures

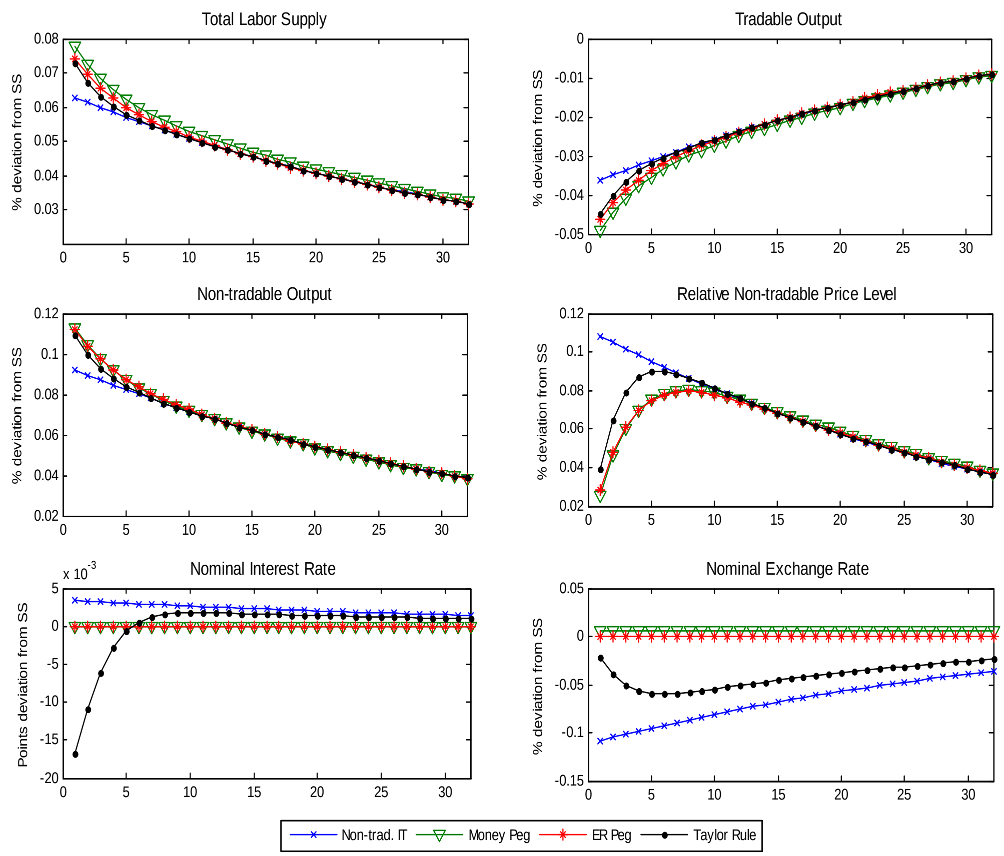

Figure 3.4 (cont.): Impulse responses for non-tradable government expenditure shock

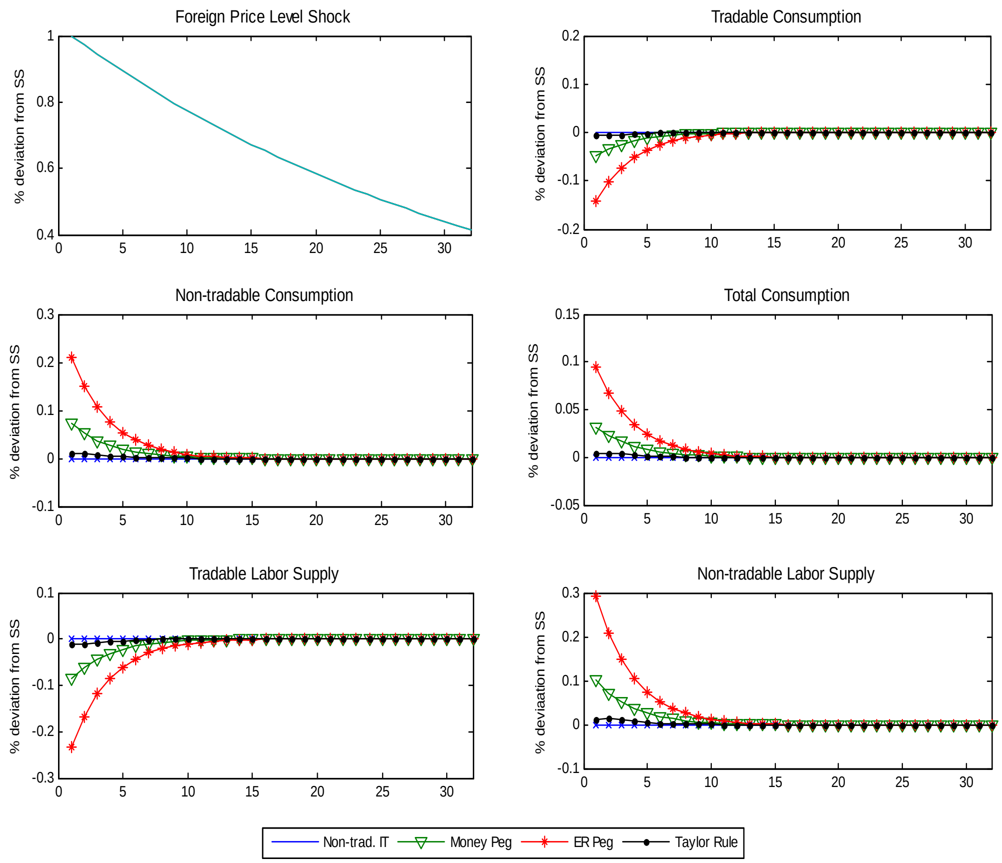

Figure 3.5: Impulse responses for foreign price level shock

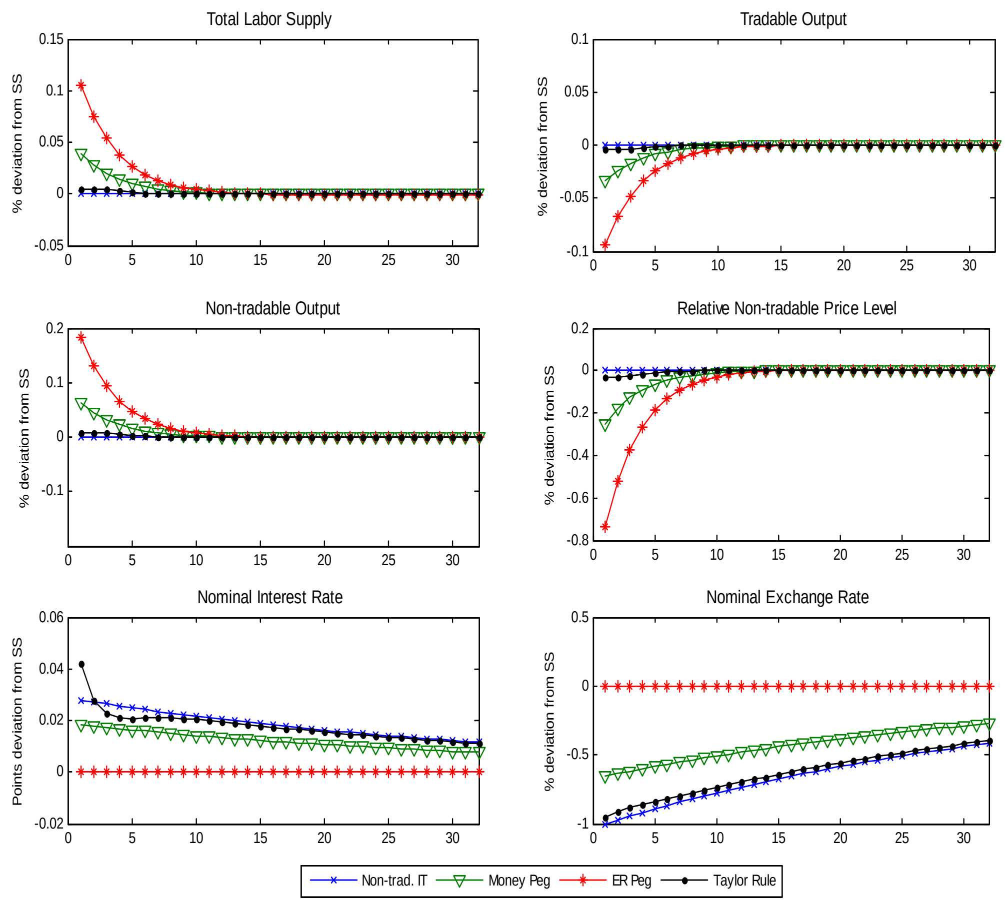

Figure 3.5 (cont.): Impulse responses for foreign price level shock

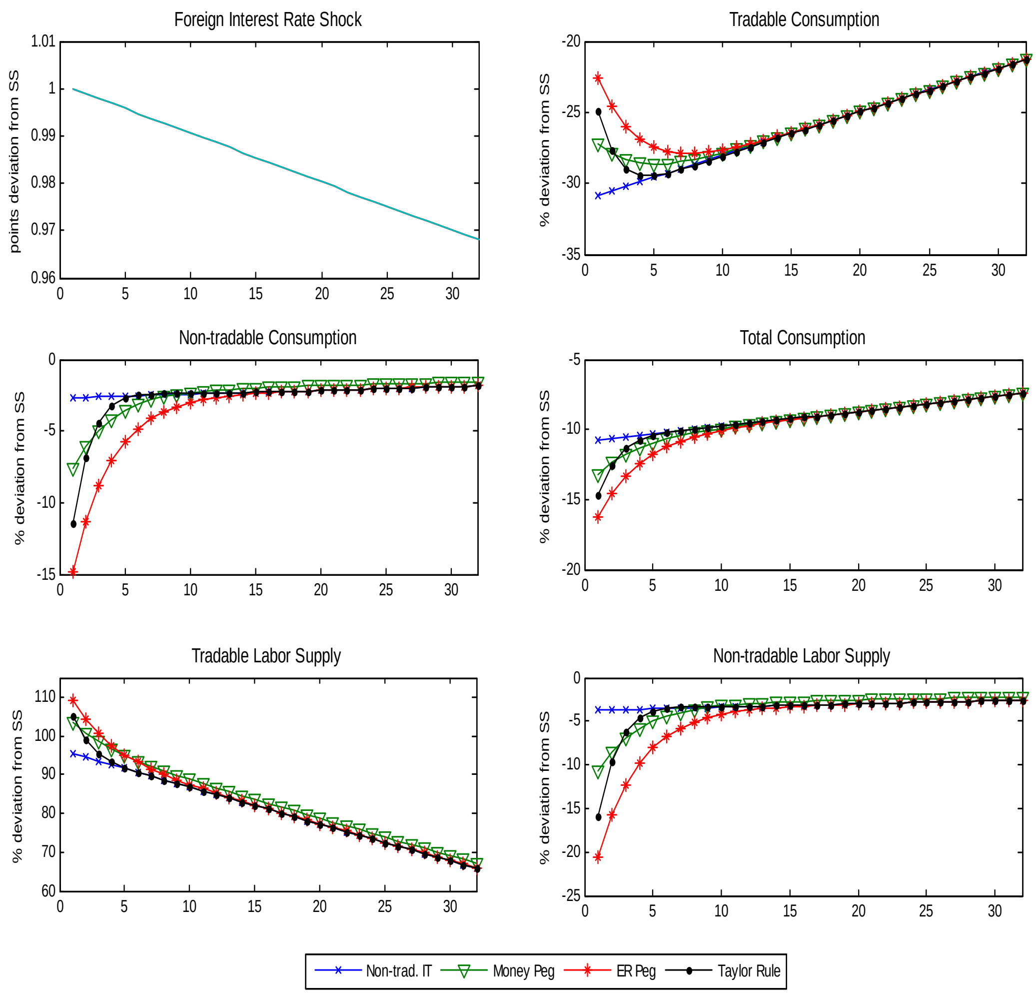

Figure 3.6: Impulse responses for foreign interest rate shock

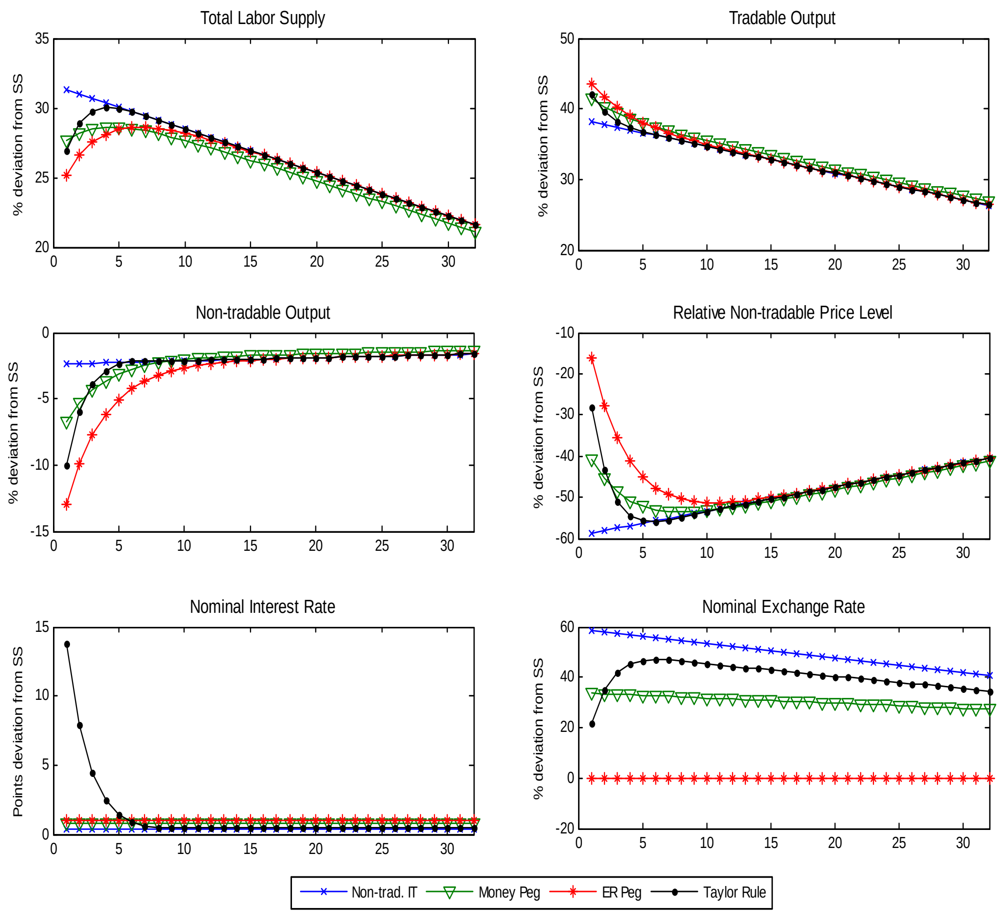

Figure 3.6 (cont.): Impulse responses for foreign interest rate shock