CHAPTER 7

RESULTS OF THE ESTIMATION AND
IMPULSE RESPONSES ANALYSIS

This chapter introduces the posterior parameter estimates and interprets the estimated value of the parameters in the parameters analysis. In order to analyze the reactions behavior of the Thai economy to specific type of shocks, the impulse response function is also shown in this chapter. Therefore, we developed a small open DSGE model of the Thai economy.

7.1 Posterior Parameter Estimates

Given the data and the prior specification, we generate Markov Chain (MC) containing 100000 draws as seen in the figure 7.1. Parameters of the import ratio (α) and time preference (discount factor β) was fixed: $\alpha = 0.4$ and $\beta = 0.99$.

The posterior estimates of parameters and shocks with 95% probability intervals are reported in Table 7.1
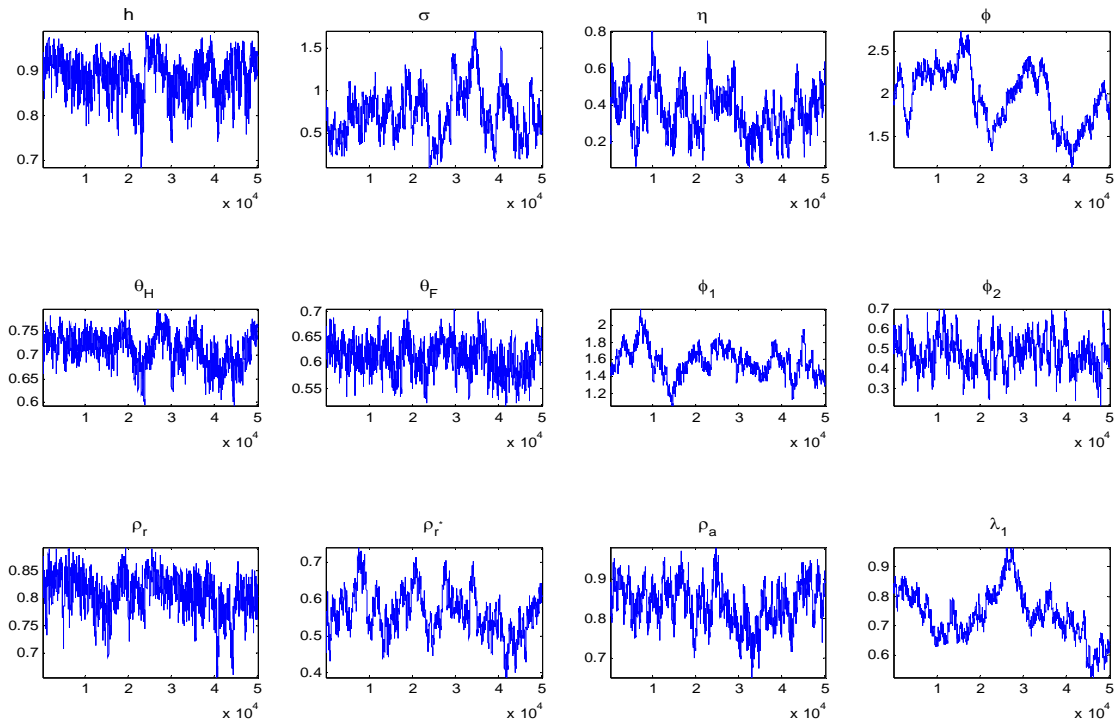
Table 7.1

Posterior Estimates of the Parameters and Innovations

Para-meter	Definition	Prior Mean	Posterior Mean	95% Posterior Interval
h	Habit formation parameter	0.9	0.8214	[0.6608, 0.9820]
σ	Inverse elasticity of intertemporal substitution	1.00	0.9699	[0.1186, 1.8214]
η	Elasticity of substitution between home and foreign goods	1.00	0.5000	[0.0427, 0.9575]
φ	Inverse elasticity of labor supply	1.00	1.6327	[0.5649, 2.7004]
θ_H	Fraction of non-optimizing firms	0.50	0.6424	[0.4916, 0.7924]
θ_F	Fraction of non-optimizing importers	0.50	0.5824	[0.4647, 0.7002]
ϕ_1	Elasticity of interest rate to inflation	1.50	1.6114	[1.0503, 2.1725]
ϕ_2	Elasticity of interest rate to output	0.50	0.4602	[0.2034, 0.7170]

Table 7.1

Posterior Estimates of the Parameters and Innovations (Continued)

Parameter	Definition	Prior Mean	Posterior Mean	95% Posterior Interval
ρ_r	Backward-looking parameter for interest rate	0.50	0.7080	[0.5254, 0.8905]
ρ_r^*	Foreign real interest rate inertia parameter	0.50	0.5774	[0.3784, 0.7765]
ρ_a	Inertia of technology development	0.50	0.7542	[0.5351, 0.9734]
λ_1	Foreign output inertia parameter	0.50	0.7105	[0.4628, 0.9581]
σ_a	Sd. of productivity shock	2.00	3.1191	[0.7027, 5.5354]
σ_s	Sd. of terms of trade shock	2.00	3.7277	[1.0538, 6.4015]
σ_q	Sd. Of real exchange rate	2.00	3.4494	[1.0073, 5.8915]
σ_{π_H}	Sd. of domestic inflation shock	2.00	3.0356	[1.1304, 4.9408]
σ_{π_F}	Sd. of import inflation shock	2.00	1.9656	[0.9769, 2.9543]
σ_r	Sd. of interest rate shock	2.00	1.0035	[0.3032, 1.7037]
σ_{y^*}	Sd. of foreign output shock	2.00	0.8811	[0.4496, 1.3127]
σ_{r^*}	Sd. of foreign real interest rate shock	2.00	1.1086	[0.5704, 1.6468]

Figure 7.1

Markov Chain of the Parameters

7.2 **Parameters Analysis**

The results of the estimation in Table 7.1 show some basic characteristics of the Thai economy. The parameter (α) was calibrated to the value 0.4 which express the import ratio (as imported consumption to the total consumption). The value of the parameter is set to reflect the economic reality and conditions of the Thai economy.[1]

The discount factor (β) was the fixed at the value 0.99 – a household' rate of time preference is relatively high. This means that a representative household believe that the utility from a future consumption is almost the same as the utility from this present period consumption.

A high value of habit formation parameter for consumption (h) implies as the current consumption is importantly influenced by the consumption in the last period (0.82). Justiniano and Preston (2004) find that incorporation of habit formation can have significant implication can substantially alter the autocorrelation of some series.

The elasticity of intertemporal substitution in consumption (σ) is 1.03 (the inverse value of the elasticity is 0.97). The higher the elasticity, the less willingness are households to accept deviations from their pattern of consumption behavior in other words, low willingness of representative household to substitute consumption between two periods. According to the elasticity to be greater than one (relatively high), the representative household is ready to postpone the current consumption to the next period with relatively very low increasing amount of the consumed goods in

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[1] According to the model, consumption consists of the domestically produced goods and imported goods. The total consumption share 0.68% of GDP according to our calculations based on the data from given this period (Q1:2000-Q4:2007). The average GDP is 1,090,952.55 (Million of Baht) and the average import consumption (not include the capital goods) is 472,337.46 (Million of Baht).

Therefore $\alpha = \dfrac{\text{imported consumption}}{\text{total consumption}} = \dfrac{472,337}{0.68 \times 1,090,952.55} \approx 0.4$

We use this value for our calibration.

future which corresponds with the high value of habit persistence. By the way, according to a standard New Keynesian this value varies by 1-3.

The behavior of the household described by the values of parameters β, h and σ seems to be consistent. The representative household has its consumption behavior and does not want to change it. The consumption depends on the last period consumption.

The elasticity of substitution between domestic and foreign produced goods for consumption (η) is 0.500. This relatively low degree of substitutability reflects that the Thai consumption basket relies heavily on foreign produced goods. The value indicates a low possibility of substitution between goods in this study (given US as a foreign country).

The elasticity of labor substitution (φ) is 0.612 (inverse elasticity is 1.6327). It indicates that slight non-elasticity of labor supply. The increase of the real wage by 1% brings only 0.612% increase of labor supply. In addition, the posterior 95% interval implies that the elasticity can take values between 0.56 and 2.70. The international evidence suggests lower elasticity. For example, Smet and Wouters (2003) with U.S. data and Liu (2005) with New Zealand data found posterior medians for φ around 2.90 and 2.60 respectively. However, this is some preference parameters shred by the Thai and U.S. economies, so that its estimate is influenced by U.S. data.

The probability of not changing price in a given period (θ_H) is 0.64 for domestic producer and 0.58 for the importer (θ_F). In other words we can say that 64% of domestic firms and 58% of import firms do not reoptimize their prices every three months. The value of parameter theta can be transformed according to the relationship $1/1 - \theta$ to an average duration. The average duration of the price contracts is almost 3 month (2.8 exactly) for the domestic producers and almost 2 months (2.38 exactly) for import firms.

The inertia of technology development is 0.75. It can be interpreted that every technological shock (new technologies, higher labor productivity) influences the level of the firm's output and the impact is long lasting.

The estimated modified Taylor rule is represented by the following relationship for all t:

$$r_t = 0.70r_{t-1} + (1-0.70)(1.61\pi_t + 0.46y_t) + \varepsilon_t^r \qquad (7.1)$$

The current level of the interest rate is set with respect to the last period interest rate and the real situation in the economy. The value of parameter of backward looking parameter for interest rate is 0.70. The second weight is connected to the changes in inflation and output. The central bank in the regime of the inflation targeting prefers to keep the current inflation at the level of the inflation target. The reaction of the central bank to 1% deviation of the inflation from the inflation target is (1-0.7)x1.61 = 0.48 change of interest rate, however 1% deviation of output from its long run equilibrium (steady state) causes only (1-0.7)x0.46=0.138% change of the interest rate.

The behavior of the foreign economy is described by $\lambda_1 = 0.71$ and $\rho_r^* = 0.57$. The development of the foreign output is relatively high inertia and depends on its last development. It is confirmation that the small open economy in the model is too small to influence the economy in the rest of the world. The development of the foreign real interest rate depends on its last period level.

## 7.3 Impulse Responses Analysis

The impulse response implied by the model can be compared with economic theory. We can study how effective the central bank fights the shock and how long the shock persists in the economy.

In this study, we calculated impulse response using 50000 Markov Chain draws. Figures 7.2 – 7.9 depict the impulse response functions of the economy to a unit increase in the structural and nonstructural shocks (labor productivity, import inflation, domestic inflation, interest rate, real exchange rate, terms of trade, foreign output, and foreign interest rate). In the figure on x-axis is time in quarters, on y-axis is depicted percentage deviation from steady state. The median impulse response are drawn in the solid lines, the dashed lines represent the 95% interval of reliability evaluated at each point of time.

First of all we can see that the figures support our assumption, that the Thai economy is relatively small economy and every shock into domestic variables has negligible impact on foreign (US) variables.

7.3.1 <u>Labor Productivity Shock</u>

Figure 7.2

Impulse Response Functions from One Unit of Labor Productivity Innovation
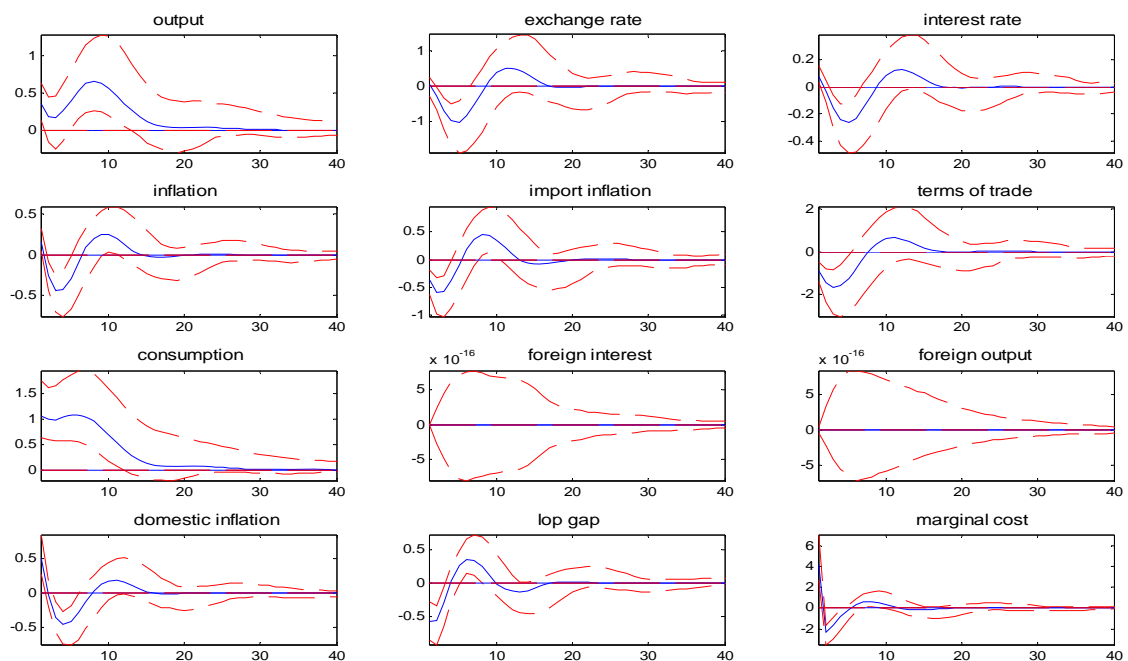
A temporary positive labor productivity shock is depicted in Figure 7.2. As a result of the shock, the marginal costs of the production decrease, which enables to increase the production as increasing in output. Domestic inflation initially falls as the higher productivity helps to reduce the production costs (according to the Phillip curve). The domestic inflation influences the overall inflation and the reaction of the central bank has to be a lower interest rate for bringing the overall inflation back to its target.

The impact on marginal costs is very short (about 2 quarters). The total influence of technology shock on the economy is more important and lasts for a quit long period – more than 15 for output and consumption compared to other shocks.

The long persistence can be explained by the relatively very high value of the estimated productivity shock parameter according to the productivity shock is described by the equation 5.31 with estimated value $\rho_a = 0.754$ $a_t = 0.754_a a_{t-1} + \varepsilon_t^a$

7.3.2 Import Inflation Shock

Figure 7.3

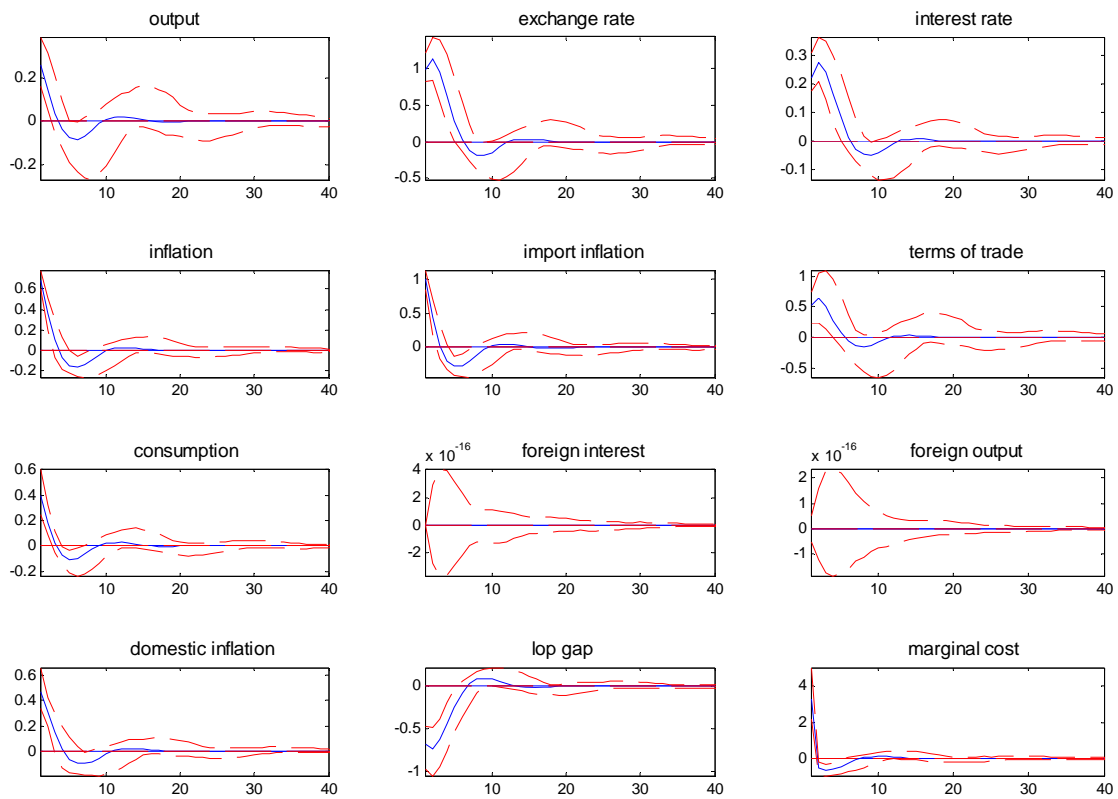Impulse Response Functions from One Unit of Import Inflation Innovation

Figure 7.3 shows the effects of a positive import inflation shock. A higher import inflation means that the price of imported goods becomes higher. It has direct impact on the overall inflation with the appropriate reaction of the central bank It means that the import inflation is increasing, the overall inflation as well as the interest rate increases to reach steady state values.

As a result, higher degree of inflation does not last for a long time and after 5 period the overall inflation is back on its to reach steady state values. The initially increasing interest rate causes an initial appreciation of a domestic currency. Later, the

decreasing interest rate late causes an depreciation of a domestic currency following by the uncovered interest parity condition (UIP). The higher foreign prices relative to domestic prices increase the competitive of the domestic economy (we can see positive initial impact on the TOT prevailing for about 5 quarters). Domestic agents want to consume cheaper domestic goods and substitute out of foreign goods. This has a positive impact on output

7.3.3 Domestic Inflation Shock

Figure 7.4

Impulse Response Functions from One Unit of Domestic Inflation Innovation
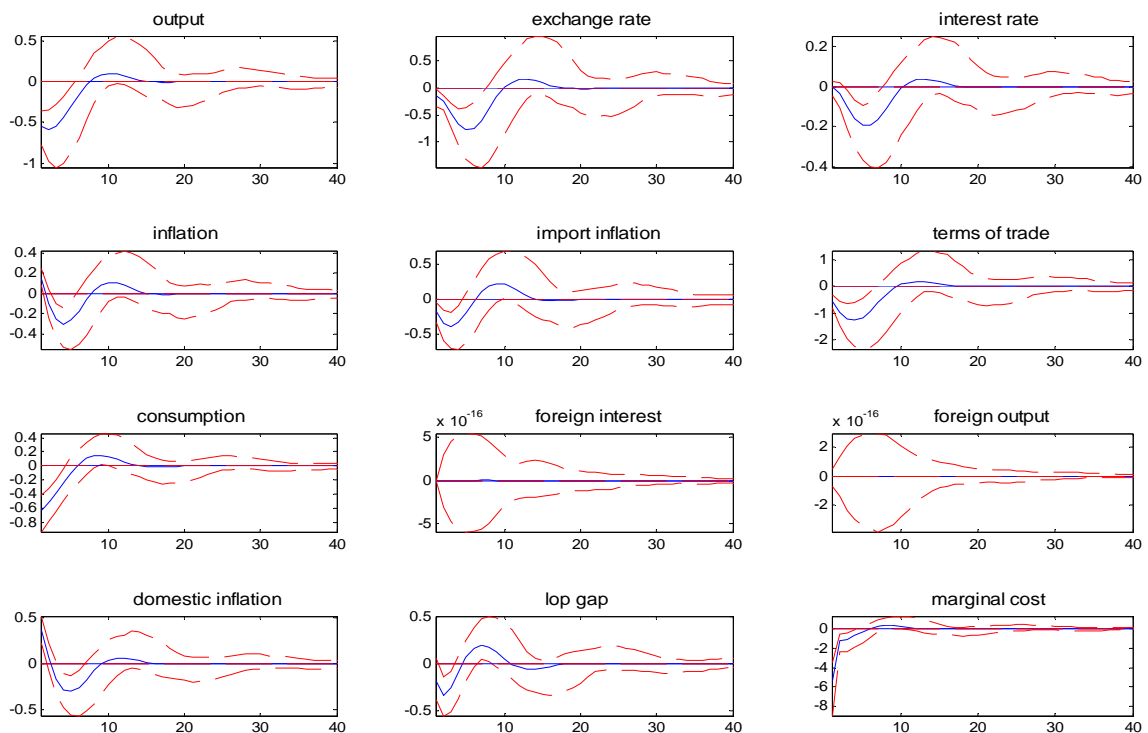
A positive domestic inflation shock is depicted in Figure 7.4. The positive domestic inflation shock influences mainly the terms of trade by a decrease of the degree of competitiveness. As a result this pushes down both output and consumption.

The increasing domestic inflation causes directly the increasing overall inflation but this increase is not so high. According to the monetary authority changes

the interest rate following the inflation target, the decreasing overall inflation leads to the monetary authority decrease the interest rate with delay to recover the economy from the adverse shock. The change in the interest rate induces the depreciation of an exchange rate (a domestic currency) before recovering back 10 quarter later

7.3.4 Domestic Interest Rate Shock

Figure 7.5

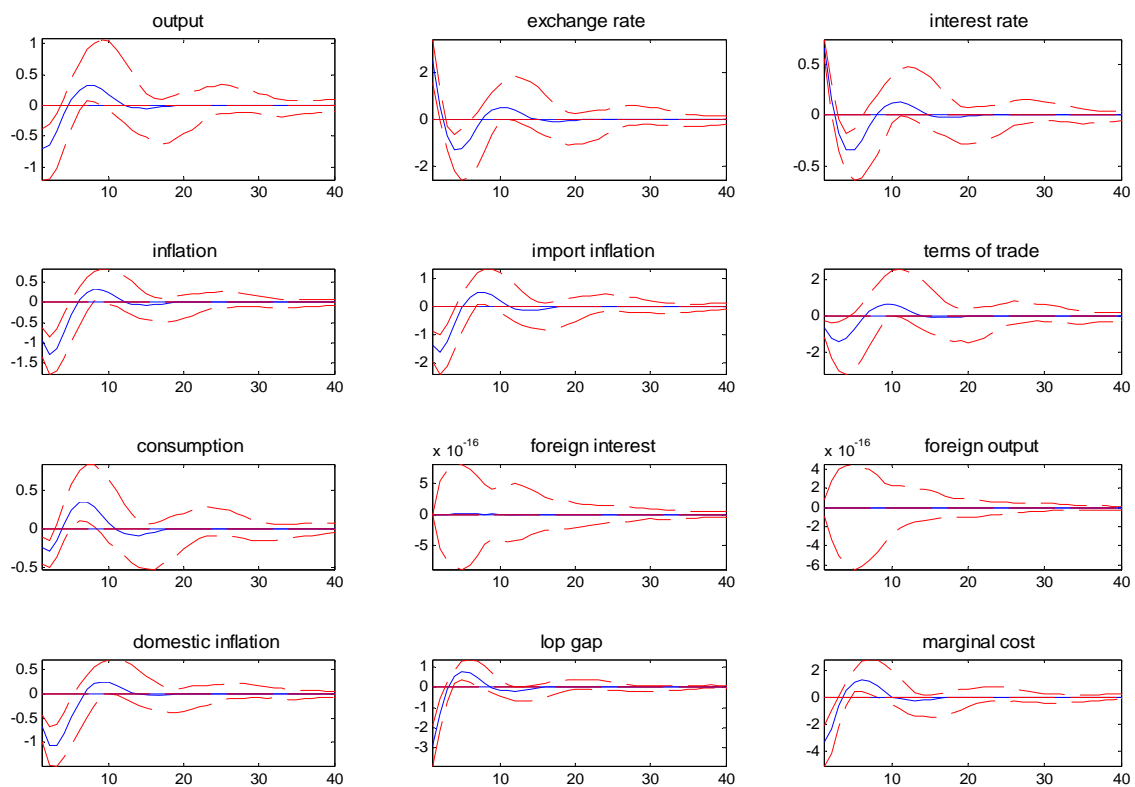Impulse Response Functions from One unit of Interest Rate Innovation

Figure 7.5 shows the effects of a monetary tightening of 1% increase in the interest rate. This assumes that the monetary authority increases the interest rate from one quarter and then reacts using a policy rule. The exchange rate will react to the monetary tightening with great initial appreciation. This has a negative impact on domestic producers, the competitiveness of domestic goods falls. The decrease in consumption is very small and consumption then rises over its initial level with the peak about 5 quarter later.

Negative output together with lower import prices caused by the exchange rate appreciation implies the fall of overall inflation. The decrease of the inflation is the reason of the central bank to decrease the interest rate. This can conclude that the possible monetary shock influences the behavior of all agents very importantly and is undeniable.

7.3.5 Real Exchange Rate Shock

Figure 7.6

Impulse Response Functions from One Unit of Exchange Rate Innovation
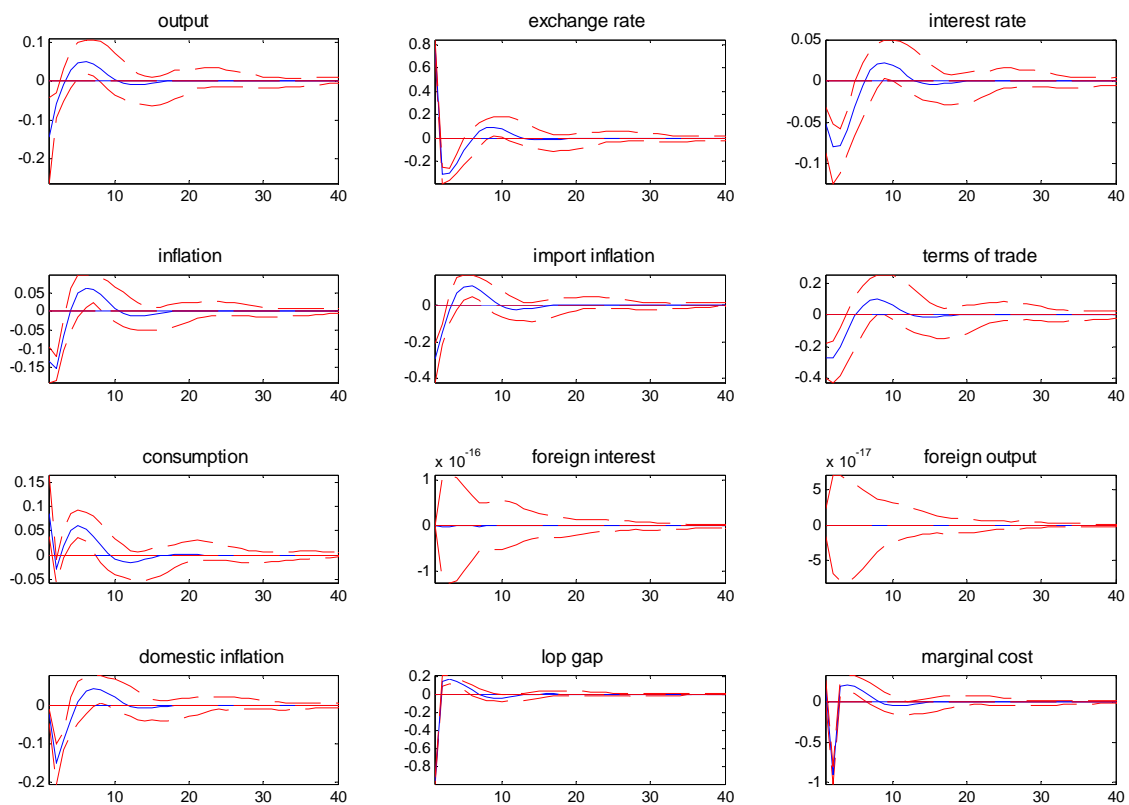
A positive exchange rate shock is depicted in Figure 7.6. After the initial shock, the exchange rate falls rapidly down with its lowest value one quarter. The shock has a relatively short-lived effect on the real exchange rate. After this (only during one period) it starts to appreciate and reaches the steady state in 15 quarters

The appreciation of exchange rate makes the domestic produced goods more expansive on the foreign market. It reduces the domestic firm's output. The strong appreciation influences the import inflation too. The imported goods become more expensive till the exchange rate starts to depreciate. The marginal costs fall caused by the terms of trade and the exchange rate. The overall inflation initially falls returning back. The monetary authority decreases the interest rate to put the inflation back to the target. There is a small monetary expansion. Although lower interest rate has positive impact on consumption, the negative effect of decreased exports dominates in the output determination.

7.3.6 Terms of Trade Shock

Figure 7.7

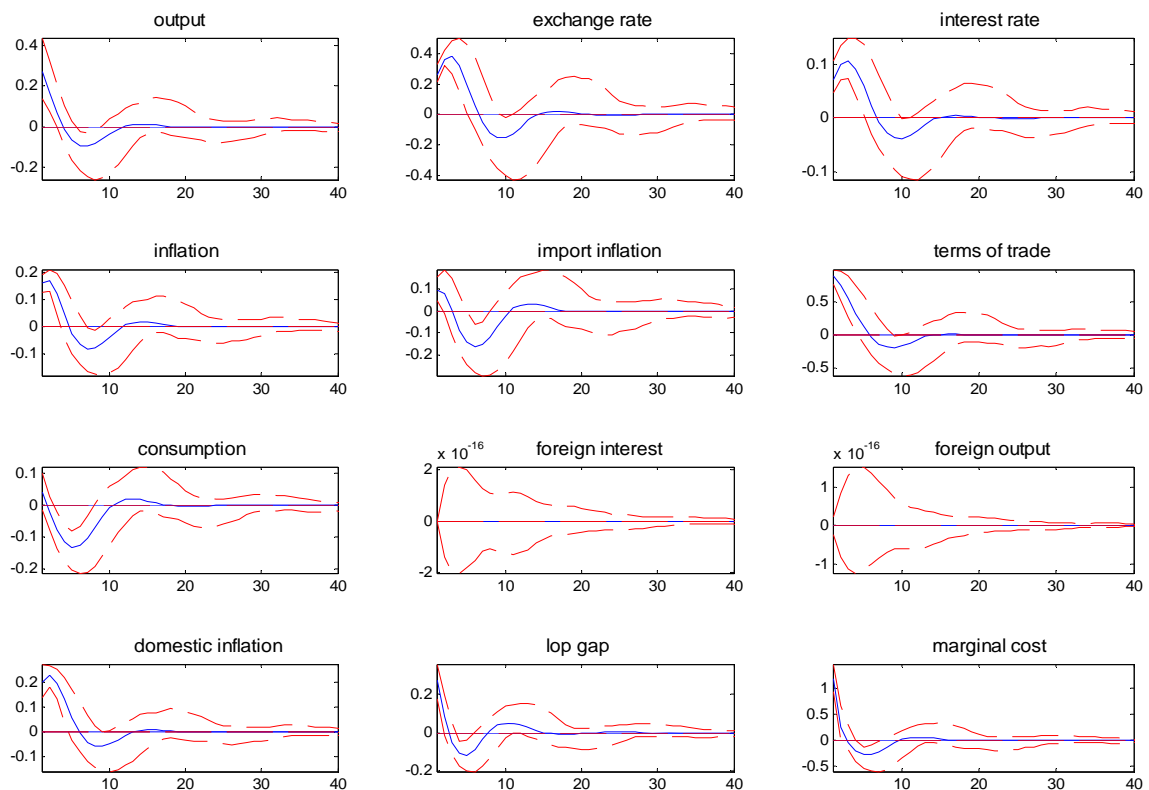Impulse Response Functions from One Unit of Terms of Trade Innovation

Figure 7.7 shows the effects of a temporary positive terms of trade shock It means an increase of the degree of international competitiveness for the domestic economy. This situation motivates the domestic producers to increase their production and export a part of their production. Both variables cause output and inflation to increase. This initial increase is followed by gradual decreasing and both variables reach their lowest value about 8 quarter later. The monetary authority reacts on the higher level of overall inflation and raises nominal interest rate. Higher interest rate causes the fall of consumption, because agents delay consumption till later.

According to the uncovered interest parity condition, the real exchange rate appreciates in reaction to the interest rate increase. The increase in the TOT implies also the rise of the marginal cost and the LOP gap, which both fall down very fast after initial increase. Increasing marginal cost raises the domestic inflation and LOP gap increases the import inflation.

7.3.7 Foreign Output Shock

Figure 7.8

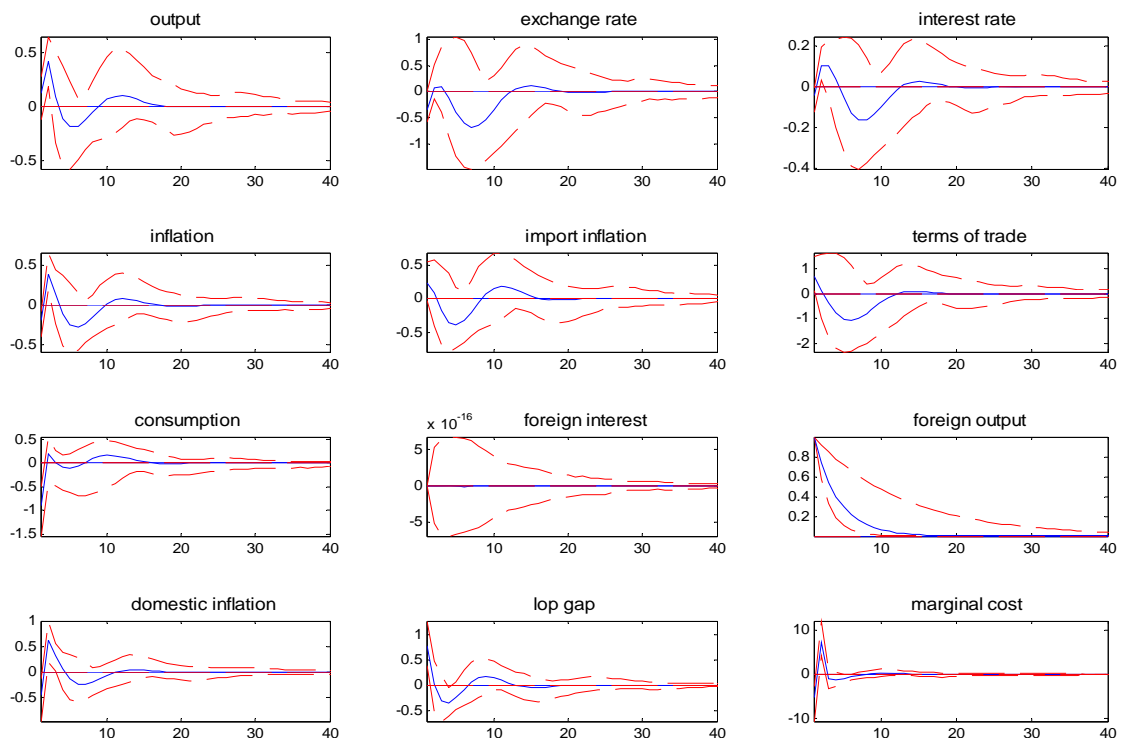Impulse Response Functions from One Unit of Foreign Output Innovation

Figure 7.8 shows the effects of a temporary positive foreign output shock. The higher foreign output enables to increase the domestic production.0.4% because foreign demand for domestic goods rises (exports). Hence, marginal costs of domestic producers and the domestic inflation rise too. Higher domestic inflation influences the overall inflation but not so long period. Initially, the central bank must increase the interest rate in order to stabilize inflation.

7.3.8 Foreign Interest Rate Shock

Figure 7.9

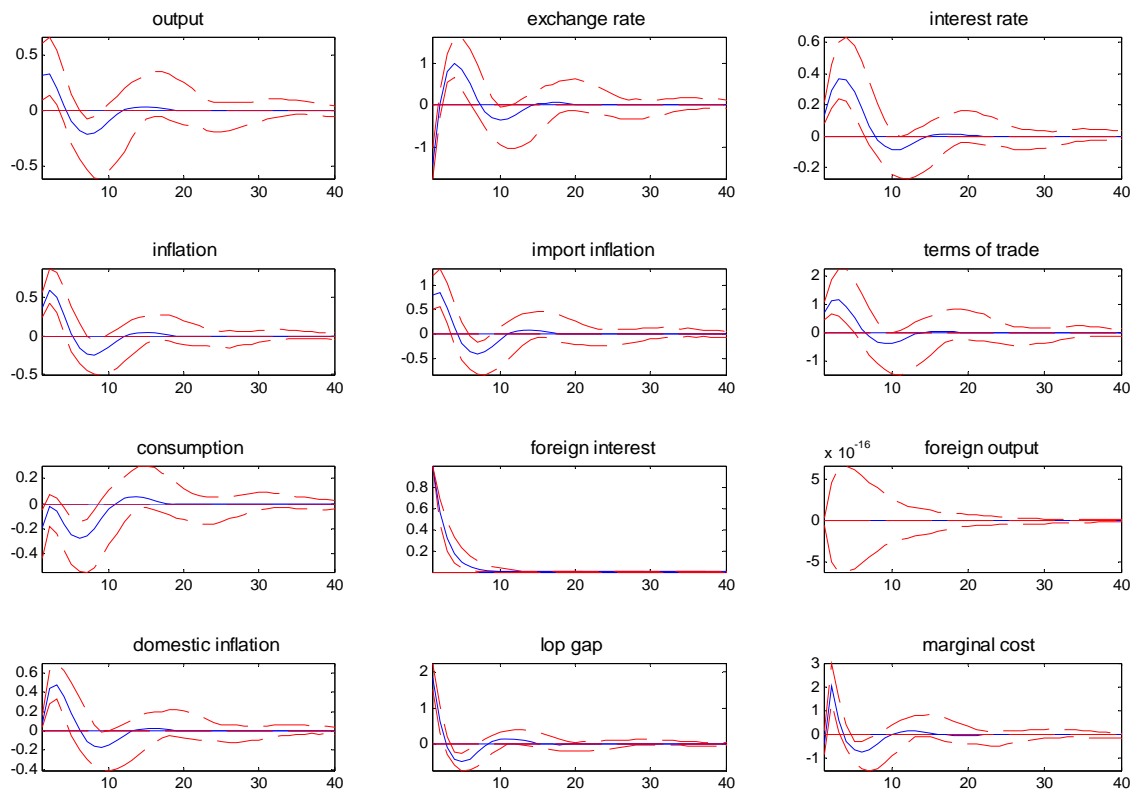Impulse Response Functions from One Unit of Foreign Interest Rate Innovation

Figure 7.9 shows the effects of a temporary positive foreign interest rate shock According to the uncovered interest rate parity condition, the increase of the foreign interest rate by 1% induces depreciation of the domestic currency more that 1%. The exchange rate reaches it steady state when the shock disappears. The

depreciation of the domestic currency influences other variables. It enables to produce and export more goods to the domestic producer. It increases the domestic inflation and marginal costs of production too.

The new value of the exchange rate makes also the imports more expansive for the domestic economy and the import inflation rises. Higher domestic and import inflation cause an increase of the overall inflation by about 0.5%.

According to the modified Taylor rule, the higher overall inflation leads to the increase of the interest rate by central bank. It is necessary to note that the rise in the interest rate is motivated by trying to equal the real domestic and foreign interest rate for the uncovered interest rate parity to hold.

Table 7.2

The Impact of the Different Type of Shocks on Output

Type of Shocks (A temporary positive shock)	Impact on Output	Time Adjustment to Steady State (Quarter)
1. Labor productivity Shock	0.6	25
2. Import Inflation Shock	0.2	15
3. Domestic Inflation Shock	-0.6	13
4. Domestic Interest Rate Shock	-0.6	12
5. Real Exchange Rate Shock	-0.1	12
6. Terms of Trade Shock	0.2	11
7. Foreign Output Shock	0.4	18
8. Foreign Interest Rate Shock	0.3	20

For testing the standard deviations of the real data and estimated data, we adopt HP-Filtered since Q1:2000-Q2:2007 as seen in the table 7.3

Table7.3

Standard Deviations of the HP-Filtered Series

Variable	Standard Deviation	
	Data	**Model**
Output	0.122	0.119
Interest rate	0.144	0.035
Inflation	0.156	0.032
Real exchange rate	0.037	0.155
Import price inflation	0.041	0.054
Consumption	0.077	0.083