Announced regime switch: Optimal policy for transition period*

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Abstract

The novelty of this work is the presentation of the theoretical framework that allows to model announced change of the monetary regime. I analyze behavior of small open economy that announced to adopt a monetary policy regime with focus on offsetting nominal exchange rate changes in given number of periods. First, I analyze effects for macroeconomic stability of choice of the monetary regime for transition period. For this analysis, I consider representative types of monetary regimes in the announcement–change period. I also try to rank the examined regimes in terms of loss functions. Moreover, I try to analyze the evolution of business cycles synchronization over the transition.

Abstrakt

Cílem této prace je prezentace modelu, který umožnuje modelovat vopred ohlášenou zmenu režimu monetární politiky. V praci analyzuji odezvy malé otevřené ekonomiky jenž je v prechodu od inflačního cílovaní k režimu se zaměřením na stabilitu kurzu. Konstrukce modelu umožnuje identifikovat změny makroekonomické stability v průběhu přechodové periody mezi režimama. S použitím ad-hoc funkce ztráty užitku monetární autority můžem identifikovat optimální měnovú politiku pro přechodovou periodu v závislosti od preferencí autority. Identifikace změn korelací ekonomických cyklů dokazuje důležitost zahraničných poptávkových tlaků pro domácí ekonomický cyklus již v periode přechodu.

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1 Introduction

It is not rare for a monetary authority to consider a switch in the focus of their monetary policy. One of the most interesting cases is a switch to a managed, pegged exchange rate or even fixed exchange rate regime. The motivation for the switch may stem from international treaties or beliefs of central bankers about the benefits of a new monetary policy regime. New members of the European Union have agreed on joining the European and Monetary Union (EMU) in the accession treaty. The ERM II accession process asks them to maintain stability of the exchange rate over the evaluation period. This periods usually ends with the adoption of the common currency, e.g., Malta, Slovenia and Slovakia as the most recent cases.

Countries like Bulgaria and Estonia voluntarily decided to set-up a currency board even before entering the evaluation period. The decision to manage or to peg the exchange rate is based on their belief that a currency board is advantageous for small open economies. Also, there exist countries that find their own monetary policy difficult to sustain, e.g., Sweden and Finland in the early 1990s. Countries like these opt for managing their exchange rate in order to achieve macroeconomic stability during currency distress. Regardless, the motivation for the policy switch, the newly adopted policy rule in the aforementioned cases, is usually a sort of nominal exchange rate peg.

Many recent works in monetary economics that focus on the choice of monetary policy study the properties of alternative monetary policy rules by analyzing macroeconomic stability [Collard and Dellas (2002)]; using the loss function of the monetary authority [Santacreu (2005)]; or the welfare function of households [Gali and Monacelli (2005)] to identify the optimal policy. These studies compare models with different monetary policy rules without possibility of change in the form of rule. Such studies are considered as static in form of rule. This static comparison does not determine if it is worth to switch to another policy rule, while it omits the transition period.

The aforementioned points motivate me to focus on the analysis of small open economy behavior over the transition period towards the exchange rate peg. An important issue is how announcing the adoption of the exchange rate peg affects the properties of the business cycles of the small open economy.

I address these issues using the standard stochastic general equilibrium model of the small open economy, e.g., Justiniano and Preston (2004), Gali and Monacelli (2005) and Cuche-Curti, Dellas, and Natal (2008). To simplify my analysis, I decided to use the model by Justiniano and Preston (2004), where all goods are tradable. However, this model uses Calvo type rigidities as the more complex models do. To provide a specific example, I identify the large economy as the Euro area and the small open economy as the Czech Republic. While the Czech Republic is a representative country that aims to adopt the common currency, it also copes with the limitations of its own independent monetary policy.

For a better description of the Czech Republic's monetary policy, I enclose the model with the policy rule based on inflation forecast. Also, structural parameters of the model are estimated for the Czech Republic.

The novelty presented in this chapter is the approach to modeling the transition period when the change in the monetary regime type is announced. As Farmer, Waggoner, and Zha (2007) summarize, recent works rely on Markov switching processes to account for changes of policy rule. Generally, the solution is computed as a average of separate models weighted by the probability matrix of the process. Instead of the Markov switching process, I extend the standard model with a binary indicator of the regime that identifies the operative monetary policy. Moreover, in my simulations the change in the regime indicator is credibly announced in advance. Therefore, a model with this indicator offers an alternative approach that more closely models the commitment to the regime change than models based on the

Markov process.

For my analysis of the macroeconomic stability over the transition, I assume that the monetary authority follows an optimal policy with respect to the loss function for the monetary authority as in Laxton and Pesenti (2003) and Santacreu (2005). As Cuche-Curti, Dellas, and Natal (2008) and Dellas and Tavlas (2003) summarize, there is no straightforward recommendation for the type of optimal policy. The optimal policy choice depends on many factors like the presence and origin of rigidities and structural shocks. Therefore, I solve for the optimal policy that takes a simple form when monetary authority reacts to the deviations output gap, inflation and change in nominal exchange rate.

Moreover, as Cuche-Curti, Dellas, and Natal (2008) point out, the simple form of the optimal policy avoids questioning information capabilities of the monetary authority. To identify the simple optimal monetary policy for the transition period for various preferences on inflation, output and policy stability, the utility has one degree of freedom as in Santacreu (2005).

The goal of monetary policy for the transition is still to support macroeconomic stability. However, it is also important to know how these policies change the characteristics of the business cycles. To analyze these changes, I compute and analyze the correlations of business cycles as described by inflation, output and interest rate.

The rest of the chapter is organized as follows. Section 2 presents the model of rule switch. In Section 3, the parameter estimation is presented. Basic characteristics and properties of the model are presented in Section 4. Section 5 presents the macroeconomic stability results obtained and Section 7 concludes. All figures can be found in the appendix sections.

2 Model

The basics of the model are taken from Justiniano and Preston (2004). The used model consists of a small open economy (domestic) and the rest of the world (foreign). The domestic economy is characterized by the existence of habit formation and indexation of prices to inflation. The fundamental model is based on the work of Gali and Monacelli (2002) and Monacelli (2005), where micro-foundations for the small open economy model are summarized and incomplete pass-through is discussed. The following sections provide commented derivations of the structural equations of Justiniano and Preston's (2004) model. Further, the modification of monetary policy and approach to modeling the transition period is described in a separate subsection.

2.1 Households

The considered small open economy is populated by a representative household that maximizes its lifetime utility function

$$E_t \sum_{t=0}^{\infty} \beta^t e^{g_t} \left[\frac{(C_t - H_t)^{1-\sigma}}{1-\sigma} - \frac{{N_t}^{1+\varphi}}{1+\varphi} \right], \tag{1}$$

where β, $0 < \beta < 1$, is the utility discount factor; σ and φ are the inverse of elasticities of the inter-temporal substitution and labor supply, respectively; N_t is total labor effort; $g_t = \rho_g g_{t-1} + \varepsilon_t^g$ is a preference shock, and $\varepsilon_t^g \sim N(0, \sigma_g^2)$; C_t is the consumption of a composite good; $H_t = hC_{t-1}$ is the external habit taken as exogenous by household as presented by Fuhrer (2000). The parameter h indexes the importance of habit formation. The household consumes a Dixit-Stiglitz composite of the domestic and foreign good:

$$C_t \;=\; [(1-\alpha)^{\frac{1}{\eta}} (C_t^H)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} (C_t^F)^{\frac{\eta-1}{\eta}}]^{\frac{\eta}{\eta-1}}, \tag{2}$$

where α is the share of the imported good in domestic consumption and $\eta > 0$ is the intra-temporal elasticity of substitution between the domestic and foreign good.

Given the specification of the household's preferences, the minimization of expenditures for the given level of consumption C_t implies, as in Walsh (2003), the following aggregate domestic consumer price index (CPI):

$$P_t = [(1-\alpha)(P_t^H)^{1-\eta} + \alpha(P_t^F)^{1-\eta}]^{\frac{1}{1-\eta}}, \tag{3}$$

where P_t^H and P_t^F are prices of the domestic and foreign Dixit-Stiglitz composite good used to produce the final composite good C_t.

In aggregate, the household maximizes lifetime utility according to the following budget constraint:

$$P_t C_t + Q_{t,t+1} D_{t+1} \leq D_t + W_t N_t + T_t, \tag{4}$$

where W_t is the nominal wage; D_{t+1} is the nominal pay-off received in the period $t+1$ acquired from the portfolio held at the end of the period t, and $Q_{t,t+1}$ is the value of the discount factor of this portfolio; T_t are transfers that include taxes/subsidies and profits collected from domestic firms and importers.

Given the Dixit-Stiglitz aggregation, households optimally (cost minimization) allocate their aggregate expenditures for the foreign and domestic good according to the following demand functions:

$$\begin{aligned} C_t^H &= (1-\alpha)\left(\frac{P_t^H}{P_t}\right)^{-\eta} C_t \\ C_t^F &= \alpha\left(\frac{P_t^F}{P_t}\right)^{-\eta} C_t. \end{aligned} \tag{5}$$

The first order necessary conditions imply the domestic Euler equation in the following form:

$$\lambda_t E_t[Q_{t,t+1}] = \beta E_t[\lambda_{t+1} \frac{P_t}{P_{t+1}}], \tag{6}$$

where λ_t is the Lagrange multiplier associated with a budget constraint. This equation is used in the following section to link the domestic and foreign economy.

2.2 International arrangements

The real exchange rate is defined as the ratio of foreign prices in domestic currency to the domestic prices $\hat{q}_t \equiv \hat{e}_t \frac{P_t^*}{P_t}$, where $\hat{e}_t$ is the nominal exchange rate (in terms of the domestic currency per unit of foreign currency); P_t^* is the foreign consumer price index and P_t is the domestic consumer price index given by Equation (3). An increase in $\hat{e}_t$ coincides with a depreciation of the domestic currency.[1] Further, I assume that $P_t^* = P_t^{F*}$ (P_t^{F*} is the price of the foreign good in a foreign currency), the law of one price gap is given by $\Psi_t^F = \hat{e}_t \frac{P_t^*}{P_t^F}$, as in Monacelli (2005). The law of one price gap represents a wedge between the foreign price of a foreign good P_t^{F*} and the price of the foreign good when sold on the domestic market P_t^F by importers [see Lubik (2005) for details]. The law of one price (LOP) holds when $\Psi_t^F = 1$; for $\Psi_t^F > 1$, importers realize losses due to increasing costs of imported goods; when $\Psi_t^F < 1$, importers enjoy profits.

The foreign economy is identical in preferences, therefore optimality conditions are similar to the domestic optimality conditions. The foreign economy is considered to be large and the domestic good takes only a negligible fraction of its consumption. Therefore, the foreign composite consumption bundle can be simplified and only foreign produced goods are considered in the overall foreign consumption. Further, under the assumption of complete international financial markets, arbitrage implies that the marginal utility of consumption in a foreign economy is

[1] The superscript * denotes "foreign" equivalents of domestic variables throughout this chapter.

proportional to that in a domestic economy. Using the domestic Euler equation (6), the following condition is derived:

$$\beta E_t[\frac{\lambda_{t+1}}{\lambda_t}\frac{P_t}{P_{t+1}}] = \quad E_t[Q_{t,t+1}] \quad = \beta E_t[\frac{\lambda^*_{t+1}}{\lambda^*_t}\frac{P^*_t}{P^*_{t+1}}\frac{\hat{e}_{t+1}}{\hat{e}_t}]. \tag{7}$$

Defining the gross nominal return on the portfolio as $R_t^{-1} = E_t[Q_{t,t+1}]$, the risk sharing condition (7) equation implies the following uncovered interest rate parity (UIP) condition:

$$E_t[Q_{t,t+1}(R_t - R^*_t(\frac{\hat{e}_t}{\hat{e}_{t+1}}))] \quad = \quad 0. \tag{8}$$

The uncovered interest rate parity places a restriction on the relative movement of the domestic and foreign interest rate and on the nominal exchange rate. However, the interest rate parity can be distorted by a risk premium shock. Therefore, as in Kollmann (2002), a shock that captures deviations from purchasing power parity and not already explained endogenously by imperfect pass-through, such as a time varying risk premium, is added into the log-linearized form of the model. Moreover, the risk premium is constant in the steady state and Equation (8) collapses to the standard uncovered interest rate parity equation for the nominal exchange rate in the steady state.

Finally, the terms of trade are defined as the relative price of imports in terms of exports:

$$S_t \quad = \quad \frac{P^F_t}{P^H_t}. \tag{9}$$

Note that changes in the terms of trade may reflect future changes in the competitiveness of an economy. The depreciation of the exchange rate induces an increase in import prices and deterioration of terms of trade. However, the depreciated exchange rate restores competitiveness of the economy since demand for cheaper exports grows and import demand from domestic consumers decreases.

2.3 Firms

In this economy, the nominal rigidities driving the price adjustment occurs due to monopolistic competition in the good market. Suppose there is a continuum of domestic firms indexed by i, $0 \leq i \leq 1$. A typical firm i in the home country produces a differentiated good with constant returns to scale according to the following production function:

$$Y_t(i) = A_t N_t(i),$$

where $N_t(i)$ is labor supplied by a household to firm i; A_t is a common stationary productivity process that follows $log(A_t) = a_t = \rho_a a_t + \varepsilon_t^a$, where $\varepsilon_t^a \sim N(0, \sigma_a^2)$ is an exogenous productivity shock common to all firms. The firm's index can be dropped, while in the symmetric equilibrium all choices of the firms are identical. According to the production function, the representative firm faces real marginal costs $MC_t = \frac{W_t}{P_t A_t}$, where W_t is the nominal wage.

Here, the domestic inflation rate is defined as $\pi_t^H = log(P_t^H / P_{t-1}^H)$. Firms producing a domestic good are monopolistically competitive with Calvo-style price setting using inflation indexation. Further, only a fraction $(1 - \theta^H)$ of firms are allowed to set their price $P_t^{H,new}$ optimally in the considered period. The remaining fraction θ^H, $0 \leq \theta^H < 1$ sets its price according to the following indexation rule:

$$log(P_t^H(i)) = log(P_{t-1}^H(i)) + \delta \pi_{t-1}^H,$$

where $0 \leq \delta < 1$ is the degree of indexation. Therefore, the aggregate price index is evolving according to the following relation:

$$P_t^H = \left[(1-\theta^H)(P_t^{H,new})^{(1-\varepsilon)} + \theta^H \left(P_{t-1}^H \left(\frac{P_{t-1}^H}{P_{t-2}^H}\right)^{\delta}\right)^{(1-\varepsilon)}\right]^{1/(1-\varepsilon)}, \quad (10)$$

where $\varepsilon > 1$ is the elasticity of substitution between the varieties of goods produced by domestic firms. Firm i, setting its price in period t and following the indexation rule in all subsequent periods T, $T \geq t$, faces the following demand curve in period T:

$$y_T^H(i) = \left(\frac{P_t^{H,new}(i)}{P_T^H}\left(\frac{P_{T-1}^H}{P_{t-1}^H}\right)^{\delta}\right)^{-\varepsilon}(C_T^H + C_T^{H*}),$$

where C_t^H is domestic demand and C_t^{H*} is foreign demand for the composite domestic good. While firm i is maximizing its present value by maximizing the value of the real profits stream, the firm's price-setting problem in period t is to solve:

$$\max_{P_t^H(i)} \quad E_t \sum_{T=t}^{\infty}(\theta^H)^{T-t}Q_{t,T}y_t^H(i)\left[P_t^{H,new}(i)\left(\frac{P_{T-1}^H}{P_{t-1}^H}\right)^{\delta} - P_T^H MC_T\right]$$

subject to the aforementioned demand curve. This implies the following first-order condition:

$$E_t \sum_{T=t}^{\infty}(\theta^H)^{T-t}Q_{t,T}y_t^H(i)\left[P_t^{H,new}(i)\left(\frac{P_{T-1}^H}{P_{t-1}^H}\right)^{\delta} - \frac{\varepsilon}{1-\varepsilon}P_T^H MC_T\right] = 0,$$

where MC_T are real marginal costs in the period of the price decision.

Similarly, as in the domestic good production, the nominal rigidities in the foreign good sector are resulting from staggered price setting and monopolistic competition. Foreign good retailers import foreign goods so that the law of one price holds "at the docks" and resell them in a monopolistically competitive market. To set their prices, importers also use Calvo pricing with indexation to past inflation of imported good prices, which is defined as $\pi_t^F = log(P_t^F/P_{t-1}^F)$.

Again, only a fraction $(1-\theta^F)$ of importers are allowed to set their new price $P_t^{F,new}$ optimally in each period. The fraction θ^F, $0 \leq \theta^F < 1$ of importers just updates its price according to the following indexation rule:

$$log(P_t^F(i)) = log(P_{t-1}^F(i)) + \delta\pi_{t-1}^F,$$

where the same degree of indexation δ as for domestic producers is assumed. The foreign good price index is evolving according to the following relation:

$$P_t^F = \left[(1-\theta^F)(P_t^{F,new})^{(1-\varepsilon)} + \theta^F \left(P_{t-1}^F \left(\frac{P_{t-1}^F}{P_{t-2}^F}\right)^{\delta}\right)^{(1-\varepsilon)}\right]^{1/(1-\varepsilon)}.$$

Similarly, importer i, who is setting its price in period t, faces the following demand curve in period T, $T \geq t$:

$$y_T^F(i) \quad = \quad \left(\frac{P_t^{F,new}(i)}{P_T^F}\left(\frac{P_{T-1}^F}{P_{t-1}^F}\right)^{\delta}\right)^{-\varepsilon} C_T^F, \tag{11}$$

as for the domestic good, here, $\varepsilon > 1$ is a parameter describing the substitution between the varieties of foreign goods. Therefore, the importer's price-setting problem in period t is to maximize

$$E_t \sum_{T=t}^{\infty} (\theta^F)^{T-t} Q_{t,T} y_t^F(i) \left[P_t^{F,new}(i)\left(\frac{P_{T-1}^F}{P_{t-1}^F}\right)^{\delta} - \hat{e}_T P_T^F MC_T\right]$$

subject to the aforementioned demand Equation (11). This implies the following first-order condition:

$$E_t \sum_{T=t}^{\infty} (\theta^F)^{T-t} Q_{t,T} y_t^F(i) \left[P_t^{F,new}(i)\left(\frac{P_{T-1}^F}{P_{t-1}^F}\right)^{\delta} - \frac{\varepsilon}{1-\varepsilon}\hat{e}_T P_T^F MC_T\right] = 0,$$

and the new optimal price $P_t^{F,new}(i)$ is the solution to this equation. The presence of monopolistic competition results in deviations from the law of one price in the short run, while a complete pass-through is reached in the long-run as presented in Monacelli (2005).

2.4 Equilibrium

Equilibrium requires that all markets clear. The good market clearing condition in the domestic economy is given by the following equation:

$$Y_t^H = C_t^H + C_t^{H*}. \tag{12}$$

Under the assumption of a large foreign economy, market clearing in the foreign economy gives $Y_t^* = C_t^*$. Households, which are assumed to have identical initial wealth, make identical consumption and portfolio decisions. So, the following analysis considers a symmetric equilibrium, domestic producers, importers, and foreign firms also behave identically. Therefore, the individual index can be dropped and the representative household, representative firm, and the single good in each sector can be used for the model solution. In period t the representative domestic producers set common prices P_T^H. Importers also set a common price P_t^F, so do the foreign producers when setting P_t^*. Finally, as in Gali and Monacelli (2002) and Justiniano and Preston (2004), I assume that the government off-sets distortions originating from monopolistic competition in the goods markets by a subsidy/transfer that is financed through a lump-sum tax T_t on a representative household.

2.5 A log-linearized model

To analyze the behavior of the underlying model, an approximation around the non-stochastic steady state of the presented model is obtained as in Justiniano and Preston (2004). For any variable, the lowercase letters denote the log-deviation from the steady state of their uppercase counterparts in the frictionless equilibrium. The non-stochastic steady state is characterized by setting all shocks to zero for all periods.

As in Justiniano and Preston (2004), I assume a zero inflation steady state, so that $\pi_t = \frac{P_t}{P_{t-1}} = \frac{P_t^H}{P_{t-1}^H} = \frac{P_t^F}{P_{t-1}^F} = 1$, and for the steady state of the nominal interest rate $1 + i_t = \frac{1}{\beta}$.

Linearizing the domestic good market clearing condition (12) together with a linearized version of the demand functions (5) implies

$$(1-\alpha)c_t = y_t - \alpha\eta(2-\alpha)s_t - \alpha\eta\psi_t^F - \alpha y_t^*, \tag{13}$$

where $\psi_t^F = (e_t + p_t^*) - p_t^F$ is a log-linear approximation of the law of one price, and $s_t = p_t^F - p_t^H$ is a log-linear approximation of the terms of trade given by Equation (9). Time differencing of the terms of trade definition implies

$$\Delta s_t = \pi_t^F - \pi_t^H. \tag{14}$$

Using the log-linearized equations of the law of one price gap and terms of the trade, the following link between the terms of trade and the real exchange rate can be derived:

$$q_t = \psi_t^F + (1-\alpha)s_t. \tag{15}$$

The log-linear approximation to the optimality conditions of domestic firms for price setting, the law of motion for the domestic producers price, and the domestic price index given by Equation (10) imply the following hybrid Philips curve:

$$\pi_t^H - \delta\pi_{t-1}^H = \frac{1-\theta^H}{\theta^H}(1-\theta^H\beta)mc_t + \beta E_t[(\pi_{t+1}^H - \delta\pi_t^H)], \tag{16}$$

where the marginal costs is

$$mc_t = \varphi y_t - (1+\varphi)a_t + \alpha s_t + \sigma(1-h)^{-1}(c_t - hc_{t-1}). \quad (17)$$

The log-linear form of the real marginal costs mc_t of the representative firm originates from the log-linearization of the aggregate production function and the household's optimality condition for labor choice.

Similarly, the optimality condition for the pricing problem of retailers results in the following Philips curve:

$$\pi_t^F - \delta\pi_{t-1}^F = \frac{1-\theta^F}{\theta^F}(1-\theta^F\beta)\psi_t^F + \beta E_t[(\pi_{t+1}^F - \delta\pi_t^F)]. \quad (18)$$

Following the arguments of Justiniano and Preston (2004) and the derivation by Gali and Monacelli (2002), the complete markets assumption together with condition (7) imply the following relation for the log-linear approximation of the Euler equation (6):

$$c_t - hc_{t-1} = y_t^* - hy_{t-1}^* + \sigma^{-1}(1-h)[\psi_t^F + (1-\alpha)s_t] + \sigma^{-1}(1-h)g_t. \quad (19)$$

The log-linear approximation of the uncovered interest rate parity Equation (8) gives $i_t - i_t^* = E_t\Delta e_{t+1}$. As mentioned in the previous section, to capture the deviations from UIP, a risk premium shock ϵ_t is added into equation (8); $\epsilon_t = \rho_s\epsilon_{t-1} + \varepsilon_t^s$, here $\varepsilon_t^s \sim N(0, \sigma_s^2)$. Using the definition of the real exchange rate,

$$\Delta e_t = \Delta q_t + \pi_t - \pi_t^*, \quad (20)$$

the following equation is derived:

$$(i_t - E_t\pi_{t+1}) - (i_t^* - E_t\pi_{t+1}^*) = E_t\Delta q_{t+1} + \epsilon_t. \quad (21)$$

The risk premium shock ϵ_t is zero in the steady state, so the steady state Equation (21) collapses to a standard uncovered interest rate parity equation. Also, note that the positive (negative) values of Δe_t reflect domestic currency depreciation (appreciation).

Finally, the approximations of the CPI equation (3) and the change in terms of trade (14) give the following relation:

$$\pi_t = \pi_t^H + \alpha \Delta s_t. \tag{22}$$

Since the goods produced in the home economy represent only a small fraction of the foreign economy consumption, I consider the large foreign economy as exogenous to the domestic economy. Therefore, I assume that the paths of foreign variables π_t^*, y_t^*, and i_t^* are determined by the following VAR process:

$$\pi_t^* = \omega_\pi^\pi \pi_{t-1}^* + \omega_y^\pi y_{t-1}^* + \omega_i^\pi i_{t-1}^* + \varepsilon_t^\pi, \tag{23}$$

$$y_t^* = \omega_\pi^y \pi_{t-1}^* + \omega_y^y y_{t-1}^* + \omega_i^y i_{t-1}^* + \varepsilon_t^y, \tag{24}$$

$$i_t^* = \omega_\pi^i \pi_{t-1}^* + \omega_y^i y_{t-1}^* + \omega_i^i i_{t-1}^* + \varepsilon_t^i, \tag{25}$$

where ε_t^π, ε_t^y, and ε_t^i; $\varepsilon_t^y \sim N(0, \sigma_y^2)$, $\varepsilon_t^\pi \sim N(0, \sigma_\pi^2)$, and $\varepsilon_t^i \sim N(0, \sigma_i^2)$, represent the independent structural shocks that drive the foreign economy.

2.6 Model of the transition period

The description of the model is closed by describing the behavior of the domestic monetary authority. While the Czech central bank reacts to the forecasted inflation, I deviate from Justiniano and Preston (2004) in my analysis. As discussed by Carlstrom and Fuerst (2000), I assume that the monetary authority acts according to expected inflation rather than using the actual level of inflation. To keep my analysis simple, I assume that the monetary authority is forward looking only for one period ahead.

The focus of this chapter is to analyze macroeconomic stability during the transition. The economy begins in time $t = 1$, when it is announced that the regime will change in period $T, T > 1$. To simplify the analysis, I also assume that the monetary authority follows the same policy rule over all periods of the transition, $t \leq T$.

So, the monetary policy rule for the model of the transition period takes the following form:

$$\begin{aligned} i_t &= regime_t(\rho_i i_{t-1} + \rho_\pi E_t[\pi_{t+1}] + \rho_y y_t + \rho_e \Delta e_t + \varepsilon_t^m) + \\ &+ (1 - regime_t)\widehat{\rho_e} \sum_{j=t}^{\infty} \left(\frac{1}{2}\right)^{t-j} \Delta E_t[e_j], \end{aligned} \tag{26}$$

where $0 \leq \rho_i < 1$, $\rho_\pi > 1$, $\rho_y > 0$ and $\rho_e \geq 0$ are weights describing the responses of the domestic monetary authority; and ε_t^m, $\varepsilon_t^m \sim N(0, \sigma_m^2)$ is the shock capturing errors arising from the description of the monetary policy. In here, the effective monetary regime is selected via the regime indicator. In my experiment when the change is announced in the first period, the indicator is defined as follows:

$$regime_t = \begin{cases} 1, & \text{if } t < T; \\ 0, & \text{if } t \geq T, \end{cases}$$

where T is the announced time of regime change.

By varying values of the rule parameters ρ_π, ρ_y and ρ_e in rule (26), I am able to model a wide range of monetary policies for the transition ($t < T$), e.g., inflation targeting or exchange rate targeting. Further, the only objective of the post-transition monetary regime $t \geq T$, is to off-set all the foreseen changes in the nominal exchange rate. This regime is characterized by $\widehat{\rho_e}$, which measures the off-setting of the change in the nominal exchange rate. To keep the level of exchange rate volatility reasonably low, I set $\widehat{\rho_e} = 2.0$.

The introduction of the regime indicator transforms the problem of modeling an announced change to a problem of foreseen changes in the indicator. To model the announced changes in the indicator, I extend the state space of the model by an information buffer of length N, where $N > T$. This information buffer is capable of storing information for N periods ahead and takes the following form:

$$\begin{aligned}
regime_t &= inf_{t,1} \\
inf_{t,1} &= inf_{t-1,2} + \nu_{t,1} \\
inf_{t,2} &= inf_{t-1,3} + \nu_{t,2} \\
&\vdots \\
inf_{t,N-1} &= inf_{t-1,N} + \nu_{t,N-1} \\
inf_{t,N} &= \nu_{t,N},
\end{aligned} \tag{27}$$

where $inf_{t,i}, i \in 1, \ldots, N$ are the new endogenous variables, and $\nu_{t,i}, i \in 1, \ldots, N$ are the announcement shocks, such that $\nu_{t,i}$ takes values 0 and 1 for all $i = 1, \ldots, N$ and $t > 0$. The initial condition for the buffer is $inf_{0,i} = 0$ and $\nu_{0,i} = 0$, $\forall i \in 1, \ldots, N$.

In the experiment, I focus on the perfectly credible announcements. Therefore, I can think about $\nu_{t,i}$s as random variables with zero mean and zero variance. However, by varying the assumption about information shocks, it is possible to model the uncertainty about keeping the commitment of the policy rule switch announced by the monetary authority. The higher the uncertainty about keeping commitments, the higher value of information shock variance should be used.

The announcement of the regime change in $t = 1$ is modeled by the realization of the information shocks $\nu_{t,i}$ $i \in 1, \ldots, N$ according to the following scheme:

$$\nu_{1,i} \;=\; \begin{cases} 1, & i \leq T; \\ 0, & i > T, \end{cases} \tag{28}$$

and $\nu_{t,i} = 0$, $\forall i$ and in the all subsequent periods t, $1 < t \leq T$. This realization of information shocks describes a one-time announcement of a policy rule switch in period T without any further changes of transition length.

The model of the transition period consists of Equations (13)–(25), the monetary policy rule (26), the information buffer given by Equations (27), and definitions of the AR(1) processes for technology and preference shocks.

Further, I assume that there are no shocks (for $t \geq T$) to risk premium when the regime of off-setting of the exchange rate changes is adopted. So, the risk premium shock ϵ_t described by Equation (21) will become $\epsilon_t = \rho_s \epsilon_{t-1}$. To make this change foreseen in the model of transition, the AR(1) process for risk premium shock ϵ_t in Equation (21) will become $\varepsilon_t = \rho_s \varepsilon_{t-1} + regime_t \varepsilon_t^s, \varepsilon_t^s \sim N(0, \sigma_s^2)$ since $t > T$.

The construction of the policy indicator $regime_t$ creates non-linearities in the monetary policy rule and risk premium process. Therefore, to solve and simulate the transition period model, the second order approximation is used. The model is solved by Dynare++.[2] A brief description of the computation of the transition period model is presented in Appendix A.

3 Estimation

To provide a specific example, in my analysis I estimate the parameters of the model using data on the Czech Republic. In recent literature, Bayesian methods

[2]Dynare++, developed by Kameník (2007), is a standalone C++ version of Dynare. Dynare is the pre-processor and collection of Matlab routines introduced by Juillard (1996), Collard and Juillard (2001b) and Collard and Juillard (2001a).

are considered an attractive tool for estimating a model's parameters, especially in open economy modeling. The most recent examples include Smets and Wouters (2003), who estimate the Eurozone model; Lubik and Schorfheide (2003) and Lubik and Schorfheide (2005), who analyze the behavior of the monetary authority; and Ireland (2004).

Due to the short span of the Czech data sample, I prefer Bayesian methods because it allows me to incorporate information from previous studies in the form of informative priors on parameter values. This approach is preferred because the use of priors makes the estimation results more stable.

Model M and its associated parameters Θ can be estimated using the method outlined by An and Schorfheide (2007). In the Bayesian context, given a prior $p(\Theta)$ and a sample of data Y, the posterior density of the model parameters Θ is evaluated, and it is proportional to the likelihood of the data multiplied by the prior $p(\Theta)$:

$$p(\Theta|Y, M) \quad \propto \quad L(\Theta|Y, M)p(\Theta). \tag{29}$$

The goal of the Bayesian estimation is to estimate the posterior distribution and to find such parameter estimates that, given the model, the likelihood value $L(\Theta|Y, M)$ is maximized.

The Bayesian estimation procedure consists of the following three steps. In the first step, the model is extended for a measurement block that links model variables to data. The extended model is solved. In the second step, the fact that the solution of the model is in the form of a state space model is exploited. This allows me to compute the likelihood function of the underlying model by use of the Kalman filter, the observed data, and priors. The objective is to maximize the value of likelihood as the function of the model parameters. The second step results in the maximum-likelihood estimates of the model parameters. The objective of these estimation steps is to get parameter values for this model.

In the third step, the likelihood function conditional on a parameters estimate is combined with the prior distribution of parameters to obtain the posterior density function. The Metropolis-Hastings (MH) algorithm, which is an implementation of the Monte Carlo Markov chain (MCMC) method, is used to estimate the posterior distributions. The objective of the posterior distributions computation is to evaluate the sensitivity of the results to my choice of priors and optimization algorithm settings.

3.1 Data and priors

The used data sample covers a period of a CPI inflation targeting regime from its introduction in 1998 until the third quarter of 2007. Over this period changes in the inflation target occurred. However, the nature of the regime was not changed thus this does not lead to structural changes. Therefore, I can abstract from the effects of a decreasing inflation target. The detailed description of data and transformations used are summarized in Appendix B.1.

The domestic block of the underlying model is estimated using the de-trended data on output growth, inflation, the nominal interest rate, terms of trade, and the real exchange rate. The foreign block is described by the de-trended series of effective output, inflation, and the nominal interest rate. The effective series are constructed as a sum of the trade partners series weighted by the export shares.

Model variables are expressed in percentage deviations from a steady state. The data series are related to model variables via a block of measurement equations. The measurement block connects the model variables with the observed data using the measurement error. The block of measurement equations and measurement errors characteristics are summarized in Appendix B.2.

The choice of parameter priors is derived from previous studies [Lubik and

Schorfheide (2003); Natalucci and Ravenna (2003); Justiniano and Preston (2004); and Musil and Vašíček (2006)] and is guided by the following considerations. The choice of prior distributions reflects the restrictions on the parameters such as non-negativity deviations or interval constraints. Therefore, for parameters constrained to the $\langle 0, 1\rangle$ interval, the beta distribution is used. Prior distributions for standard deviations of shocks have been set to inverse gamma. Similarly, for parameters taking positive values, the gamma distribution is used. The standard deviation of priors also reflects my beliefs about confidence in the priors, and I decided to use loose priors rather than tighter ones. Tables 3 and 4 provide an overview of my choice of priors. Further, I assume $\beta = 0.99$ (strict prior), which implies an annual interest rate of about 4% in a steady state.

The model for estimation is closed by the simple monetary policy rule given as follows:

$$i_t = \rho_i i_{t-1} + \rho_\pi E_t[\pi_{t+1}] + \rho_y y_t + \rho_e \Delta e_t + \varepsilon_t^m, \tag{30}$$

and the risk premium process is given by equation (8) is used. The estimated model also does not include the information buffer.

For construction of the joint probabilistic distribution, I assume that the priors are independent of each other to simplify the use of the MCMC algorithm. The Dynare toolbox is used to estimate the presented model. Given the data and priors, I generated 300,000 draws for each of the 7 Markov chains using the MH algorithm. While acceptance rates between 20% and 40% are considered as reasonable for distribution sampling, I set the scaling parameter for jumping distribution in MH so that the average acceptance rate is 0.35.

3.2 Estimation results

The estimation results are summarized in Tables 3 and 4 in Appendix B.3. The analysis of the posterior distributions for each estimated parameter does not indicate the presence of computational problems.

The openness parameter α is estimated to be 0.35, implying 0.54 for a steady state ratio of domestic to foreign goods in the domestic consumption basket. The estimated value is very close to openness estimates by Natalucci and Ravenna (2003) and Musil and Vašíček (2006). These works base their estimates on the share of imports in consumption rather than on the share of imports in gross domestic product. The openness parameter is also in accordance with the value 0.27 of foreign-domestic good substitution η because it indicates low willingness of households to substitute domestic for foreign goods.

The value 0.92 of inverse elasticity of inter-temporal substitution σ implies inter-temporal elasticity of 1.08. This value of elasticity indicates that households are concerned about their consumption path and they are willing to substitute today's consumption for future consumption. The acceptance of consumption changes is consistent with a low value of habit persistence. Also, the value of inverse elasticity of labor substitution, $\sigma = 1.08$, implies non-elasticity of the labor supply. The increase in real wage by 1% implies just 0.92% increase in the labor supply. I believe that this value is consistent with the low labor mobility that characterizes the Czech labor market, especially at the beginning of the considered period.

According to the estimation results of policy rule, interest rate smoothing ρ_i takes just a slightly higher value (0.58) than my prior (0.50). The weight of inflation and the output gap deviation are taking values 1.38 and 0.47, respectively. These values of ρ_π and ρ_y reveal that the monetary authority places 2.9 times weight on keeping future inflation stable than closing the output gap. Moreover, the low value of reaction to the deviation of the nominal exchange rate ρ_e reflects the inflation targeting focus declared by the Czech National Bank.

My priors for the price stickiness parameters θ's are chosen based on Lubik and Schorfheide (2005), and they reflect the evidence on US prices. The prior value of price indexation to inflation is set to 0.70, while studies exists where the value of indexation is set to unity. My estimation results show that there is a high fraction of domestic firms (estimate of θ_H takes value 0.26) that optimize their prices every quarter. This is consistent with the estimates using the European data presented by Smets and Wouters (2003). Approximately the same fraction of importers optimize their prices every period so the average contract length is approximately 4 quarters. The value of inflation indexation δ means that the price of the good is updated by half of the price level change. I find it consistent while not much indexation is needed when the price is frequently optimized. The estimated value of 0.56 for inflation indexation δ is almost three times as high as the estimates reported by Justiniano and Preston (2004).

I assume a high persistency of technological, risk premium and taste shocks, so the priors are set to 0.85. However, estimates show that the most persistent shock is the preference shock with a value of 0.95 for ρ_g. This indicates that impacts of the preference shocks are not temporary but near permanent. I believe that the low persistency of technological shock, taking value 0.83, with a large standard deviation of technological shock, reflects the structural changes of Czech industry over the considered period.

For the foreign block, I assume the autocorrelation of foreign shocks to be 0.7 [used by Natalucci and Ravenna (2002)], while I find the values of Justiniano and Preston (2004) quite low. However, my estimation results show little persistency in the foreign inflation series. The foreign monetary policy described by equation (25) reveals persistency close to the prior value, thus indicating significant interest rate smoothing in the Eurozone. Only, the foreign output series reveal persistency higher then prior values, and the value of 0.93 is in accordance with estimates for developed economies like the USA.

Priors and estimates of the standard deviation of structural shocks are summarized in Table 4. These results show that the preference shock ε_t^g is most volatile. However, this does not mean that the preference shock is the main driving force of the variables of my interest. Using variance decomposition, I found that the preference shock generates only 7.5% of inflation volatility, 4.5% of output growth, and 7.3% of nominal interest rate variance. Due to the high value of openness, I determined that the risk premium shock generates 26% of domestic CPI inflation variance. However, for the estimated coefficients, variance decomposition shows that the foreign shocks are not the main drivers of domestic variables volatility. The shocks to foreign inflation and interest rates are responsible for approximately 11.3%, respectively 2.8% of domestic inflation variance.

	Data		Model	
Variable	Std. dev.	Corr.	Std. dev.	Corr.
Output growth	1.05	1.00	2.28	1.00
Nominal interest rate	1.38	-0.53	0.53	-0.35
CPI inflation	3.14	-0.12	3.34	-0.06
Change in nominal ex. rate	8.37	0.17	8.12	0.11
Real ex. rate	3.48	0.17	6.87	0.01
Foreign output gap	0.81	0.02	0.74	0.03
Foreign inflation	0.66	0.21	0.81	-0.02
Foreign nom. int. rate	0.65	-0.03	0.73	-0.02

Table 1: Moments summary

To evaluate the empirical properties of the generic model, Table 1 compares moments of the time series used for estimation with moments of the variables of the estimated model. This comparison shows that the model exhibits more volatile output and real exchange rate series and excess interest rate smoothing. However, the estimated model matches the properties of the foreign series.

Finally, to evaluate the amount of information included in the observed series, I use a comparison of priors and posteriors distributions. This comparison helps to gain insight about the extent to which the data provide information about the estimated parameters. According to plots presented in Figure 1, I conclude that some of the priors are significantly updated by information included in the data.

4 Impulse response analysis

The goal of the following comparison is to point to differences induced by adding the possibility of a policy rule switch in the estimated model [model with the monetary policy rule (26)]. Therefore, the models of the announced change of monetary policy are calibrated with the same parameters values as the benchmark model. Figures 2–8 present impulse response functions of the following four models: estimated model (dash-dotted red line); model of switch in 4 (solid magenta line); 8 (dashed blue line); and 40 (dotted black line) periods. The results are presented as quarterly percentage deviations from the steady state.

Figure 2 depicts responses to the 1% deviation in the domestic technology shock ε_t^a. As it is expected for the case of a supply shock, output increases and inflation decreases. Via the uncovered interest rate parity relation, the decrease in the domestic inflation is accompanied with a currency appreciation (since the inflation and interest rate of a foreign economy does not react to domestic shocks). The monetary authority decreases interest rates. Due to the currency appreciation and the fact that importers do not update their prices immediately for lower input costs, the law-of-one-price (LOP) gap closes, eliminating importer profits. The presence of habit formation supports the hump-shaped consumption profile because households gradually adjust their consumption profile. However, an update of imported good prices, with slowing currency appreciation and real depreciation, restrain the rise in demand for the foreign good. As inflation in the imported good sector rises, the steady state is established.

In the case of the estimated model (dash-dotted red line), due to the absence of regime change, much stronger appreciation is observed. The price rigidity in the imported goods sector and appreciation leads to a long period deflation of imported goods prices. Due to low inflation, the authority responds with expansive monetary policy. The main difference in responses between the model of an announced rule switch and the model of independent monetary policy is in the extent of response to technology shocks.

Figure 3 presents responses to the domestic taste shock ε_t^g. This shock initiates an increase in domestic inflation and output as expected in the case of demand shock. Because of the initial currency appreciation, which results from an expected hike in interest rates, importers decrease the prices of their goods. The foreign goods become cheaper and this supports an increase in demand for the foreign good. Due to output rigidities, the increase in output follows with lag. In response to inflation and output increases, the domestic monetary authority increases the interest rate. Due to the price indexation of import prices to CPI inflation, the initial response of the LOP gap is negative and importers enjoy profits.

For the benchmark model, the import price decrease is of a larger extent than in the case of a rule switch and this makes households increase their demand for the foreign good. This results from the reaction of the monetary authority, which can not rely on the expectations formed according to exchange rate stabilizing policy. Moreover, the extent of these deviations is very small.

Figure 4 presents responses to the risk premium shock ε_t^s. In the case of an announced change in monetary regime, this leads to initial depreciation and an immediate increase in the interest rate to prevent further depreciation and a rise in inflation. For the models of the policy switch, the monetary authority strongly increases the interest rate in order to offset the change in the nominal exchange rate immediately. However, due to the extent of the depreciation and the inflation indexation of import prices, a significant increase in the price of imported goods is observed. Here, the main difference between the models is the extent of the initial depreciation.

In the case of the monetary policy shock ε_t^m, as shown in Figure 5, the shape of the responses does not differ much between models of transition because of the low persistency of the shock, and the steady state is quickly established. A positive monetary policy shock is equivalent to a contractionary policy. Therefore, output decreases in line with consumption as inter-temporal substitution motivates households to postpone consumption. The induced appreciation results in a drop in import prices. The estimated change model initially reacts with much stronger appreciation, leading to a significant drop in inflation and output, therefore expansionary policy is conducted in the following periods.

Responses to a foreign inflation shock ε_t^π are presented in Figure 6. In models of transition, an increase in the foreign inflation rate leads to an immediate appreciation of the domestic currency (implied by UIP). An increase in import prices supports a rise in domestic inflation. The monetary authority has to react with contractionary policy, which suppresses output. But this deviation is very small. In the estimated model initial appreciation is very strong so the real exchange rate together with the contractionary policy does not allow for an initial increase in output fueled by increased foreign demand.

Figure 7 depicts responses to the foreign positive output shock ε_t^y. An increase in foreign economic activity leads to an increase in demand for the domestic goods and domestic inflation, thus domestic output rises in response to this shock. High foreign demand leads to an increase of foreign good prices, leading to an increase in imported goods price which together with domestic inflation delivers domestic currency depreciation via UIP. Depreciation eliminates importer profits and is followed by a large increase in domestic interest rates.

For the foreign output shock, the main differences in responses occur in the initial period, where more extensive depreciation is observed for the estimated model in the period following the shock realization. Therefore, the monetary authority responds with contractionary policy.

Finally, Figure 8 depicts responses to the 1% increase of foreign interest rate ε_t^i. The UIP implies an initial depreciation of domestic currency because of the negative interest rate differential. Domestic currency depreciation is able to support an initial increase in foreign demand that fuels an increase in domestic output and inflation. The domestic monetary authority reacts with contractionary monetary policy in the following periods. However, even through interest rate increases, the analysis of the LOP gap shows that importers are facings losses. This means that importers are bearing the costs of depreciation due to the high rigidity of import prices.

5 Macroeconomic stability

As discussed in the previous section, impulse response functions mostly differ in the extent of the deviations in reactions to shocks. Therefore, I focus on the volatility of inflation, output gap, and exchange rate change.

The focus on macroeconomic stability was used as the standard approach in the early literature on monetary policy evaluations. It simplifies the analysis because of its independence from the welfare function specification. I believe it can still offer interesting comparisons, as recently presented by Cuche-Curti, Dellas, and Natal (2008) and Collard and Dellas (2002).

However, due to the volatility of trade-offs between variables, a simple comparison of volatilities does not straightforwardly identify the regime that delivers the highest level of macroeconomic stability. As Cuche-Curti, Dellas, and Natal (2008) summarize, an exchange rate peg can outperform a flexible exchange rate regime under assumptions of a stable external environment and that the main source of nominal rigidity is in the goods market. They also find that policies ignoring movements in the exchange rate can be dominated by a simple exchange rate targeting policy. Also, Dellas and Tavlas (2003) show that pegging of the exchange rate may be beneficial in the presence of nominal rigidities.

Therefore, for the purpose of monetary regime comparison, I use the traditional form of the per-period loss function [e.g., as in Laxton and Pesenti (2003) and Santacreu (2005)]:

$$L_t = \tau Var(\pi_t) + (1-\tau)Var(y_t) + \frac{\tau}{4}Var(\Delta i_t), \tag{31}$$

where $\tau \in < 0, 1 >$ is used to describe the preferences of the monetary authority about inflation output and monetary policy stability. To compute the loss over the transition, β is used as the discount factor and the overall loss is computed as a discounted sum of per period losses. Using the loss function, I compute optimal policies that minimize the value of the loss by choice of the weights ρ_i, ρ_π, ρ_y and ρ_e for the monetary policy rule given by equation (26).

In this experiment, the variances from the estimated model are used as the initial conditions for recursive computation, as described in Appendix A. Further, I compute the optimal policy for various lengths of transition. I also repeat the minimization problem for the various specifications of preferences of the monetary authority by varying τ. The resulting loss is shown in Figure 9.

It can be observed that a longer transition period leads to lower values of loss. Also, as the monetary authority becomes more concerned about the output volatility (low values of τ), the authority is generally achieving lower loss.

Figure 10 shows the parameters of the optimal policy rule for the transition period as a function of transition length and preferences specification. The plot for the interest rate smoothing parameter ρ_i shows that for all transition periods, policy rigidity is steeply increasing as inflation stability is gaining greater weight. The plot for the choice of the inflation targeting parameter ρ_π does not show much variance over the considered transition lengths. Intuitively, as the focus on inflation stability in loss function is increasing (τ increases), ρ_π is also increasing.

Further, for ρ_y the value of output gap targeting is varying among transition lengths and preference specifications. Also, intuitively when output stability is extremely preferred, ρ_y reaches the upper constraint. It seems that there is a trade-off between the output gap and a change in nominal exchange rate targeting while as preferences are shifted towards inflation, stability ρ_e decreases. This can be explained by the foreign shock absorbing nature of the exchange rate. Lower values of exchange rate targeting provide a more flexible exchange rate, which is able to absorb the foreign inflation movements. At the same time, changes in exchange rate can affect domestic output via foreign demand. Therefore to avoid an increase in the domestic output volatility, ρ_y is increasing.

5.1 Variance decomposition

As in Collard and Dellas (2002) and in order to better understand the forces that drive change in the business cycle behavior, change in the origins of the variance is analyzed. I analyze the changes in variance decomposition between the estimated model and the model of post-transition ($t \geq T$). I report the changes in variance contribution shock to the volatility of variables in Table 2. These changes are computed as a difference of shock contribution to the total variance of the considered variable (in percent) in the estimated model and in the model of a post-transition regime. In here, a positive value signals an increase in the contribution to volatility in the model of the post-transition regime.

The negative change in the contribution of the monetary policy shock and risk premium originates from the design of my experiment when these shocks are eliminated in the post-transition model. The 64.3% decrease in the contribution of the taste shock ε^a to the volatility of change in the exchange rate shows that the

Variable	Shocks						
	ε^a	ε^m	ε^g	ε^s	ε^π	ε^y	ε^i
Δe_t	-1.4	-16.4	-64.3	-9.8	16.4	41.1	40.4
i_t	-19.5	-1.5	-7.3	-59.5	11.9	52.4	23.5
mc_t	-1.2	-18.0	45.6	-10.7	0.2	-14.7	-1.3
π_t	-6.0	-43.9	84.1	-26.4	1.0	-6.1	-2.7
pi_t^F	-2.3	-16.9	-69.1	-10.2	51.0	39.8	7.7
pi_t^H	-3.4	-18.6	41.2	-11.2	0.4	-7.3	-1.1
ψ_t^F	-0.2	-18.2	-69.2	-10.8	80.7	4.7	12.9
y_t	-0.1	-1.7	2.7	-1.0	0.1	0.2	-0.1

Table 2: Variance decomposition: Changes

exchange rate operates as a shock absorber in the estimated model. The taste shock ε^g become the dominant source of domestic and CPI inflation volatility in the model of the post-transition regime, as the increases by 41.2% and 84.1% show. So offsetting the nominal exchange rate changes makes the stability of inflation significantly more vulnerable to the domestic preference shock that acts as a demand shock in the estimated model.

As the exchange rate become less volatile in the model of the post-transition regime, foreign shocks become the major sources of macroeconomic volatility. The source of volatility in LOP gap (ψ_t^F) shifts from domestic preference and monetary shock towards foreign inflation shock (80.7%) and foreign interest rate (12.9%). This indicates that profits of importers become very sensitive to shocks originating in the foreign economy in the post-transition period. This also applies for imported inflation because importers' profits are closely connected with changes in foreign price levels. The reason for this change is that the stable exchange rate is not able to work as a shock absorber for foreign shocks. Therefore, all foreign shocks are directly transferred to the domestic economy.

A significant shift in sources of volatility occurs for domestic interest rates as the monetary policy focuses on the exchange rate. For the interest rate, all domestic sources of volatility are eliminated and volatility is almost fully driven by foreign shocks; 87.8% shift toward foreign shocks. This originates from the increase in exchange rate stability while the domestic economy becomes more vulnerable to foreign demand shocks. Also, the quite high persistency of foreign output and interest rate shocks is the reason that these shocks generate a large fraction (75%) of the domestic interest rate volatility.

There are no important shifts in sources of output gap volatility over the regimes. Output volatility remains mainly driven by preference, technology and foreign output shocks that act as a demand shock. As the contribution of the supply shock ε^a to the interest rate is decreased, I can conclude that the demand shocks will be the dominant source of volatility.

5.2 Business cycles correlations

In the previous sections, my examples show how macroeconomic volatility is changing over the transition period. Also, the comparison of an estimated and a post-transition regime provides a closer look at the changes in the sources of inflation. As the adoption of a pegged or fixed exchange rate strengthens the links between economies, the transmission of disturbances is also increased. According to theories of currency areas, business cycle synchronization is a necessary condition for successful implementation and sustainability of pegged or fixed exchange rate regimes.

This section is devoted to the analysis of changes in the synchronization of business cycles between a small and large economy. Therefore, Figures 11–13 show the evolution of the correlations with foreign variables over the various transition period lengths; 2, 4, 8 and 12 quarters. To compute the correlations, the optimal policies for these lengths are used. For these computations $\tau = 0.75$ is chosen to reflect the preference for inflation stability as observed in the estimated rule, where the inflation targeting weight ρ_π is 2.9 times higher than output gap weight ρ_y.

As shown in Figure 11, the correlation of foreign inflation and exchange rate movements is suddenly changed to a value close to zero after the regime switch because under the post-transition rule, changes in the exchange rate are significantly eliminated. This indicates that the exchange rate loses its shock-absorbing nature. As expected, domestic inflation is becoming more correlated with foreign inflation over the transition period via the imported goods channel. Interestingly, at the end of the transition period this correlation drops temporarily. A similar pattern is observed for the correlation of foreign inflation and domestic nominal interest rate. This indicates that the monetary authority trades-offs exchange rate inflation targeting for exchange rate stability at the end of transition. After transition is over, the increase of this correlation continues as the domestic monetary authority has to follow changes in imported goods prices while these are not absorbed by the exchange rate movements.

As shown in Figure 12, a steep increase in the correlation of foreign and domestic interest rate is observed. As the focus of a post-transition regime is a stable exchange rate, domestic monetary policy has to eliminate the pressures for exchange rate change originating from change in the foreign interest rate that is transferred via UIP. The steep increase in the foreign interest rate and changes in the nominal exchange rate is also observed. Over the transition the domestic monetary authority does allow for changes in the exchange rate that helps as a shock absorber for foreign shocks. Therefore, the correlation of the foreign interest rate and domestic CPI inflation is close to zero or negative. However, the focus on stability of the exchange rate eliminates this shock absorbing feature so the steep increase in this correlation is achieved after the regime change. Figure 12 shows that the domestic monetary authority strongly reacts to changes in the foreign interest rate. Also, domestic output is getting more positively correlated with the foreign interest rate, while the UIP implies more depreciation pressures as a reaction to the foreign interest rate increase. However, these changes in correlation are relatively small.

Further, Figure 13 shows a correlation with foreign output. Also, in here an increase in domestic-foreign output synchronization is observed. These correlation changes are small while the increase in CPI inflation-foreign output correlation signals that the price is increased in response to higher foreign demand for domestic goods. Therefore, the positive value of foreign output-domestic interest rate correlation over the transition is a result of inflationary pressures that originate from changes in foreign demand. These pressures require a response by the domestic monetary authority to suppress inflation. Also the negative value of the exchange rate-foreign output correlation shows that the exchange rate is helping to absorb the output shock. Figure 13 also shows a drop in correlation of the domestic nominal interest and exchange rates with foreign output at the end of transition. This shows that in the last periods of transition, the domestic monetary policy is less contractive while the changes in foreign demand are absorbed by the exchange rate.

6 Policy implications

A very important concern of the monetary authority of a small open economy is its influence on inflation and output. Figure 14 shows the evolution of the correlation of inflation, output and exchange rate changes with domestic nominal interest rates over the transition. In these plots, the optimal policies for various lengths of the transition are considered as in the previous section.

The inflation-interest rate correlation drops mainly in the initial and late phase of the transition. The initial drop is originating from the announcement of the policy rule change. At this point, households realize that in the future, inflation stability will not be the main concern of the monetary authority. The plot for inflation-interest rate correlation shows that the monetary authority loses its control over domestic CPI inflation rapidly in the transition. The second drop in its influence over inflation occurs in the last periods of the transition when monetary policy is at the most contractive level for output.

Consistent with the experiment design, the interest rate gets more correlated with the changes in the exchange rate over the transition. This correlation reaches almost unity in the post-transition regime, as the increase in the domestic interest rate is used to eliminate the depreciation of the exchange rate.

Interestingly, the correlation of output and interest rate is initially negative, as an increase in interest rate leads to a contraction of output. As the output-interest rate plot in Figure 14 shows, monetary policy is gaining more contractionary power towards the end of the transition. However, after the regime is changed, the increasing interest rate losses its contractionary nature. This loss originates from the nature of the new regime, under which the increase in interest rate is closely related to depreciation under the post-transition regime, as the interest-exchange rate plot shows.

7 Conclusions

In this chapter, I analyze the effects of an announced transition towards the regime of pegged exchange rate for the small open economy. The change of regime to a pegged exchange rate is generally removing the freedom to make individual monetary policy responses. However, the change towards the pegged exchange regime may be a result of political decisions. In this work, the change is motivated by possible entry of the Czech Republic into the European Monetary Union and the design of Exchange Rate Mechanism II.

Therefore, a model of a credible and foreseen regime switch needs to be created. I do this by extending the standard model of the small open economy with the binary regime indicator and information buffer that makes the changes of the indicator foreseen. In the presented model of transition towards the pegged exchange rate, the announcement of the change is modeled as the realization of information shocks that are entering the information buffer.

To parameterize the model, its parameters are estimated via the Bayesian method using data on the Czech Republic. The properties of the estimated model are examined via the impulse response functions. The impulse responses are computed for the estimated model with respect to the various lengths of the transition toward the pegged exchange rate regime.

Further, setting up the ad-hoc loss function allows me to compute simple optimal policies for the transition period with respect to preferences for inflation-output stabilization and length of transition. Generally, the optimal policies are able to deliver a lower loss for long transition periods and under the strong focus on output stability. The monetary policies delivering the lowest loss are characterized by very low interest rate smoothing and low weight on inflation targeting.

The business cycle synchronization analysis shows that there are significant changes in the correlations of inflation, interest rate and exchange rate changes. The correlation of domestic variables and the interest rate shows that in the last period of transition, the contractionary effect of the interest rate is reaching its maximum. While after the adoption of the pegged exchange rate regime, increases in the interest rate becomes a sign of expansion as the result of reaction to expected depreciation.

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A Transition period model

The solution of the transition period model given by Equations (13)–(25), and Equations (27) takes the following general form:

$$x_t = F(x_{t-1}, \varepsilon_t, \nu_t),\ 0 < t \leq T$$

where x_t is the vector of the model variables, $\varepsilon_t = \{\varepsilon_t^\pi, \varepsilon_t^y, \varepsilon_t^i, \varepsilon_t^a, \varepsilon_t^m, \varepsilon_t^g, \varepsilon_t^s\}$ is the vector of foreign and domestic structural shocks, $\nu_t = \{\nu_{t,1}, \ldots, \nu_{t,N}\}$ is the vector of information shocks, and $F(.)$ is the second-order polynomial. However, due to the independence of information and structural shocks after the evaluation of information shocks (an announcement of the future regime change), the system will be become linear. The evaluation takes the form given by scheme (28) and $\nu_{t,i} = 0$, $\forall i$ and for all subsequent periods t, $1 < t \leq T$. Therefore, the transition period model with a given length of the transition period takes the following form:

$$x_t = A_t x_{t-1} + B\varepsilon_t,\ 0 \leq t \leq T, \tag{32}$$

where matrices A_t, $t = 0, \ldots, N$ and matrix B depend on the structural parameters of the model and the transition period length. Matrix B is time invariant while the structural shocks are independent. However for $t_1, t_2 > T$, I have $A_{t_1} = A_{t_2}$ because ν_t for $t > 1$ is a vector of zeros and after period T the information buffer is filled only with zeros.

The state-space solution conditional on evaluation of the information shocks is used to simulate the model and compute the covariance matrices Σ_t. To compute the covariance matrix Σ_t recursively, the following formula is used:

$$\Sigma_t = A_t \Sigma_{t-1} A_t^T + BVar(\varepsilon_t)B^T,\ 0 < t \leq T, \tag{33}$$

where Σ_0 is the covariance matrix from the model estimated on data, and $Var(\varepsilon_t)$ is time invariant covariance matrix of structural shocks. Further, to compute the evolution of variance after the change of regime, the following recursive formula for $t > T$ is used:

$$\Sigma_{t+1} = A^f \Sigma_t A^{f^T} + B^f Var(\varepsilon_t) B^{f^T},\ t > T \tag{34}$$

where matrices A^f and B^f are taken from the solution of the model with the monetary policy rule given by equation (26) for $regime_t = 0$.

B Estimation

B.1 Data description

All data in the estimation are from the Czech National Bank database. Series are seasonally adjusted with TRAMO/Seats and X12. All observed series are measured at quarterly frequency and filtered. Series are in logs; therefore they can be interpreted as the percentage deviations from steady state levels.

- Domestic output growth (ΔGDP_t) is the HP de-trended annualized logarithm of real GDP growth.
- Domestic CPI inflation deviation (PI_t) is the HP de-trended annualized quarterly growth rate of the logarithm of the consumer price index (CPI).
- Foreign good inflation (PIF_t) is the HP de-trended annualized quarterly logarithm of the growth rate of imported good price (in domestic currency) index.
- Nominal interest rate (RS_t) is the HP de-trended annualized quarterly value of the 3-month PRIBOR.
- Real exchange rate (Q_t) is the HP de-trended quarterly value of the real exchange rate.
- Foreign output gap (GDP_t^*) is the real GDI gap for an effective Eurozone created by the use of the export values weights and de-trended by the Kalman filter.
- Foreign real interest rate (RS_t^*) is the HP de-trended annualized quarterly value of the 3-month EURIBOR.
- Foreign inflation (PI_t^*) is the HP de-trended annualized quarterly growth rate in the log of consumer price index for the effective Eurozone (export weights).

All series used for the estimation cover the period from the first quarter of 1998 to the second quarter of 2007.

B.2 Measurement block

For my estimation the following measurement block is used to relate model variables to observed time series data:

$$\begin{aligned}
\Delta GDP_t &= 4 * (y_t - y_{t-1} + \varepsilon_t^a) + \varepsilon_t^{GDP} \\
PI_t &= 4 * \pi_t + \varepsilon_t^{PI} \\
PIF_t &= 4 * \pi_t^F + \varepsilon_t^{PIF} \\
RS_t &= 4 * i_t + \varepsilon_t^{RS} \\
Q_t &= q_t + \varepsilon_t^Q \\
PI_t^* &= 4 * pi_t^* + \varepsilon_t^{PI^*} \\
RS_t^* &= 4 * i_t^* + \varepsilon_t^{RS^*} \\
GDP_t^* &= y_t^* + \varepsilon_t^{GDP^*},
\end{aligned}$$

where I assume that $\varepsilon_t^{GDP}, \varepsilon_t^{PI}, \varepsilon_t^{PIF}, \varepsilon_t^{RS}, \varepsilon_t^{Q}, \varepsilon_t^{PI^*}, \varepsilon_t^{RS^*}, \varepsilon_t^{GDP^*}$ are independent normally distributed with zero mean. For estimation I assume that the standard deviations of the measurement errors take the following values 0.25, 0.5, 0.3, 2.0, 1.0, 0.1, 0.1, 0.1 (in the given order).

B.3 Priors and posteriors

The following tables summarize the distribution type and parameters choice (mean, and standard deviation) of prior distributions used to estimate the parameters of posterior distributions (mode and standard deviation).

		Prior			Posterior	
Variable	Description	Distr.	Mean	s.d.	Mode	s.d.
β	Discount factor		0.99			
α	Degree of openness	Beta	0.40	0.05	0.35	0.04
η	Elasticity of F-H substitution	Gamma	1.50	0.50	0.27	0.07
δ	Degree of inflation indexation	Beta	0.70	0.10	0.56	0.13
σ	Inverse elasticity of substitution	Gamma	0.90	0.50	0.92	0.29
φ	Inverse elasticity of labor supply	Gamma	1.50	0.50	1.08	0.48
θ_F	Calvo pricing - foreign	Beta	0.50	0.10	0.22	0.04
θ_H	Calvo pricing - domestic	Beta	0.50	0.10	0.26	0.04
h	Degree of habit formation	Beta	0.80	0.10	0.65	0.11
ρ_i	Interest rate smoothing	Beta	0.50	0.05	0.58	0.04
ρ_π	Response to inflation	Gamma	1.50	0.20	1.38	0.23
ρ_y	Response to output gap	Gamma	0.50	0.10	0.47	0.09
ρ_e	Response to ex. rate change	Gamma	0.10	0.05	0.04	0.02
ω_{11}	Foreign VAR	Normal	0.70	0.30	0.18	0.18
ω_{12}	Foreign VAR	Normal	0.00	0.20	0.10	0.04
ω_{13}	Foreign VAR	Normal	0.00	0.20	-0.14	0.16
ω_{21}	Foreign VAR	Normal	0.50	0.30	-0.07	0.22
ω_{22}	Foreign VAR	Normal	0.70	0.20	0.93	0.06
ω_{23}	Foreign VAR	Normal	-0.10	0.20	-0.09	0.18
ω_{31}	Foreign VAR	Normal	1.50	0.20	0.27	0.09
ω_{32}	Foreign VAR	Normal	0.50	0.20	0.05	0.02
ω_{33}	Foreign VAR	Normal	0.70	0.30	0.58	0.13
ρ_a	Technology - VAR(1)	Beta	0.85	0.10	0.83	0.11
ρ_s	Ex. rate risk - VAR(1)	Beta	0.85	0.10	0.59	0.20
ρ_g	Taste shock - VAR(1)	Beta	0.85	0.10	0.95	0.02

Table 3: Results from posterior parameters (parameters)

		Prior			Posterior	
Variable	Description	Distribution	Mean	s.d.	Mode	s.d.
ε^{π}	Foreign inflation	$Gamma^{-1}$	0.60	0.50	0.18	0.02
ε^{y}	Foreign demand shock	$Gamma^{-1}$	0.30	0.50	0.30	0.03
ε^{i}	Foreign monetary shock	$Gamma^{-1}$	0.30	0.50	0.08	0.01
ε^{a}	Domestic technology shock	$Gamma^{-1}$	0.80	0.50	0.25	0.03
ε^{m}	Domestic monetary shock	$Gamma^{-1}$	0.30	0.10	0.44	0.07
ε^{g}	Domestic preference shock	$Gamma^{-1}$	1.50	0.50	3.07	0.43
ε^{s}	Risk premium shock	$Gamma^{-1}$	1.00	0.50	0.34	0.05

Table 4: Estimation summary: Standard deviation of structural shocks

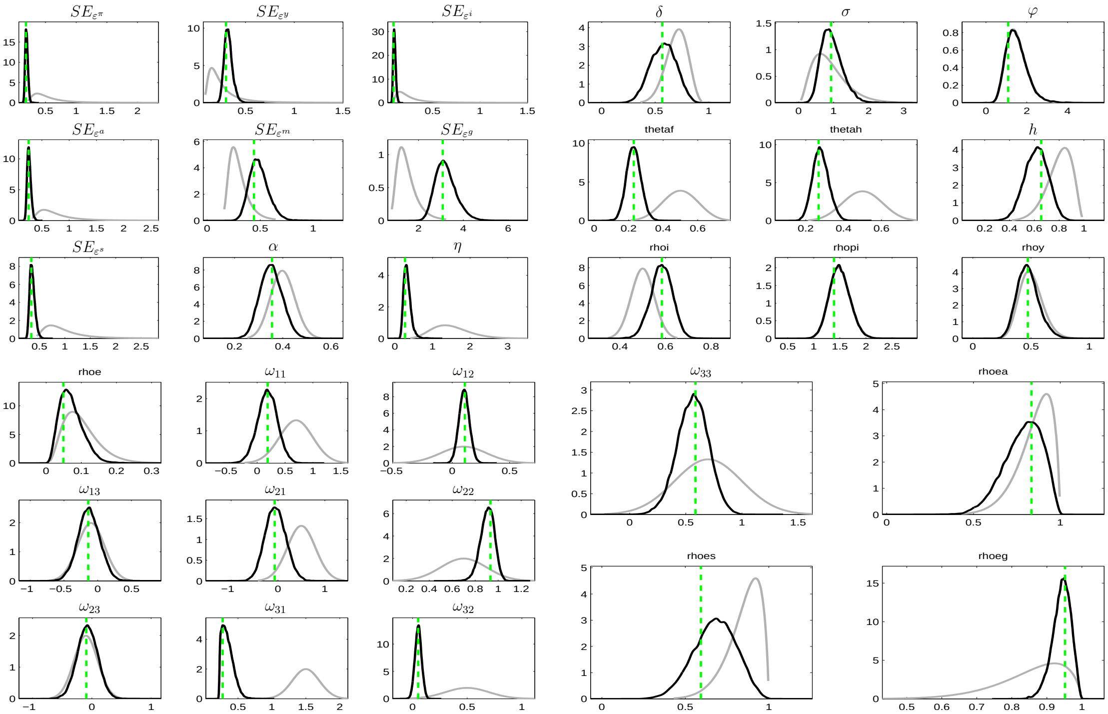

Figure 1: Priors and posterior distributions

C Impulse response functions

Here, the dash-dotted red line represents an estimated model; the magenta solid line is for regime switch in 4; the dashed blue line in 8; and the dotted black line in 40 periods. The results are presented as quarterly percentage deviations from the steady state.

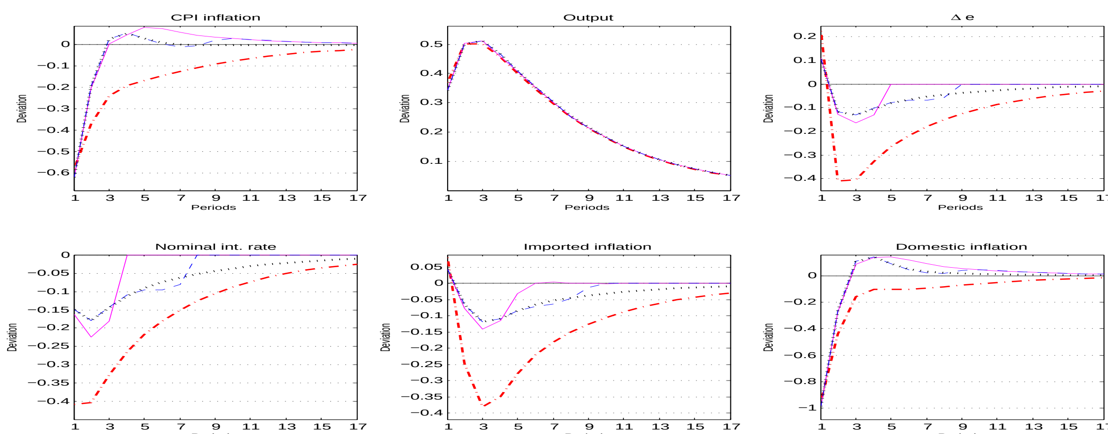

Figure 2: IRF comparison - Response to technology shock ε^a

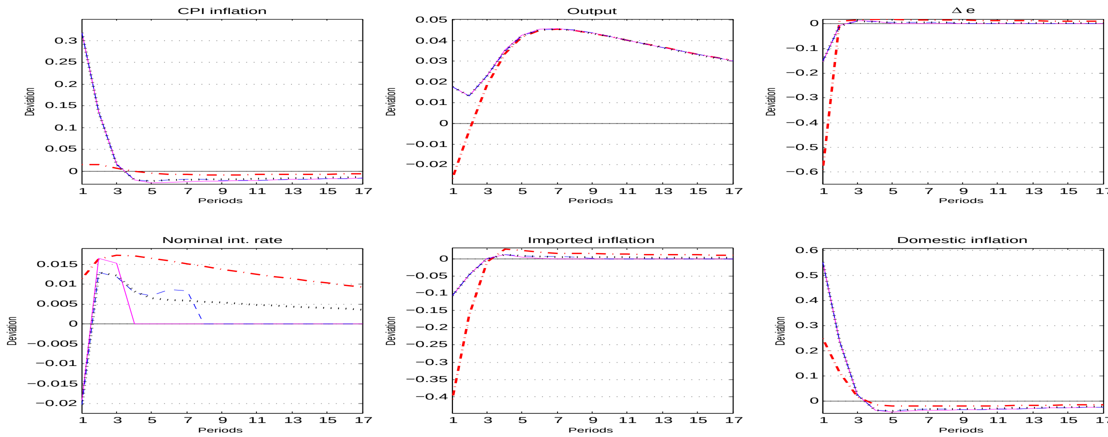

Figure 3: IRF comparison - Response to preference shock ε^g

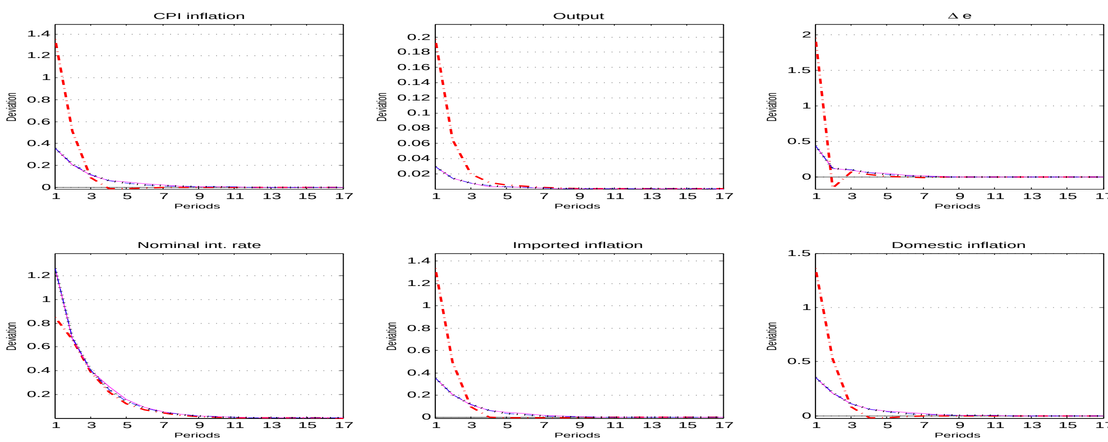

Figure 4: IRF comparison - Response to risk premium shock ε^s

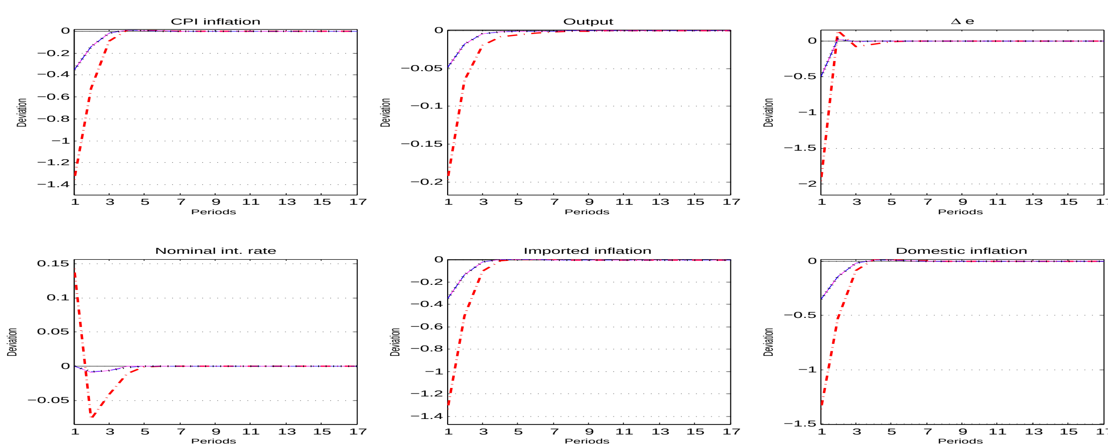

Figure 5: IRF comparison - Response to policy shock ε^m

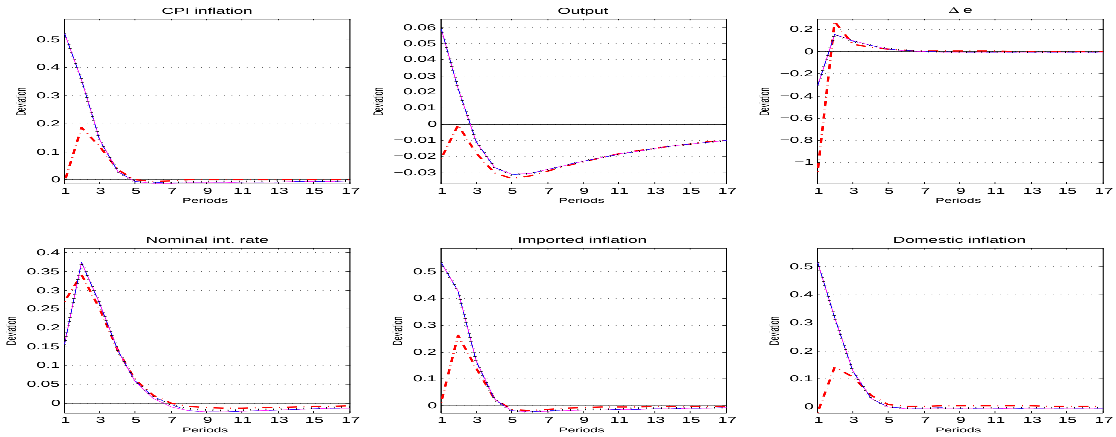

Figure 6: IRF comparison - Response to foreign inflation ε^{π}

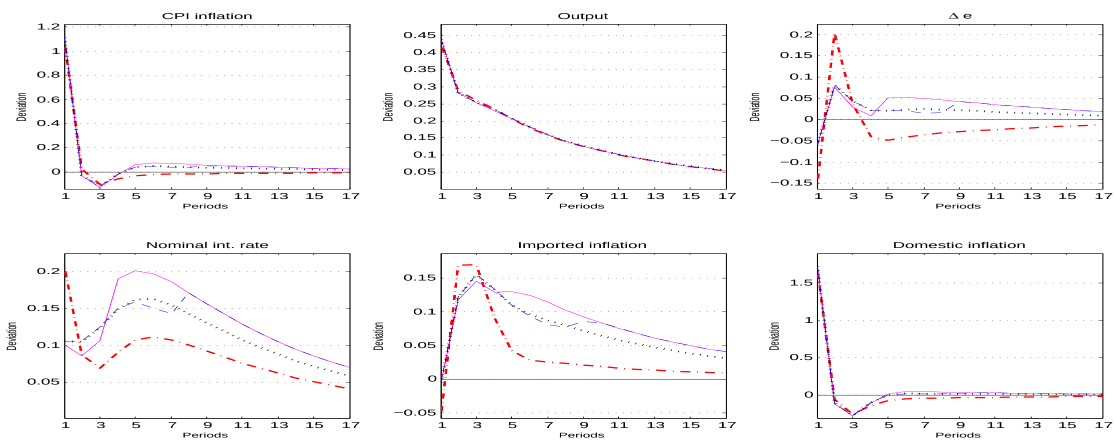

Figure 7: IRF comparison - Response to foreign output ε^{y}

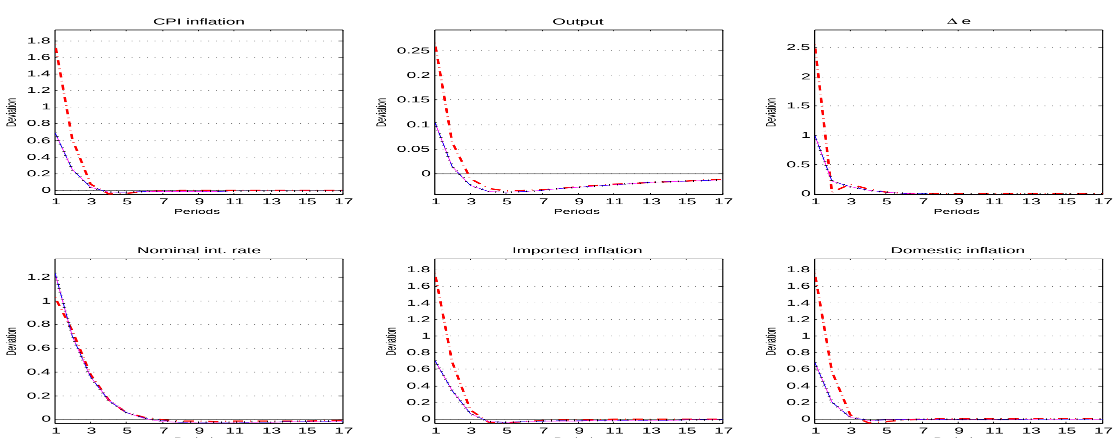

Figure 8: IRF comparison - Response to foreign interest rate ε^{i}

D Volatility and loss evaluation

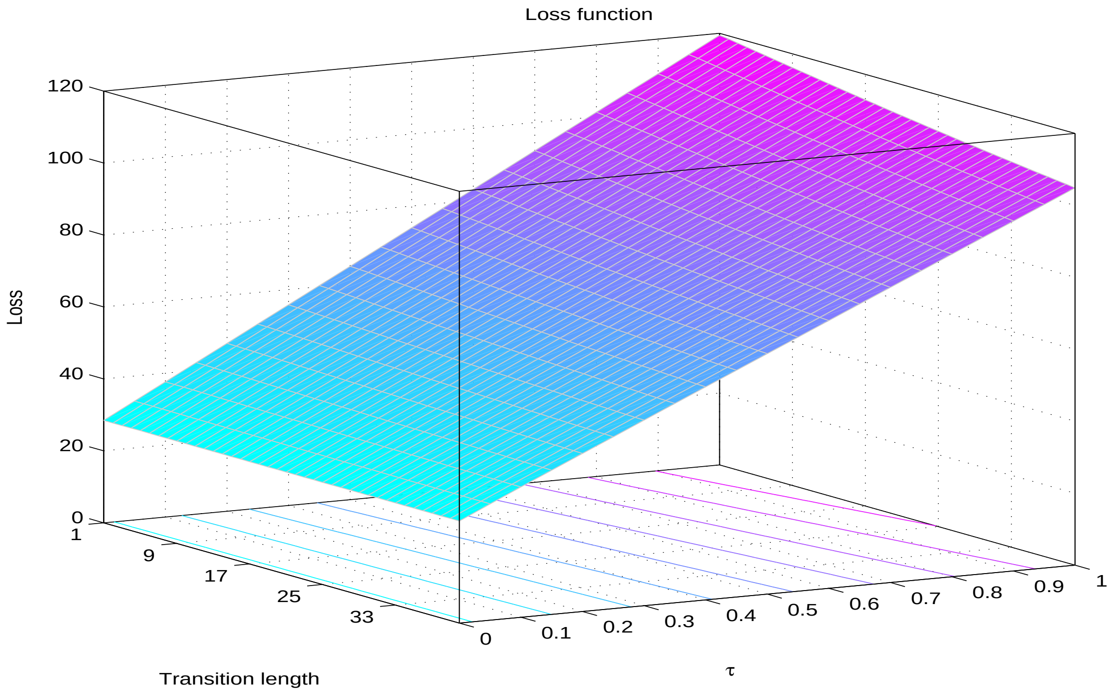

Figure 9: Loss function: Different specifications and transition lengths

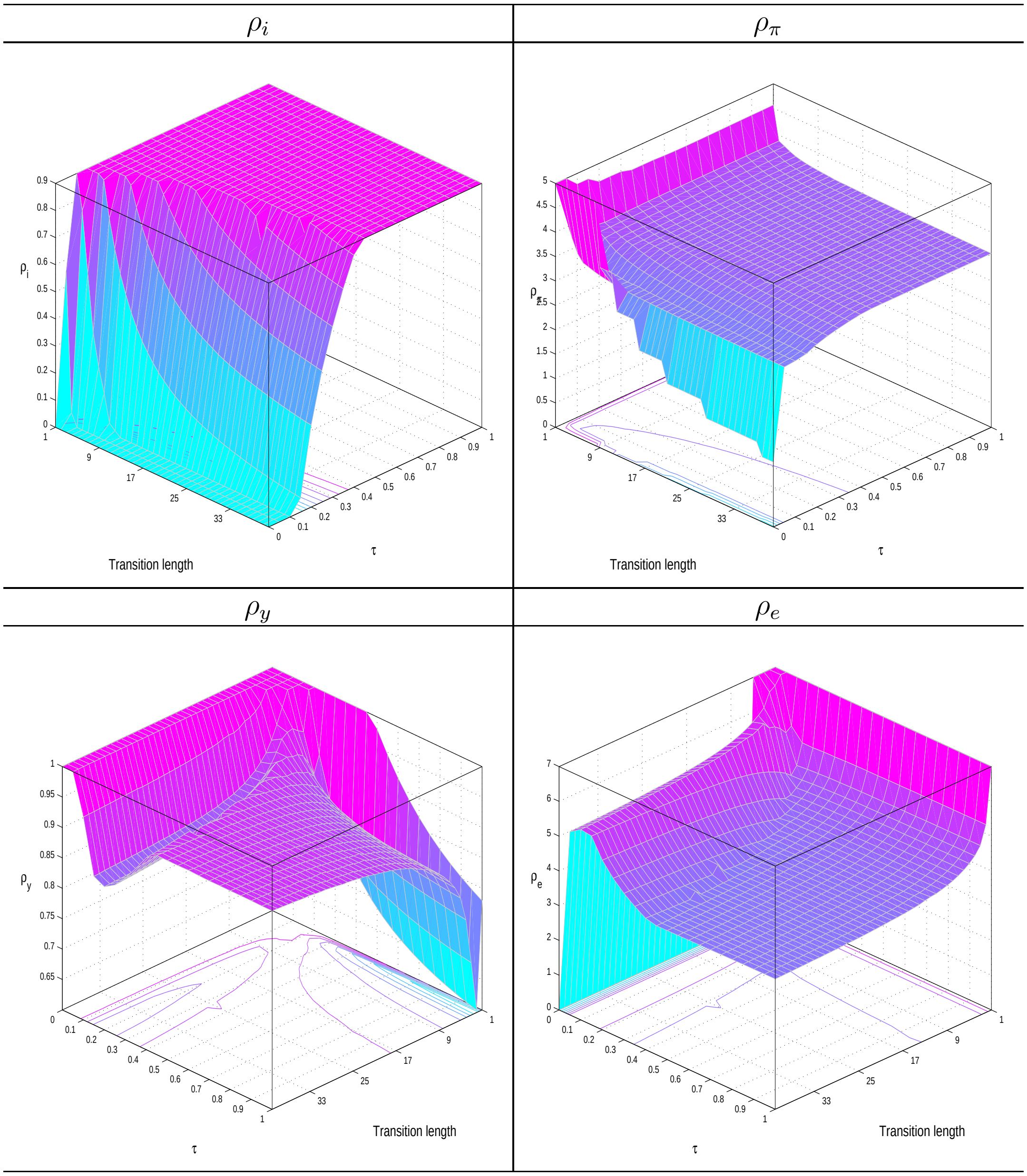

Figure 10: Optimal policies: Different specifications and transition lengths

E Cycles synchronization

Here, the dash-dotted red line is for a policy switch in 2 periods; the magenta solid line is for regime switch in 4; dashed blue line in 8; the dotted black line in 12 periods. The results are presented as quarterly percentage deviations from the steady state.

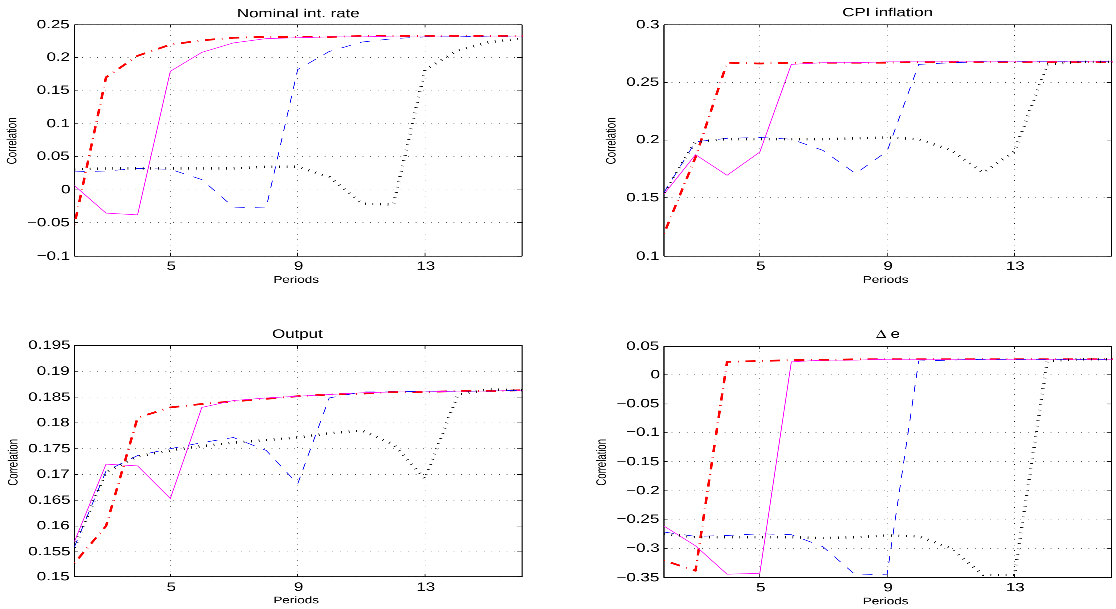

Figure 11: Correlation: π_t^*

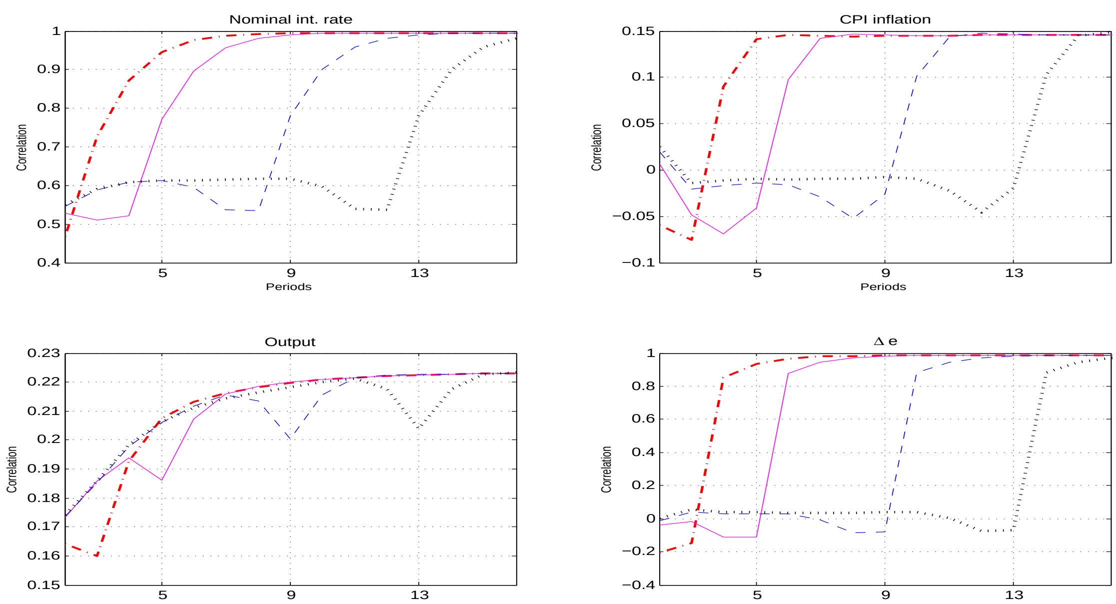

Figure 12: Correlation: i_t^*

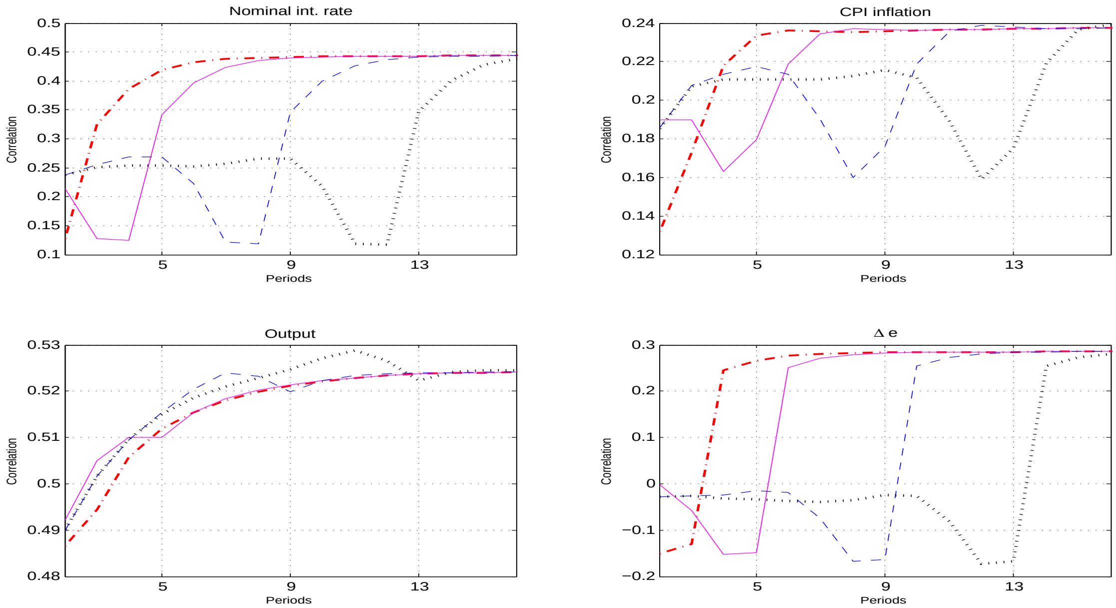

Figure 13: Correlation: y_t^*

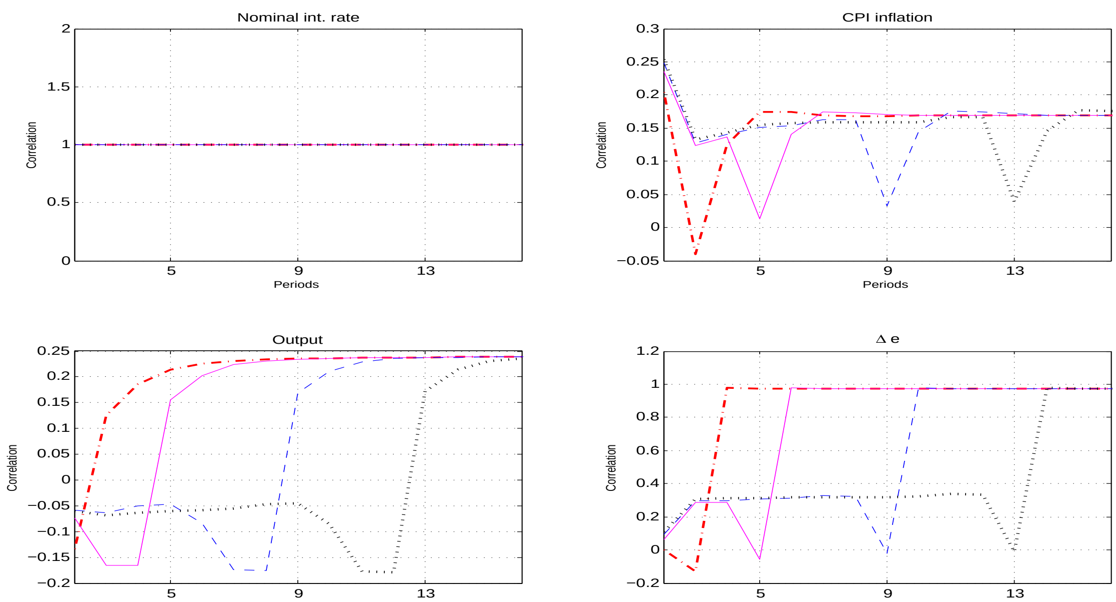

Figure 14: Correlation: i_t