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An Announced Regime Switch: Optimal Policy for the Transition Period*

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Abstract

The novelty of this article is its theoretical framework, which allows for modeling of an announced change in the type of monetary regime operated. The behavior of a small open economy that has announced the adoption of a monetary policy regime of offsetting nominal exchange rate changes is analyzed. The optimal monetary regime for the transition period and its effects on macroeconomic stability are studied. Moreover, the evolution of business cycle synchronization over the transition is analyzed.

1. Introduction

It is not rare for a monetary authority to consider switching the type of monetary policy it operates. One of the most common cases is a switch to a managed or pegged exchange rate, or even the adoption of a common currency. The motivation for the switch may stem from international treaties or from the beliefs of central bankers about the benefits of the new policy type. New members of the European Union agree in the accession treaty to join the European and Monetary Union (EMU). The ERM II accession process asks them to maintain exchange rate stability over the evaluation period. This process usually ends with the adoption of the common currency. Recent cases include Malta, Slovenia, and Slovakia.

Countries such as Bulgaria and Estonia decided voluntarily to set up a currency board even before entering the evaluation period. The decision to manage or to peg their exchange rates is based on their belief that a currency board is advantageous for small open economies. There are also 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 of the motivation for the policy switch, the newly adopted policy rule in the aforementioned cases is usually some sort of nominal exchange rate peg.

Many papers 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 either 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 regimes without allowing for any change in the form of the rule. Such studies are considered to be static in the form of the rule. This static comparison does not determine if it is worth switching to another policy rule and omits the transition period.

* The views expressed in this article are those of the author and do not necessarily reflect those of the Czech National Bank.

The aforementioned points motivate this paper's focus on the analysis of the behavior of a small open economy over the transition period toward a regime of low exchange rate volatility. An important issue is how the announcement of the adoption of the new regime affects the properties of the business cycles of a small open economy.

In this paper, these issues are addressed using a standard stochastic general equilibrium model of a small open economy (Justiniano and Preston, 2004) extended to include an information buffer to model an announced monetary policy regime switch. The standard model, with only tradable goods, uses Calvo-type rigidities, as do more complex models. To make the analysis more specific, the large economy is identified as the euro area and the small open economy as the Czech Republic. The Czech Republic is representative of a country that may adopt the euro and is also coping with the limitations of its own independent monetary policy. To provide a detailed description of the Czech Republic's monetary policy, the model is closed by a policy rule based on the inflation forecast. Also, the structural parameters of the model are estimated for the Czech Republic.

The innovation presented in this paper is the approach to modeling the transition period after the change in the monetary regime type is announced. As Farmer, Waggoner, and Zha (2007) summarize, recent studies rely on Markov switching processes to account for policy rule changes. Markov switching models compute the solution as an average of separate models weighted by the probability matrix of the process. Instead of the Markov switching process, the standard model is extended to include a binary regime indicator that identifies the active type of monetary policy. Moreover, in the simulations the change in the regime indicator is credibly announced in advance. Therefore, the model with this indicator offers an alternative approach that models the commitment to the regime change more closely than models based on the Markov process.

For the analysis of macroeconomic stability over the transition, it is assumed that the monetary authority follows the optimal policy with respect to the ad-hoc loss function, as in Laxton and Pesenti (2003) and Santacreu (2005). Furthermore, Cuchi-Curti, Dellas, and Natal (2008) and Dellas and Tavlas (2003) summarize that there is no straightforward recommendation for the optimal policy type. The optimal policy choice depends on many factors, such as the presence and origin of rigidities and structural shocks. Therefore, the parameters of the optimal policy, which reacts to deviations in the output gap and expected inflation and changes in the nominal exchange rate, are identified.

Moreover, as pointed out, the simple form of the optimal policy avoids questioning the information capabilities of the monetary authority. To identify the simple optimal monetary policy for the transition period for various preferences regarding inflation, output, and policy stability, the utility has one degree of freedom, as in Santacreu (2005). Furthermore, under the optimal rule it is important to know how the regime change affects the characteristics of business cycles. To analyze these changes, the correlations of business cycles are assessed.

The rest of the paper is organized as follows. Section 2 presents the model and its extension. In Section 3, the parameter estimation is presented. The basic characteristics and properties of the model are presented in Section 4. Sections 5–7 present the macroeconomic stability results, policy implications, and conclusions. All *figures* and *tables* can be found in the *appendix sections*.

2. The Model

The basics of the model are taken from Justiniano and Preston (2004). The model consists of a small open economy (domestic) and the rest of the world (foreign).[1] The domestic economy is characterized by the existence of habit formation and indexation of prices to inflation. The fundamental model is based on Gali and Monacelli (2005) and Monacelli (2005), where the micro-foundations for the small open economy model are summarized. The modification of monetary policy and the approach to modeling the transition period are described in a separate subsection.

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

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

where β,0<β<1, is the utility discount factor; σ and φ are the inverse of the elasticities of 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, where $\varepsilon_t^g \sim N(0, \sigma_t^2)$; C_t is the consumption of a composite good; and $H_t = hC_{t-1}$ is the external habit, taken as exogenous by the 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:

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

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.

The real exchange rate is defined as the ratio of foreign prices in domestic currency to domestic prices $\Delta q_t \equiv \Delta e_t \left[\left(P_t^*\right) / \left(P_t\right) \right]$, where Δe_t is the nominal exchange rate (in terms of domestic currency per unit of foreign currency), P_t^* is the foreign consumer price index, and P_t is the domestic consumer price index. An increase in Δe_t coincides with a depreciation of the domestic currency. It is assumed that $P_t^* = P_t^{F^*}$ ($P_t^{F^*}$ is the price of the foreign good in foreign currency), so the law of one price gap is given by $\Psi_t^F = \Delta e_t \left[\left(P_t^*\right) / \left(P_t^F\right) \right]$, as in Monacelli (2005). Under the assumption of complete international financial markets, arbitrage implies that the marginal utility of consumption in the foreign economy is proportional to that in the domestic economy and the uncovered interest rate parity (UIP) condition can be derived.

[1] Throughout this paper the superscript * denotes the "foreign" equivalents of domestic variables.

The nominal rigidities driving price adjustment occur due to monopolistic competition in the goods market. Suppose that a typical firm i in the home country produces a differentiated good according to the following production function:

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

where $N_t(i)$ is the labor supplied by the 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. According to the production function, the representative firm faces real marginal costs $MC_t = \left[(W_t)/(P_t A_t)\right]$, where W_t is the nominal wage and the domestic inflation rate is defined as $\pi_t^H = \log\left(P_t^H / P_{t-1}^H\right)$. Firms producing the domestic good are monopolistically competitive with Calvo-style price setting using inflation indexation:

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

where $0 \leq \delta < 1$ is the degree of indexation.

Similarly as in domestic goods production, the nominal rigidities in the foreign goods sector result from staggered price setting and monopolistic competition. Foreign goods 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 goods prices, which is defined as $\pi_t^F = \log\left(P_t^F / P_{t-1}^F\right)$. The foreign goods importers use the same form of indexation rule and the same degree of indexation δ as domestic producers.

2.1 A Log-Linearized Model

The approximation around the non-stochastic steady state closely follows Justiniano and Preston (2004), therefore the following equations provide just a summary of the model equations. For any variable, lowercase letters denote the log-deviation from the steady state of their uppercase counterparts in the frictionless equilibrium. A zero-inflation steady state is assumed, so that
$\pi_t = \left[(P_t/P_{t-1})\right] = \left[\left(P_t^H / P_{t-1}^H\right)\right] = \left[\left(P_t^F / P_{t-1}^F\right)\right] = 1$, and $1 + i_t = [1/\beta]$.

Linearizing the domestic goods market clearing condition together with the demand functions implies:

$$(1-\alpha)c_t = y_t - \alpha\eta(2-\alpha)s_t - \alpha\eta\psi_t^F - \alpha y_t^* \qquad (3)$$

where $\psi_t^F = \left(e_t + p_t^*\right) - p_t^F$ 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. Time differencing of the terms of trade definition implies:

$$\Delta s_t = \pi_t^F - \pi_t^H \qquad (4)$$

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

$$q_t = \psi_t^F - (1-\alpha)s_t \tag{5}$$

The log-linear approximation of the optimality conditions of domestic firms for price setting and the law of motion for the domestic producers' price imply the following hybrid Phillips curve:

$$\pi_t^H - \delta\pi_{t-1}^H = \frac{1-\theta^H}{\theta^H}\left(1-\theta^H\beta\right)mc_t + \beta E_t\left[\left(\pi_{t+!}^H - \delta\pi_t^H\right)\right] \tag{6}$$

where the marginal costs are:

$$mc_t = \varphi y_t - \left(1+\varphi\right)a_t + \alpha s_t + \sigma\left(1-h\right)^{-1}\left(c_t - hc_{t-1}\right) \tag{7}$$

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 the labor choice. Similarly, the optimality condition for the pricing problem of retailers results in the following Phillips curve:

$$\pi_t^F - \delta\pi_{t-1}^F = \frac{1-\theta^F}{\theta^F}\left(1-\theta^F\beta\right)\psi_t^F + \beta E_t\left[\left(\pi_{t+!}^F - \delta\pi_t^F\right)\right] \tag{8}$$

Following the arguments of Justiniano and Preston (2004) and the derivation by Gali and Monacelli (2005) the complete markets assumption implies:

$$c_t - hc_{t-1} = y_t^* - hy_{t-1}^* + \sigma^{-1}\left(1-h\right)\left[\psi_t^F + \left(1-\alpha\right)s_t\right] + \sigma^{-1}\left(1-h\right)g_t \tag{9}$$

The log-linear approximation of the uncovered interest rate parity gives $i_t - i_t^* = E_t\Delta e_{t+1}$. However, there is a lot of empirical evidence that the uncovered interest rate relation can be violated. Therefore, as in Kollman (2002), a risk premium shock $E_t, E_t = \rho_s E_{t-1} + \varepsilon_t^s$, where $\varepsilon_t^s \sim N\left(0,\sigma_s^2\right)$ captures deviations from purchasing power parity not already explained endogenously by imperfect pass-through, such as a time-varying risk premium, is added to the log-linearized form of the model. The following equation can be derived:

$$\left(i_t - E_t\pi_{t+!}\right) - \left(i_t^* - E_t\pi_{t+!}^*\right) = E_t\Delta q_{t+1} + \varepsilon_t \tag{10}$$

The risk premium shock ε_t is zero in the steady state, and the equation collapses to a standard uncovered interest rate parity equation. Finally, the approximations of the price level and the change in terms of trade give the following relation:

$$\pi_t = \pi_t^H + \alpha\Delta s_t \tag{11}$$

Since the goods produced in the home economy represent only a small fraction of the foreign economy's consumption, the foreign economy is considered to be large and exogenous to the domestic economy. As in the literature on small open economies (Gali and Monacelli, 2005), it is assumed that the paths of foreign variables π_t^*, y_t^*, and i_t^* are described by the following backward-looking VAR process:

$$\pi_t^* = \omega_\pi^\pi \pi_{t-1}^* + \omega_y^\pi y_{t-1}^* + \omega_i^\pi i_{t-1}^* + \varepsilon_t^\pi \tag{12}$$

$$y_t^* = \omega_\pi^y \pi_{t-1}^* + \omega_y^y y_{t-1}^* + \omega_i^y i_{t-1}^* + \varepsilon_t^y \tag{13}$$

$$i_t^* = \omega_\pi^i \pi_{t-1}^* + \omega_y^i y_{t-1}^* + \omega_i^i i_{t-1}^* + \varepsilon_t^i \tag{14}$$

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

2.2 Monetary Policy for the Transition Period

The description of the model is closed with a description of the behavior of the domestic monetary authority. Here, the model deviates from Justiniano and Preston (2004) in the form of the monetary policy rule. The model of the transition period is not closed by the monetary policy rule alone, but is extended to include an information buffer. The following section describes the policy rule, the buffer, and the simulation of the transition.

First, the policy rule responds to expected inflation one period ahead. Assume that at time $t=1$ it is announced that the regime will change in period T, $T > 1$. Second, assume that the parameters of the policy rule (a Taylor-type rule) do not change over all periods of the transition, $t \leq T$. Third, the only objective of the post--transition monetary policy $t \geq T$ is to offset all the foreseen changes in the nominal exchange rate. To simulate the announcement of the regime change at time T, the indicator $regime_t$ is defined as follows:

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

The indicator $regime_t$ is used to indicate the type of monetary policy rule for the model of the transition. The indicator transforms the problem of modeling an announced change into a problem of foreseen changes in $regime_t$. The monetary policy rule for the model of the transition takes the following form:

$$\begin{aligned} i_t = {} & regime_t \left(\rho_i i_{t-1} + \rho_\pi E_t\left[\pi_{t+1}\right] + \rho_y y_t + \rho_e \Delta e_t + \varepsilon_t^m\right) \\ & + \left(1 - regime_t\right) \hat{\rho}_e \sum_{j=t}^{\infty} \left(\frac{1}{2}\right)^{j-t} \Delta E_t\left[e_j\right] \end{aligned} \tag{15}$$

where $0 \leq \rho_i < 1$ describes interest rate smoothing, $\rho_\pi > 1$, $\rho_y > 0$, and $\rho_e \geq 0$ are weights describing the responses of the domestic monetary authority to deviations in inflation and output and change in the exchange rate, and $\varepsilon_t^m, \varepsilon_t^m \sim N\left(0, \sigma_m^2\right)$, is the monetary policy shock. Variations in parameters ρ_π, ρ_y, and ρ_e allow us to describe a wide range of monetary policy types for the transition ($t < T$). The post--transition monetary policy is described by $\Delta\rho_e$, which measures the offsetting of the change in the nominal exchange rate. To keep the level of exchange rate volatility reasonably low, it is set to $\Delta\rho_e$=2.0.

To close the model of the transition, an information buffer capable of storing information for N periods ahead is added to the model, where $N > T$. This information buffer takes the following form:

$$\begin{aligned} regime_t &= inf_{t,1} \\ inf_{t,1} &= inf_{t-1,2} + v_{t,1} \\ inf_{t,2} &= inf_{t-1,3} + v_{t,2} \\ &\dots \\ inf_{t,N} &= v_{t,N} \end{aligned} \tag{16}$$

where $inf_{t,i}$, $i = 1,...,N$, are the new variables, and $v_{t,i}$, $i = 1,...,N$, are the announcement shocks, such that $v_{t,i}$ takes values of 0 and 1 for all $i = 1,...,N$ and $t > 0$. The initial condition for the buffer is $inf_{0,i} = 0$ and $v_{0,i} = 0$, $i = 1,...,N$.[2]

Further, it is also assumed that there are no shocks (for $t \geq T$) to the risk premium after the regime of offsetting exchange rate changes is adopted. So, the risk premium shock E_t in equation (10) will follow $E_t = \rho_s E_{t-1}$ for $t \geq T$. To make this foreseen in the model of the transition, the risk premium shock follows $E_t = \rho_s E_{t-1} +$ $+ regime_t \varepsilon_t^s, \varepsilon_t^s \sim N\left(0, \sigma_s^2\right)$.

The announcement of the regime change at $t = 1$ is simulated by setting up the information shocks $v_{t,i}$, $i \in 1,...,N$, as follows:

$$v_{1,it} = \begin{cases} 1, \text{if } i < T \\ 0, \text{if } i \geq T \end{cases} \tag{17}$$

and $v_{t,I} = 0$, $\forall\, i$ and in all subsequent periods t, $1 < t \leq T$. This set-up of information shocks describes the announcement of a monetary policy regime switch in period T. As this paper is focused on perfectly credible announcements, $v_{t,i}s$ are random variables with zero mean and zero variance. However, a possible extension is to model the uncertainty of the commitment to change the regime by the use of non--zero variance for information shocks $v_{t,i}$. The higher the uncertainty about keeping commitments, the higher the value of the information shock variance.

3. Estimation

The parameters of the model are estimated using a Czech data sample. Due to the short span of the Czech data sample, Bayesian estimation is preferred because it allows for the incorporation of information from previous studies in the form of informative priors. The use of informative priors delivers more stable estimation results. Also, simulated posterior distributions are used to evaluate the sensitivity of the results with respect to the choice of priors and estimation settings.

The data sample covers the period of CPI inflation targeting from its introduction in 1998 until the third quarter of 2007. Changes in the inflation target occurred in this period. However, the nature of the regime was not changed, so this

[2] The construction of the policy indicator $regime_t$ introduces non-linearity into the model. Therefore, to solve and simulate the model of the transition, second-order approximation is used. The model is solved by Dynare++. A brief description of the computation of the transition period model is presented in *Appendix A*.

does not lead to structural changes. All data in the estimation are taken from the Czech National Bank database and are seasonally adjusted. The series are HP de-trended.

The domestic block of the underlying model is estimated using the de-trended data on output growth, inflation, the nominal interest rate, the 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 the sum of trade partners' series weighted by export shares.

The model variables are expressed in percentage deviations from the steady state. The data series are related to the model variables via a block of measurement equations. The measurement block connects the model variables with the observed data using the measurement errors. As Ruge-Murcia (2007) summarizes, the use of measurement errors sidesteps stochastic singularity and is helpful in limiting the effect of misspecification on the parameter estimates in the estimation framework used. The measurement block structure and the calibration of measurement error volatility ensure that the contribution of the measurement errors to the overall variance is low in comparison with the structural shocks.

The choice of parameter priors is derived from previous studies (Lubik and Schorfheide, 2003; Nataluccci and Ravenna, 2002; 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 and interval constraints. The standard deviation of the priors also reflects beliefs about confidence in the priors, so loose priors rather than tighter ones are used. *Tables 1* and *2* in *Appendix B* provide an overview of the choice of priors.

For the estimation it is assumed that $\beta = 0.99$ (strict prior), which implies an annual interest rate of about 4% in the steady state. The model for the estimation is closed by the simple monetary policy rule given as follows:

$$i_t = \rho_i i_{t-1} + \rho_\pi E_t[\pi_{t+1}] + \rho_y y_t + \rho_e \Delta e_t + \varepsilon_t^m \tag{18}$$

and the risk premium process as given by equation (10) is used.

3.1 Estimation Results

The estimation results are summarized in *Tables 1* and *2*. 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 the steady state ratio of domestic to foreign goods in the domestic consumption basket. These values are very close to the estimates by Nataluccci and Ravenna (2002) and Musil and Vašíček (2006), which are based 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 goods substitution η, because it indicates a low willingness of households to substitute domestic for foreign goods.

The value 0.92 of the inverse elasticity of inter-temporal substitution σ implies an inter-temporal elasticity of 1.08. This elasticity value 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 the inverse elasticity of labor substitution, σ = 1.08, implies inelasticity of the labor supply. This value is consistent with the low labor mobility that characterizes the Czech labor market, especially at the beginning of the period considered.

According to the policy rule estimation results, interest rate smoothing ρ_i takes a value of 0.58. The weights of inflation and output gap deviations are 1.38 and 0.47, respectively. These values reveal that the monetary authority places a 2.9 times greater weight on keeping future inflation stable than on closing the output gap. The low value of the reaction to changes in the nominal exchange rate ρ_e reflects the inflation targeting focus of the Czech National Bank.

The priors for the price stickiness parameters, θ, are chosen based on Lubik and Schorfheide (2005) and reflect the evidence on US prices. The prior value of price indexation to inflation is set to 0.70, although studies exist where the indexation value is set to unity. The results show that a high fraction of domestic firms (the estimate of θ_H takes the value 0.26) optimize their prices every quarter. This is consistent with the estimates using 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 around four quarters. The value of inflation indexation δ means that the price of the good is updated by half of the price level change, this seems consistent with the frequent price re-optimization.

High persistence of technological, risk premium, and preference shocks is assumed. However, the estimates show that the most persistent shock is the preference shock, with a value of 0.95 for ρ_g. This indicates that the impacts of these shocks are near permanent. The persistency of the technological shock (0.83), with its large standard deviation, reflects the brisk structural changes of Czech industry over the period considered.

In the foreign economy, the autocorrelation of foreign shocks is assumed to be 0.7 (Natalucci and Ravenna, 2002), while the values of Justiniano and Preston (2004) are quite low. However, the estimation results show little persistence in the foreign inflation series. The foreign monetary policy described by the equation reveals persistence close to the prior value, thus indicating significant interest rate smoothing in the Eurozone. Only the foreign output series reveal persistence higher than the prior values, and the value of 0.93 is in accordance with estimates for developed economies such as the USA.

The priors and the estimates of the standard deviation of structural shocks are summarized in *Table 2*. These results show that the preference shock ε_t^g is the most volatile. However, the preference shock is the main driving force of the fluctuations. Using variance decomposition, it is identified that the preference shock generates only 7.5% of the inflation volatility, 4.5% of the output growth, and 7.3% of the nominal interest rate variance. Due to the high value of openness, the risk premium shock generates 26% of the domestic CPI inflation variance. However, for the estimated coefficients, the variance decomposition shows that the foreign shocks are not the main drivers of the volatility in domestic variables. The shocks to foreign inflation and interest rates are responsible for approximately 11.3% and 2.8% of the domestic inflation variance, respectively.

To evaluate the empirical properties of the generic model, *Table 3* in *Appendix B* compares the moments of the time series used for the estimation with the 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 contained in the observed series, the prior and posterior distributions are compared. It can be concluded 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 to the estimated model (the model with the monetary policy rule (15)). Therefore, the models of the announced change in monetary policy are calibrated with the same parameter values as the benchmark model. *Figures 2–7* in *Appendixes C–E* present impulse response functions of the following four models: the estimated model (dash-dotted line) and the model of a switch in 4 (solid line), 8 (dashed line), and 40 (dotted line) periods. The results are presented as quarterly percentage deviations from the steady state.

Figure 1 in *Appendix C* depicts the responses to a 1% deviation in the domestic technology shock ε_t^a. This supply shock increases output and reduces inflation. Via the uncovered interest rate parity, the inflation reduction is accompanied by a currency appreciation and an interest rate decrease. The currency appreciation and lagged update of imported goods prices eliminates importers' profits. However, an update of imported good prices together with slowing currency appreciation restrains the rise in demand for the foreign good. As inflation in the imported goods sector rises, the steady state is established.

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

Figure 2 in *Appendix C* presents the responses to the domestic taste shock ε_t^g This demand shock increases domestic inflation and output. Due to the initial currency appreciation, which results from an expected hike in interest rates, importers lower the prices of their goods. The imported goods become cheaper and this supports an increase in demand for the foreign good. Due to output rigidities, the increase in output follows with a lag. In response to the inflation and output increases, the domestic monetary authority increases the interest rate. Due to the price indexation of import prices to CPI inflation, importers enjoy profits.

For the estimated model, the import price decrease is larger than in the case of the model of a switch and this makes households increase their demand for the foreign good. This result follows from the reaction of the monetary authority, which cannot rely on the expectations formed on the basis of exchange rate stabilizing policy. Moreover, the extent of these deviations is very small.

5. Macroeconomic Stability

A focus on macroeconomic stability is used as the standard approach to the evaluation of monetary policy. This approach simplifies the analysis because of its independence of the welfare function specification, and it offers interesting comparisons, as 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 the 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.

For the purpose of loss evaluation, the traditional form of the per-period loss function is used (as in, for example, Laxton and Pesenti, 2003, and Santacreu, 2005):

$$L_t = \tau \mathrm{Var}(\pi_t) + (1-\tau)\,\mathrm{Var}(y_t) + \frac{\tau}{4}\mathrm{Var}(\Delta i_t) \tag{19}$$

where $\tau \in <0,1>$ is used to describe the preferences of the monetary authority about inflation, output, and interest rate stability. To compute the loss over the transition, β is used as the discount factor and the overall loss is computed as the discounted sum of per period losses. Using the loss function, the optimal policies that minimize the value of the loss by the choice of weights ρ_i, ρ_π, ρ_y, and ρ_e for the monetary policy rule given by equation (15) are identified.

In this experiment, the variances from the estimated model are used as the initial conditions for recursive computation, as described in *Appendix A*. Furthermore, the optimal policies for various lengths of transition are computed and the preferences of the monetary authority are computed. It can be observed that a longer transition period leads to lower loss values.

Figure 3 in *Appendix D* shows the parameters of the optimal policy rule for the transition period as a function of transition length and preference specification. The plot for the interest rate smoothing parameter ρ_i shows that for all transition periods, policy rigidity increases steeply as inflation stability gains greater weight. The plot for the choice of the inflation targeting parameter ρ_π does not show much variance over the transition lengths considered. Intuitively, as the focus on inflation stability in the loss function increases (τ increases), ρ_π also increases.

Furthermore, for ρ_y the value of output gap targeting varies across 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 the change in nominal exchange rate targeting, while as preferences shift toward 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 foreign inflation movements. At the same time, changes in the exchange rate can affect domestic output via foreign demand. Therefore, to avoid an increase in domestic output volatility, ρ_y increases. These results are consistent with the loss function design because the inflation-output volatility tradeoff is embedded.

5.1 Variance Decomposition

As in Collard and Dellas (2002), and in order to better understand the forces that drive changes in business cycle behavior, the change in the origins of the variance is analyzed. The differences in variance decomposition between the estimated model and the model of the post-transition regime ($t \geq T$) provide insights into the variance change. These changes in the variance shock contribution to the volatility of the variables are reported in *Table 4* in *Appendix D*. The changes are computed as the difference between the shock contribution to the total variance of the considered variable (in percent) in the estimated model and that in the model of the post-transition regime. Here, a positive value indicates an increase in the contribution to the 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 the experiment, as 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 the change in the exchange rate shows that the exchange rate operates as a shock absorber in the estimated model. The taste shock ε^g becomes the dominant source of domestic and CPI inflation volatility in the model of the post--transition regime, as the increases of 41.2% and 84.1% show. So, offsetting nominal exchange rate changes makes the stability of inflation significantly more vulnerable to the domestic preference shock, which acts as a demand shock in the estimated model.

As the exchange rate becomes less volatile in the model of the post-transition regime, foreign shocks become the major sources of macroeconomic volatility. The source of volatility in the LOP gap (ψ_t^F) shifts from a domestic preference and monetary shock toward a foreign inflation shock (80.7%) and a foreign interest rate shock (12.9%). This indicates that the profits of importers become very sensitive to shocks originating in the foreign economy in the post-transition period. This also applies to 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 the sources of volatility occurs for domestic interest rates as monetary policy focuses on the exchange rate. For the interest rate, all domestic sources of volatility are eliminated and the volatility is almost fully driven by foreign shocks (an 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 persistence of foreign output and interest rate shocks explains why these shocks generate a large fraction (75%) of the domestic interest rate volatility.

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

5.2 Business Cycle Correlations

The examples in the previous sections show how macroeconomic volatility changes over the transition period. Also, the comparison of the estimated and post-transition regime provides a closer look at the changes in the sources of inflation. As the adoption of low exchange rate volatility 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 4–7* in *Appendix E* show the evolution of the correlations with foreign variables over 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 4*, the correlation between 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 becomes 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 between foreign inflation and the domestic nominal interest rate. This indicates that the monetary authority trades off inflation targeting for exchange rate stability at the end of the transition. After the transition is over, this correlation continues to increase, as the domestic monetary authority has to follow changes in imported goods prices, while these are not absorbed by exchange rate movements.

As shown in *Figure 5*, a steep increase in the correlation between the foreign and domestic interest rate is observed. As the focus of the post-transition regime is a stable exchange rate, domestic monetary policy has to eliminate the pressures for exchange rate change originating from changes in the foreign interest rate, which are transferred via UIP. A steep increase in the foreign interest rate and changes in the nominal exchange rate are also observed. Over the transition, the domestic monetary authority allows for changes in the exchange rate, which help as a shock absorber for foreign shocks. Therefore, the correlation between 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 a steep increase in this correlation is achieved after the regime change. *Figure 5* shows that the domestic monetary authority reacts strongly to changes in the foreign interest rate. Also, domestic output becomes more positively correlated with the foreign interest rate, while

UIP implies greater depreciation pressures in reaction to the increase in the foreign interest rate. However, these changes in correlation are relatively small.

Figure 6 shows the correlation with foreign output. An increase in domestic-foreign output synchronization is observed here as well. These correlation changes are small, while the increase in the CPI inflation-foreign output correlation signals that the price increases in response to higher foreign demand for domestic goods. Therefore, the positive value of the 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. The negative value of the exchange rate-foreign output correlation also shows that the exchange rate helps to absorb the output shock. *Figure 6* also shows a drop in the correlation between domestic nominal interest and exchange rates and foreign output at the end of the transition. This shows that in the last periods of the transition, domestic monetary policy is less contractionary, while the changes in foreign demand are absorbed by the exchange rate.

6. Policy Implications

An important concern of the monetary authority of a small open economy is its influence on inflation and output. *Figure 7* 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 transition lengths are considered, as in the previous section.

The inflation-interest rate correlation drops mainly in the initial and late phases of the transition. The initial drop originates 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 the inflation-interest rate correlation shows that the monetary authority loses control over domestic CPI inflation rapidly in the transition. The second drop in its influence over inflation occurs in the last period of the transition, when monetary policy is at the most contractionary level for output.

Consistent with the experiment design, the interest rate gets more correlated with 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 between output and the interest rate is initially negative, as an increase in the interest rate leads to a contraction of output. As the output-interest rate plot in *Figure 7* shows, monetary policy gains more contractionary power toward the end of the transition. However, after the regime is changed, the increasing interest rate loses its contractionary nature. This loss originates from the nature of the new regime, under which an increase in the interest rate is closely related to depreciation under the post-transition regime, as the interest-exchange rate plot shows.

7. Conclusions

In this paper, the change of monetary policy type is motivated by the possible entry of the Czech Republic into the European Monetary Union and the design of Exchange Rate Mechanism II. The switch to a regime of low exchange rate volatility generally removes the freedom to make individual monetary policy responses.

To analyze the effects of this switch, a model of a credible and foreseen transition toward a low volatility exchange rate regime is created. The model is created by extending the standard model of a small open economy to include a binary regime indicator and an information buffer. The announcement of the change is modeled as the realization of information shocks that enter the information buffer.

The parameters of the model are estimated using data on the Czech Republic. The analysis of moments shows that the estimated model delivers more volatility in the domestic series, but is able to match the characteristics of the foreign series.

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

The business cycle synchronization analysis shows that during the transition there are significant changes in the correlations of inflation, interest rate and exchange rate changes. The correlation between domestic variables and the interest rate shows that in the last period of the transition, the contractionary effect of the interest rate reaches its maximum. After the adoption of the low exchange rate volatility regime, increases in the interest rate become a sign of expansion as a result of the reaction to the expected depreciation.

APPENDIX A

Transition Period Model

The solution of the transition period model is given by equations (3)–(16) and takes the following general form:

$$\mathbf{x_t} = F\left(\mathbf{x_{t-1}}, \boldsymbol{\varepsilon}_\mathbf{t}, \mathbf{v_t}\right), 0 < t \le T$$

where $\mathbf{x_t}$ is the vector of the model variables, $\boldsymbol{\varepsilon}_\mathbf{t} = \left\{\boldsymbol{\varepsilon}_\mathbf{t}^{\boldsymbol{\pi}}, \boldsymbol{\varepsilon}_\mathbf{t}^{\mathbf{y}}, \boldsymbol{\varepsilon}_\mathbf{t}^{\mathbf{i}}, \boldsymbol{\varepsilon}_\mathbf{t}^{\mathbf{a}}, \boldsymbol{\varepsilon}_\mathbf{t}^{\mathbf{m}}, \boldsymbol{\varepsilon}_\mathbf{t}^{\mathbf{g}}, \boldsymbol{\varepsilon}_\mathbf{t}^{\mathbf{s}}\right\}$ is the vector of foreign and domestic structural shocks, $\mathbf{v_t} = \{\mathbf{v_{t,1},...,v_{t,N}}\}$ 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 (the announcement of the future regime change), the system will become linear. The evaluation takes the form given by scheme (17) and $\mathbf{v_{t,I}} = 0$, $\forall\, i$ and for all subsequent periods t, $1 < t \le T$. Therefore, the transition period model with a given transition period length takes the following form:

$$\mathbf{x_t} = \mathbf{A_t x_{t-1}} + \mathbf{B}\boldsymbol{\varepsilon}_\mathbf{t}, 0 \le t \le T \tag{20}$$

where matrices $\mathbf{A_t}$, $t = 0,..., N$, and matrix $\mathbf{B}$ depend on the structural parameters of the model and the transition period length. Matrix $\mathbf{B}$ is time-invariant while the structural shocks are independent. However, for $t1$, $t2 > T$, it follows that $\mathbf{A_{t1}} = \mathbf{A_{t2}}$ because $\mathbf{v_t}$ 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 the evaluation of the information shocks is used to simulate the model and compute the covariance matrices $\mathbf{\Sigma_t}$. To compute the covariance matrix $\mathbf{\Sigma_t}$ recursively, the following formula is used:

$$\mathbf{\Sigma_{t+1}} = \mathbf{A_t}\mathbf{\Sigma_{t-1}}\mathbf{A_t^T} + \mathbf{B}\mathrm{Var}(\boldsymbol{\varepsilon}_t)\mathbf{B}^T, 0 < t \leq T \tag{21}$$

where $\mathbf{\Sigma_0}$ is the covariance matrix from the model estimated on the data, and Var($\boldsymbol{\varepsilon}_t$) is the 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:

$$\mathbf{\Sigma_{t+1}} = \mathbf{A^f}\mathbf{\Sigma_t}\mathbf{A^f}^T + \mathbf{B^f}\mathrm{Var}(\boldsymbol{\varepsilon}_t)\mathbf{B^f}^T, t > T \tag{22}$$

where matrices $\mathbf{A^f}$ and $\mathbf{B^f}$ are taken from the solution of the model with the monetary policy rule given by the equation for $regime_t = 0$.

APPENDIX B

Estimation

The *Tables 1–3* summarize the distribution type and parameter choice (mean and standard deviation) of the prior distributions used to estimate the parameters of the posterior distributions (mode and standard deviation).

Table 1 Estimation Summary: Parameter Values

Variable	Description	Prior			Posterior	
		Distr.	Mean	s.d.	Mode	s.d.
β	Discount factor		0.99			
α	Degree of openness	Beta	0.4	0.1	0.35	0.0
η	Elasticity of F-H substitution	Gamma	1.5	0.5	0.27	0.1
δ	Degree of inflation indexation	Beta	0.7	0.1	0.56	0.1
σ	Inverse elasticity of substitution	Gamma	0.9	0.5	0.92	0.3
φ	Inverse elasticity of labor supply	Gamma	1.5	0.5	1.08	0.5
θ_F	Calvo pricing - foreign	Beta	0.5	0.1	0.22	0.0
θ_H	Calvo pricing - domestic	Beta	0.5	0.1	0.26	0.0
h	Degree of habit formation	Beta	0.8	0.1	0.65	0.1
ρ_i	Interest rate smoothing	Beta	0.5	0.1	0.58	0.0
ρ_π	Response to inflation	Gamma	1.5	0.2	1.38	0.2
ρ_y	Response to output gap	Gamma	0.5	0.1	0.47	0.1
ρ_e	Response to ex. rate change	Gamma	0.1	0.1	0.04	0.0
ω_{11}	Foreign VAR	Normal	0.7	0.3	0.18	0.2
ω_{12}	Foreign VAR	Normal	0.0	0.2	0.1	0.0
ω_{13}	Foreign VAR	Normal	0.0	0.2	-0.14	0.2
ω_{21}	Foreign VAR	Normal	0.5	0.3	-0.07	0.2
ω_{22}	Foreign VAR	Normal	0.7	0.2	0.93	0.1
ω_{23}	Foreign VAR	Normal	-0.1	0.2	-0.09	0.2
ω_{31}	Foreign VAR	Normal	1.5	0.2	0.27	0.1
ω_{32}	Foreign VAR	Normal	0.5	0.2	0.05	0.0
ω_{33}	Foreign VAR	Normal	0.7	0.3	0.58	0.1
ρ_a	Technology - VAR(1)	Beta	0.85	0.1	0.83	0.1
ρ_s	Ex. rate risk - VAR(1)	Beta	0.85	0.1	0.59	0.2
ρ_g	Taste shock - VAR(1)	Beta	0.85	0.1	0.95	0.0

Table 2 Estimation Summary: Standard Deviation of Structural Shocks

Variable	Description	Prior			Posterior	
		Distribution	Mean	s.d.	Mode	s.d.
ε^{π}	Foreign inflation	$Gamma^{-1}$	0.6	0.5	0.18	0.02
ε^{y}	Foreign demand shock	$Gamma^{-1}$	0.3	0.5	0.3	0.03
ε^{i}	Foreign monetary shock	$Gamma^{-1}$	0.3	0.5	0.08	0.01
ε^{a}	Domestic technology shock	$Gamma^{-1}$	0.8	0.5	0.25	0.03
ε^{m}	Domestic monetary shock	$Gamma^{-1}$	0.3	0.1	0.44	0.07
ε^{g}	Domestic preference shock	$Gamma^{-1}$	1.5	0.5	3.07	0.43
ε^{s}	Risk premium shock	$Gamma^{-1}$	1.0	0.5	0.34	0.05

Table 3 Moments Summary

Variable	Data		Model	
	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

APPENDIX C

Impulse Response Functions

Here, the dash-dotted line represents the estimated model; the solid line is for a regime switch in 4 periods, the dashed line is for a regime switch in 8 periods, and the dotted line is for a regime switch in 40 periods. The results are presented as quarterly percentage deviations from the steady state – see *Figures 1–2*.

Figure 1 IRF Comparison – Response to Technology Shock ε^{a}

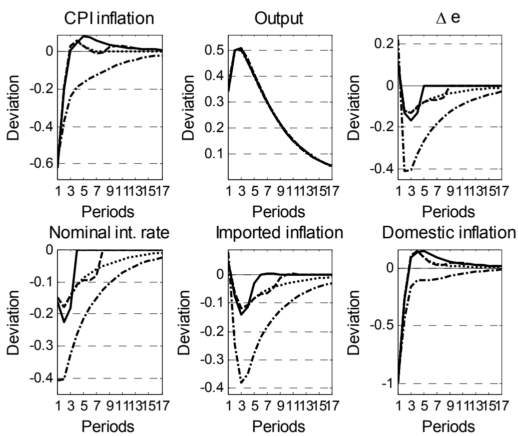
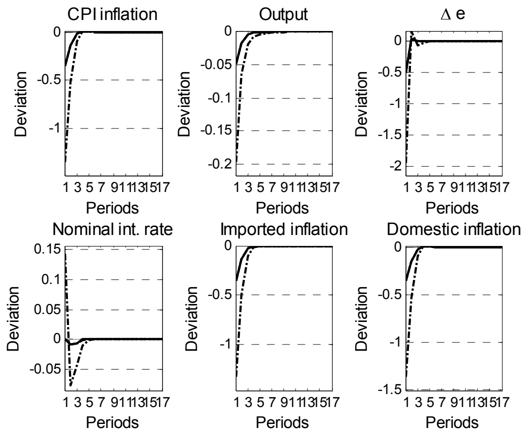


Figure 2 IRF Comparison – Response to Preference Shock ε^g



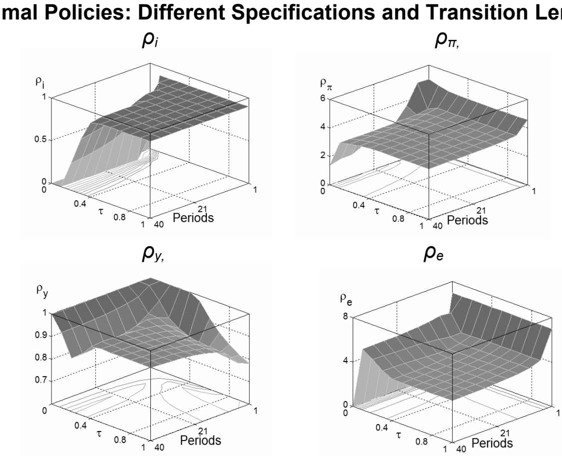
APPENDIX D

Volatility and Loss Evaluation

Table 4 Variance Decomposition: Changes in Variance Decomposition

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^F_t	-2.3	-16.9	-69.1	-10.2	51.0	39.8	7.7
pi^H_t	-3.4	-18.6	41.2	-11.2	0.4	-7.3	-1.1
ψ^F_t	-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

Figure 3 Optimal Policies: Different Specifications and Transition Lengths



APPENDIX E

Cycle Synchronization

Here, the dash-dotted line is for a policy switch in 2 periods, the solid line is for a policy switch in 4 periods, the dashed line is for a policy switch in 8 periods, and the dotted line is for a policy switch in 12 periods. The results are presented as quarterly percentage deviations from the steady state – see *Figure 4–7*.

Figure 4 Correlation π^*_t

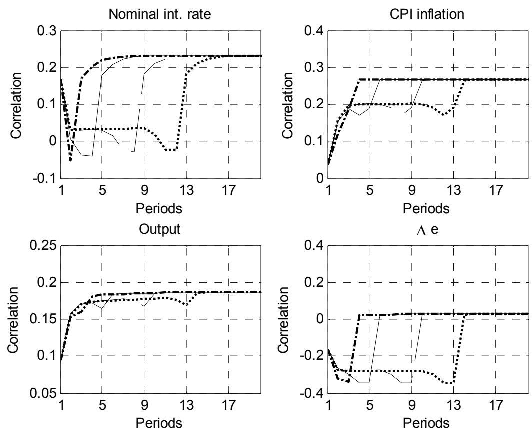


Figure 5 Correlation i^*_t

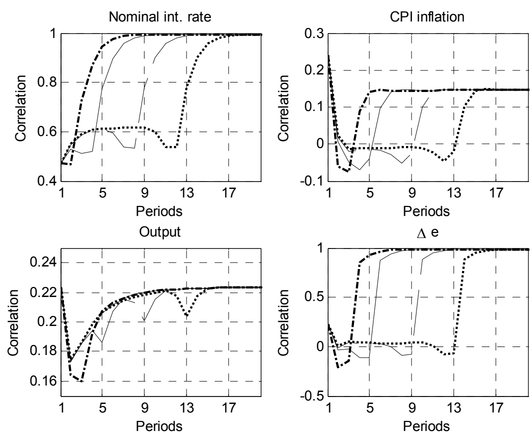


Figure 6 Correlation y^*_t

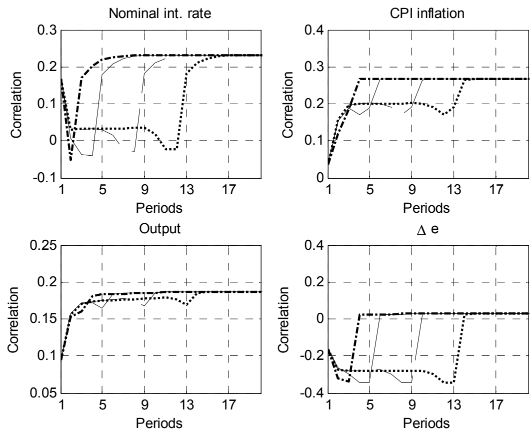
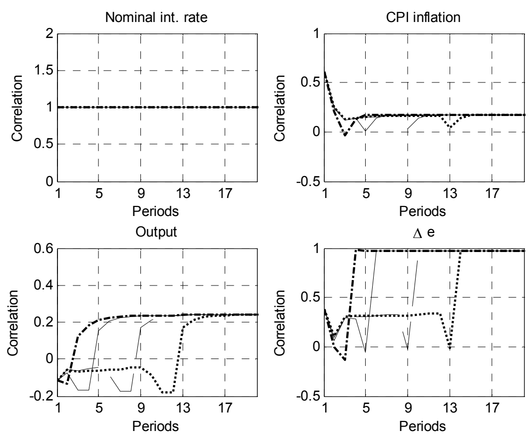


Figure 7 Correlation i_t



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