Small Inflation Model of Mongolia (SIMOM)

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Bank of Mongolia

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SMALL INFLATION MODEL OF MONGOLIA (SIMOM) †

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ABSTRACT

This paper describes a preliminary version of the small inflation model of Mongolia (SIMOM), a successor of the inflation model built at the Bank of Mongolia (in cooperation with the National Bank of Poland) by Urgamalsuvd Nanjid in July 2007. The model is rooted in theoretical concepts, however – due to the fact that it will be used for regular inflation forecasting at the Bank of Mongolia – it is the empirical adequacy and consistency, which played the most important role in solutions applied while building it. The SIMOM consists of ten estimated equations – domestic currency loan rate and foreign currency loan rate equations, the IS curve, the LM curve, the exchange rate equation, the Phillips curve in terms of the net inflation (excluding food prices and fuel prices), food price dynamics and fuel price dynamics equations as well as approximating (ad-hoc) equations for the real GDP and public wage. In the paper we discuss each equation and present in detail estimation results.

The intended primary use of the model is analysis of the monetary transmission mechanism and the inflation process in Mongolia, estimation of dynamic responses of selected variables to different shocks hitting the Mongolian economy as well as forecasting macroeconomic categories (e.g. exchange rate, output gap, inflation) over a medium term, consistent with the lags in the monetary transmission mechanism.

Conclusions from the paper are the following: Mongolian inflation is driven by a large number of shocks, both internal and external. At the same time the effectiveness of the monetary transmission mechanism is relatively weak (although stronger than previously perceived). The exchange rate channel seems to be the most important channel of monetary transmission mechanism in Mongolia.
I. INTRODUCTION

It is widely recognized that due to the lags in the monetary transmission mechanism, monetary policy actions should be forward-looking. Therefore inflation forecasts constitute extremely important input to the decision making process at central banks. They are also principal communication tool of central banks.

Central banks use many sources of information to predict future inflation rate. For this purpose they usually make inflation forecast by using different types of economic models, characterized by different degrees of theoretical and empirical coherence (Pagan, 2002, 2003). Moreover, central banks – especially inflation targeting ones – collect information on private agents’ (producers’, consumers’, financial markets’) inflation expectations, which affect the inflation process (Łyziak, 2005).

In recent years, the Bank of Mongolia has also paid attention to enlarging the information set used in the decision making process and making it more forward looking. Research studies on the Mongolian economy and econometric models aimed at forecasting macro-economic performance have been developed.

In this paper, we present a new small scale model SIMOM built to analyse features of the monetary transmission mechanism and of the inflation process in Mongolia. Moreover, we formulate some recommendations on the future improvement in terms of modeling and forecasting at the Bank of Mongolia, especially in the context of likely adoption of the inflation targeting strategy in future.

Evaluating the model we took into account the three following characteristics:

- Firstly, we analysed statistical properties of the model equations and their economic consistency.
- Secondly, we derived responses of selected variables to different types of shocks and assessed their adequacy on the basis of our knowledge concerning the Mongolian economy.
- Thirdly, we performed additional checks of the forecasting properties of the endogenous part of the model.

This paper is structured in the following way. Section II presents a detailed description of the model. Section III shows estimation results of parameters of the model equations. Section IV presents simulations of the model, while section V is focused on forecasting accuracy of the model. Finally, section VI offers some conclusions and recommendations.

II. DETAILED DESCRIPTION OF THE MODEL

In this section we present a small scale highly aggregated model of the Mongolian economy, SIMOM. Such small-scale models have been used in many central banks to understand monetary transmission mechanism, derive optimal policy rules or forecast inflation
(e.g. Bank of England, 1999; Batini and Haldane, 1999; Łyziak, 2002; Kłos et al., 2005). The SIMOM was designed to capture specific features of the inflation process in Mongolia.

The model is both theoretically and empirically based, although empirical consistency was the priority while building it. There are following estimated equations in the model:

- **Domestic currency loan rate equation**: domestic currency loan rate depends on: (1) its lag; (2) monetary policy rate; (3) reserve money (M0); (4) seasonal dummy variables.

- **Foreign currency loan rate equation**: foreign currency loan rate depends on: (1) its lag; (2) monetary policy rate; (3) reserve money (M0); (4) a seasonal dummy variable.

- **IS curve**: output gap depends on: (1) real average loan rate; (2) real effective exchange rate; (3) foreign demand (Chinese economic growth); (4) change in exported commodity prices (copper and gold prices); (5) reserve money (M0); (6) a dummy variable.

- **LM curve**: reserve money (M0) depends on: (1) its lag; (2) monetary policy rate; (3) real GDP; (4) Fiscal expenditure; (5) seasonal dummy variable; (6) dummy variable related to changes in regulation on central bank bill auctions.

- **Exchange rate equation**: USD/MNT exchange rate depends on: (1) its lag; (2) interest rate disparity; (3) PPP deviation; (4) change in exported commodity price (gold); (5) fiscal expenditure relative to GDP (proxy for the risk premium); (6) cross exchange rate of Yuan against US dollar.

- **Phillips curve**: net inflation depends on: (1) its lag; (2) fuel price inflation; (3) output gap, (4) public wage growth; (5) import price growth; (6) a seasonal dummy variable.

- **Food price dynamics**: food price inflation depends on: (1) its lag; (2) net inflation; (3) headline inflation; (4) dummy variable related to significant increase in oil price and exchange rate; (5) a seasonal dummy variable.

- **Fuel price dynamics**: fuel price inflation depends on: (1) growth of oil price in the world market; (2) changes in the USD/MNT exchange rate; (3) a seasonal dummy.

- **Real GDP equation (approximating equation, ad-hoc specification)**: GDP in real term depends on: (1) its lag; (2) the output gap; (3) seasonal dummy variables.

- **Public wage equation (approximating equation, ad-hoc specification)**: public wage depends on: (1) its lag; (2) real GDP; (3) change in exported commodity prices (copper and gold prices); (4) seasonal dummy variables.
The equations and identities of the model are the following:

**INTEREST RATES**

**Domestic currency loan rate equation:**
\[
I_{r,dc}^t - I_{r,dc}^{t-1} = c_{r,dc} + \alpha_1 \left(I_{r,dc}^{t-2} + m_{0,dc}^{t-1}\right) + \alpha_2 (i_{t-1} - i_{t-2}) + \alpha_3 S^2 + \alpha_5 S^3, \quad \alpha_1 < 0
\] (1)

**Foreign currency loan rate equation:**
\[
I_{r,fc}^t - I_{r,fc}^{t-1} = c_{r,fc} + \beta_1 \left(I_{r,fc}^{t-2} + m_{0,fc}^{t-1}\right) + \beta_2 (i_{t-1} - i_{t-2}) + \beta_4 S^2, \quad \beta_1 < 0
\] (2)

**Average loan rate in nominal and real terms:**
\[
I_{r,ave}^t = w_{r,ave}^t \left(1 - w_{r}^fc\right) I_{r,dc}^t
\] (3)
\[
I_{r,ave}^q = \frac{I_{r,ave}^t}{4}
\] (4)
\[
rl_{q,ave}^t = I_{q,ave}^t - \pi_{t-1}
\] (5)

**IS CURVE**
\[
\dot{y}_t = c_{\gamma} + \gamma_1 r_{l,q-3}^t + \gamma_2 e_{q-3}^t + \gamma_3 \left(D_{l,q-3}^{China}\right) + \gamma_4 \left(p_{op,t-3}^t - p_{op,t-4}^{t-1}\right) + \gamma_5 \left(p_{gold,t-3}^t - p_{gold,t-4}^{t-1}\right) + \gamma_6 \left(m_{0,t-3} - m_{0,t-4}\right) + \gamma_7 D_{Q,0,3}
\] (6)

**LM CURVE**
\[
m_{0,t} = \phi_1 m_{0,t-1} + \phi_2 i_t + \phi_3 y_t + \phi_4 rfe_t + \phi_5 D_{Q,0,3} + \phi_6 S^4
\] (7)

**EXCHANGE RATE EQUATION**
\[
e_{t,USD/MNT} = \phi_1 e_{t-1,USD/MNT} + \phi_2 e_{t-2,USD/MNT} + \phi_3 \left(I_{r,dc}^{t-2} - i_{t-2}^f\right) + \phi_4 dev_{t-1} - ppp_{t-1} + \phi_5 \left(p_{gold,t-2} - p_{gold,t-3}\right) + \phi_6 rfe_{t-3} + \phi_7 e_{t-4,USD/MNT}
\] (8)

**PRICE SYSTEM**

**Phillips curve (net inflation equation):**
\[
\pi^N_t = \pi^{x_1} + \theta_1 \pi^N_{t-1} + \theta_2 \pi^o_{t-1} + \theta_3 \left(p_{op,t-2}^{IM,D} - p_{t-3}^{IM,D}\right) + \theta_4 \left(w_{t-2} - w_{t-3}\right) + \theta_5 S^2
\] (9)

**Food price dynamics:**
\[
\pi^F_t = c_{\pi_F} + \delta_1 (\pi^E_{t-1} + \pi_{t-1}) + \delta_2 \pi^N_{t-1} + \delta_3 \pi^F_{t-2} + \delta_4 S^2
\] (10)

**Fuel price dynamics:**
\[
\pi^0_t = c_{\pi^o} + \lambda_1 \left(p_{oil,t-2}^o - p_{oil,t-3}^o\right) + \lambda_2 \left(p_{oil,t}^o - p_{oil,t-1}^o\right) + \lambda_3 \left(e_{t-3,USD/MNT}^{USD/MNT} - e_{t-4,USD/MNT}^{USD/MNT}\right) + \lambda_4 S^1
\] (11)

**Quarterly CPI inflation:**
\[
\pi_t = w_t^F \pi^F_t + w_t^o \pi^o_t + \left(1 - w_t^F - w_t^o\right) \pi^N_t
\] (12)
Annual CPI inflation:

\[ \Pi_t = (1 + \pi_t)(1 + \pi_{t-1})(1 + \pi_{t-2})(1 + \pi_{t-3}) - 1 \]  

(13)

\[ \Pi_t^N = (1 + \pi_t^N)(1 + \pi_{t-1}^N)(1 + \pi_{t-2}^N)(1 + \pi_{t-3}^N) - 1 \]  

(14)

\[ \Pi_t^F = (1 + \pi_t^F)(1 + \pi_{t-1}^F)(1 + \pi_{t-2}^F)(1 + \pi_{t-3}^F) - 1 \]  

(15)

\[ \Pi_t^O = (1 + \pi_t^O)(1 + \pi_{t-1}^O)(1 + \pi_{t-2}^O)(1 + \pi_{t-3}^O) - 1 \]  

(16)

APPROXIMATING EQUATIONS (AD-HOC SPECIFICATIONS)

Real GDP equation:

\[ y_t - y_{t-1} = \theta_1 \hat{y}_t + \theta_2 S^1 + \theta_3 S^2 + \theta_4 S^4 \]  

(17)

Public wage equation:

\[ w_t^p = c_w + \eta_1 w_{t-1} + \eta_2 y_t + \eta_3 p_{t-1}^{gold\&cop} + \eta_4 S^1 + \eta_5 S^2 + \eta_6 S^3 \]  
or:

\[ w_t^p = w_{t-1} + \pi_{t-1} \]  

(18)

DEFINITIONS

Prices (CPI):

\[ p_t = p_{t-1} + \pi_t \]  

(20)

\[ p_t^F = p_{t-1}^F + \pi_t^F \]  

(21)

Import prices:

\[ p_{t-1}^{IM-D} = p_{t-1}^{IM-F} - e_t^{USD/MNT} \]  

(22)

\[ p_{t-1}^{IM-F} = w_t^{RMB}(p_t^{china-Index^{RMB}}) + (1 - w_t^{RMB})p_t^{USA}, \quad w_t^{RMB} = 0.05 \]  

(23)

Exchange rates:

\[ e_t^n = e_t^{USD/MNT} + w_t^{RMB} e_t^{RMB/USD}, \quad w_t^{RMB} = 0.05 \]  

(24)

\[ e_t^f = e_t^n + p - p_{t-1}^{IM-F} \]  

(25)

PPP deviation:

\[ dev_{ppp_t} = e_t^{USD/MNT} - ppp_t \]  

(26)

\[ ppp_t = p_t - w_t^{RMB}(p_t^{china-Index^{RMB}}) + (1 - w_t^{RMB})p_t^{USA}, \quad w_t^{RMB} = 0.05 \]  

(27)

Nominal GDP:

\[ y_t^n = \hat{y}_t + p \]  

(28)

Fiscal expenditure relative to GDP:

\[ rfe_t = fe_t - y_t^n \]  

(29)
Other prices:

\[ p_{t}^{\text{gold&cop}} = w_{t}^{\text{cop}} p_{t}^{\text{cop}} + (1 - w_{t}^{\text{cop}}) p_{t}^{\text{gold}} \]  
\[ p_{t}^{\text{China}} = p_{t-4}^{\text{China}} + \pi_{t}^{\text{China}} \]  
\[ p_{t}^{\text{USA}} = p_{t-4}^{\text{USA}} + \pi_{t}^{\text{USA}} \]  

The following symbols have been used:

- \( l_{t}^{dc} \) - domestic currency loan rate in nominal terms (annual);
- \( i \) - short-term BoM bill rate (monetary policy rate) in nominal terms (annual);
- \( m0 \) - reserve money M0 (in logs);
- \( S_{d} \) - d-quarter seasonal dummy;
- \( l_{t}^{fc} \) - foreign currency loan rate in nominal terms (annual);
- \( l_{t}^{ave} \) - weighted average of domestic and foreign currency loan rates in nominal terms (annual);
- \( l_{q}^{ave} \) - weighted average of domestic and foreign currency loan rates in nominal terms (quarterly);
- \( rl_{q}^{ave} \) - weighted average of domestic and foreign currency loan rates in real terms (quarterly);
- \( w_{t}^{fc} \) - weight of foreign currency loans in total loans;
- \( \pi \) - inflation, quarter on quarter;
- \( \hat{y} \) - output gap;
- \( e' \) - real effective exchange rate (in logs);
- \( \Delta y_{\text{China}} \) - real GDP growth rate in China;
- \( p_{t}^{\text{cop}} \) - copper price (in logs);
- \( p_{t}^{\text{gold}} \) - gold price (in logs);
- \( D_{Q4,03} \) - dummy variable for the 4th quarter 2003;
- \( D_{Q3,07} \) - dummy variable for the 3rd quarter 2007 (related to the changing of required reserve regulation);
- \( y_{t} \) - real GDP (in logs);
- \( e_{t}^{\text{USD/MNT}} \) - USD/MNT exchange rate (in logs);
- \( i_{t}^{f} \) - LIBOR 3M in nominal terms;
- \( ppp \) - USD/MNT exchange rate (in logs) consistent with purchasing power parity (PPP);
- \( \text{dev}_{-}ppp \) - deviation of the USD/MNT exchange rate (in logs) from \( ppp \);
- \( p_{t}^{\text{gold&cop}} \) - weighted price index of gold and copper (in logs);
- \( w_{t}^{\text{cop}} \) - copper weight in the weighted average price index of copper and gold;
- \( rfe \) - fiscal expenditures related to the GDP;
\( \pi^N \) - net inflation (price growth of consumer goods and services excluding food and fuels), quarter on quarter;
\( \pi^F \) - food price dynamics, quarter on quarter;
\( \pi^O \) - fuel price dynamics, quarter on quarter
\( w^F \) - weight of food in the CPI basket;
\( w^O \) - weight of fuels in the CPI basket;
\( p^{IM\_F} \) - import prices in foreign currency (in logs);
\( p^{IM\_D} \) - import prices in domestic currency (in logs);
\( w^P \) - wage in the public sector (in logs);
\( p^{oil} \) - USD oil price per barrel in international markets (in logs);
\( \Pi \) - CPI inflation, year-on-year;
\( \Pi^N \) - net inflation, year-on-year;
\( \Pi^F \) - food price dynamics, year-on-year;
\( \Pi^O \) - fuel price dynamics, year-on-year;
\( p \) - headline consumer price index (CPI);
\( p^F \) - food price index;
\( e^{RMB/USD} \) - RMB/USD exchange rate (in logs);
\( e^n \) - nominal effective exchange rate (in logs);
\( w^{RBM} \) - Chinese RMB weight used to calculate the nominal effective exchange rate (5%);
\( p^{china} \) - Chinese CPI (in logs);
\( p^{USA} \) - US CPI (in logs);
\( y^n \) - nominal GDP (in logs);
\( fe \) - fiscal expenditures, in nominal terms (in logs);
\( \pi^{China} \) - Chinese CPI inflation, year-on-year;
\( \pi^{USA} \) - US inflation, year-on-year.

There are 12 endogenous and 10 exogenous variables in the model. The relationships between these variables are summarized using the flow-chart (Figure 1), with endogenous variables shown in the grey boxes. We can use the flow-chart to understand the main linkages in the model.
Figure 1. Flow-chart scheme of the SIMOM

Comments:

- Starting point
- Endogenous variables
- Exogenous variables
- Identities
III. ESTIMATION RESULTS

We estimated the model with OLS technique equation by equation using quarterly time series covering the period 2001Q1-2008Q1. Model variables are not subject to seasonal adjustment – the exception is the GDP series, which is used to determine the output gap. However, in some of the equations there is a need to include seasonal dummies in order to capture strong seasonality in the Mongolian economy. The model uses a statistical measure of the output gap (obtained with the use of Hodrick-Prescott filter). Data sources are presented in the Annex 1 and equations’ estimations with principal diagnostics are show in Annex 2.

Table 1 presents estimated parameters of the SIMOM.

**Table 1. Estimated parameters of the SIMOM**

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Value (S.E. if estimated)</th>
<th>Interpretation</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$c_{i,t}$</td>
<td>1.28</td>
<td>Intercept</td>
<td>(1) Domestic currency loan rate equation</td>
</tr>
<tr>
<td>$\alpha_1$</td>
<td>-0.62</td>
<td>ECM parameter</td>
<td></td>
</tr>
<tr>
<td>$\alpha_2$</td>
<td>0.14</td>
<td>reserve money (long run)</td>
<td></td>
</tr>
<tr>
<td>$\alpha_3$</td>
<td>0.12</td>
<td>lagged change in monetary policy rate</td>
<td></td>
</tr>
<tr>
<td>$\alpha_4$</td>
<td>-0.02</td>
<td>2nd quarter seasonal dummy</td>
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</tr>
<tr>
<td>$\alpha_5$</td>
<td>0.01</td>
<td>3rd quarter seasonal dummy</td>
<td></td>
</tr>
<tr>
<td>$c_{f,t}$</td>
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<td>Intercept</td>
<td>(2) Foreign currency loan rate equation</td>
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<td>ECM parameter</td>
<td></td>
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<td>$\beta_2$</td>
<td>0.07</td>
<td>reserve money (long run)</td>
<td></td>
</tr>
<tr>
<td>$\beta_3$</td>
<td>0.12</td>
<td>lagged change in monetary policy rate</td>
<td></td>
</tr>
<tr>
<td>$\beta_4$</td>
<td>0.01</td>
<td>2nd quarter seasonal dummy</td>
<td></td>
</tr>
<tr>
<td>$c_{\gamma}$</td>
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<td>Intercept</td>
<td>(3) IS curve</td>
</tr>
<tr>
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<td>lagged weighted average loan rate in real terms</td>
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</tr>
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<td>lagged real effective exchange rate</td>
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</tr>
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<td>2.79</td>
<td>lagged Chinese GDP growth</td>
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</tr>
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<td>growth in the copper price, 3 lags</td>
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</tr>
<tr>
<td>$\gamma_5$</td>
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<td>lagged growth in the gold price</td>
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</tr>
<tr>
<td>$\gamma_6$</td>
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<td>lagged reserve money dummy variable for 2003Q4</td>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
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<td></td>
</tr>
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<td>$\phi_2$</td>
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<td>monetary policy rate</td>
<td></td>
</tr>
<tr>
<td>Coefficient</td>
<td>Value (S.E. if estimated)</td>
<td>Interpretation</td>
<td>Equation</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------</td>
<td>----------------</td>
<td>-----------</td>
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<tr>
<td>$\phi_3$</td>
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<td>real activity (real GDP)</td>
<td>(4) LM curve</td>
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<tr>
<td>$\phi_4$</td>
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<td>(5) Exchange rate equation</td>
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<td>Interest rate disparity</td>
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<td>$\varphi_3$</td>
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<td>lagged PPP deviation</td>
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</tr>
<tr>
<td>$\varphi_4$</td>
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<td>change in the gold prices</td>
<td></td>
</tr>
<tr>
<td>$\varphi_5$</td>
<td>0.14</td>
<td>lagged relative fiscal expenditures (risk premium)</td>
<td></td>
</tr>
<tr>
<td>$\varphi_6$</td>
<td>-0.04</td>
<td>lagged exchange rate of Yuan against US dollar</td>
<td></td>
</tr>
<tr>
<td>$\varphi_7$</td>
<td>-0.17</td>
<td>lagged exchange rate (2 lags)</td>
<td></td>
</tr>
<tr>
<td>$c_{\pi^u}$</td>
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<td>Intercept</td>
<td>(6) Phillips curve (net inflation equation)</td>
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<tr>
<td>$\theta_1$</td>
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<td>$\theta_3$</td>
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<td>lagged output gap</td>
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<td>$\theta_4$</td>
<td>0.27</td>
<td>lagged import price growth</td>
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<td>$\theta_5$</td>
<td>0.12</td>
<td>lagged public wage growth</td>
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<tr>
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<td>$2^{nd}$ quarter seasonal dummy</td>
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<td>(7) Food price dynamics</td>
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<td>$\delta_1$</td>
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<td>Net Inflation</td>
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<td>Food price inflation</td>
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<td>$c_{\pi^o}$</td>
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<td>Intercept</td>
<td>(8) Fuel price dynamics</td>
</tr>
<tr>
<td>$\lambda_1$</td>
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<td>change in the oil price per barrel in the world market, 2 lags</td>
<td></td>
</tr>
<tr>
<td>$\lambda_2$</td>
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<td>change in the oil price per barrel in the world market, 3 lags</td>
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</tr>
<tr>
<td>$\lambda_3$</td>
<td>-2.05</td>
<td>change in USD/MNT exchange rate</td>
<td></td>
</tr>
<tr>
<td>$\lambda_4$</td>
<td>-0.09</td>
<td>$1^{st}$ quarter seasonal dummy</td>
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<tr>
<td>$\theta_1$</td>
<td>0.84</td>
<td>output gap</td>
<td>(9) Real GDP equation (ad-hoc)</td>
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<tr>
<td>$\theta_2$</td>
<td>-0.40</td>
<td>$1^{st}$ quarter seasonal dummy</td>
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<tr>
<td>Coefficient</td>
<td>Value (S.E. if estimated)</td>
<td>Interpretation</td>
<td>Equation</td>
</tr>
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<td>-------------</td>
<td>--------------------------</td>
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<td>----------</td>
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<tr>
<td>$\theta_1$</td>
<td>0.44</td>
<td>2nd quarter seasonal dummy</td>
<td>specification</td>
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<tr>
<td>$\theta_4$</td>
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<td>4th quarter seasonal dummy</td>
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<tr>
<td>$c_w$</td>
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<td>Intercept</td>
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</tr>
<tr>
<td>$\eta_1$</td>
<td>0.74</td>
<td>lagged public wage</td>
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<tr>
<td>$\eta_2$</td>
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<td>real GDP</td>
<td></td>
</tr>
<tr>
<td>$\eta_3$</td>
<td>0.04</td>
<td>Weighted average price of copper and gold</td>
<td>(10) Public wage equation (ad-hoc specification)</td>
</tr>
<tr>
<td>$\eta_4$</td>
<td>0.22</td>
<td>1st quarter seasonal dummy</td>
<td></td>
</tr>
<tr>
<td>$\eta_5$</td>
<td>0.07</td>
<td>2nd quarter seasonal dummy</td>
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</tr>
<tr>
<td>$\eta_6$</td>
<td>-0.11</td>
<td>3rd quarter seasonal dummy</td>
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The estimated coefficients seem to be in line with our expectations, economic intuition and data typical for small open economies. Signs of estimated coefficients are theoretically and empirically consistent. Diagnostic tests of the SIMOM equations are satisfactory (see Annex 2).

IV. SIMULATIONS OF THE MODEL

After estimating the model we checked its dynamic properties by conducting different simulations. They allowed us analyzing responses of different variables to a number of shocks and comparing them with our intuition. Below we present the response of annual inflation to the following shocks:

1. **Chinese GDP growth impulse**: increase of the Chinese GDP growth by 1 pp for 4 quarters;
2. **Fiscal expenditure impulse**: increase of fiscal expenditures by 10% for 1 quarter;
3. **Domestic interest rate temporary impulse**: increase of the domestic short-term interest rate by 1 pp for 4 quarters (or for 8 quarters);
4. **Domestic interest rate permanent impulse**: increase of the domestic short-term interest rate permanently;
5. **Oil price impulse**: increase of oil prices in international markets by 10% for 4 quarters;
6. **Copper price impulse**: increase of the copper price by 10% for 4 quarters;
7. **Gold price impulse**: increase of the gold price by 10% for 4 quarters;
8. **Chinese inflation impulse**: increase of Chinese inflation by 1 pp for 4 quarters;
9. **RMB/USD cross exchange rate impulse**: increase of the RMB/USD exchange rate (USD appreciation) by 1% for 1 quarter;
10. **US inflation impulse**: increase of the US inflation by 1 pp for 4 quarters;
11. **Food price impulse**: increase of the q-o-q food inflation by 1 pp for 1 quarter;
(12) **Foreign interest rate impulse:** increase of the foreign short-term interest rate by 1 pp for 4 quarters.

Below we inspect in detail the results of the monetary transmission mechanism simulation, in which we change the short-term domestic interest rate by 1 pp for 8 quarters (Figure 2) as well as present annual inflation responses to the shocks defined above (Figure 3).

In the monetary transmission mechanism simulation we present inflation response to the interest rate changes including both interest rate channel and exchange rate channel effects and separately we assess the importance of the interest rate channel. It seems that the exchange rate channel constitutes the dominant channel of monetary transmission mechanism in the Mongolian economy.

The maximum impact of monetary policy changes on inflation manifests in the 9th quarter after an 8-quarter interest rate impulse. It equals approximately 0.3 pp. Monetary policy actions are relatively good in terms of their impact on inflation. As far as the maximum impact is concerned, the effects of interest rate changes defined above are roughly the same as:

- oil price change by less than 1% (average absolute quarterly change: 6%);
- change in the Chinese GDP by 0.1 pp (average absolute quarterly change: 0.6 pp);
- increase of fiscal expenditures by 7.5% (average absolute quarterly change: 20%);
- change in copper price by 2.5% (average absolute quarterly change: 8%).
Figure 2, part 1: Reaction of different variables to the increase of the domestic short-term interest rates by 1 pp for 8 quarters.

- Short-term interest rate (I, in pp)
- Loan rate on loans in domestic currency (LR, in pp)
- Loan rates on loans in foreign currency (LR_F, in pp)
- Money base (M0_L, in %)
- USD/TOG exchange rate (USDTG_L, in %, +=appreciation)
- Nominal effective exchange rate (NEER_L, in %, +=appreciation)
- Real effective exchange rate (REER_L, in %, +=appreciation)
- Output gap (GAP, in pp)
Figure 2, part 2: Reaction of different variables to the increase of the domestic short-term interest rates by 1 pp for 8 quarters

Annual net inflation (ANINF, in pp)  Annual food inflation (AFINF, in pp)  Annual fuel inflation (AOINF, in pp)  Annual CPI inflation (AINF, in pp)

Figure 3, part 1: Annual CPI inflation responses to different impulses

(9) RMB/USD impulse  (10) US inflation impulse  
(11) Food inflation impulse  (12) Foreign interest rate impulse
Figure 3, part 2: Annual CPI inflation response to different impulses

Definition of impulses:
(1) increase of the Chinese GDP growth by 1 pp for 4 quarters; (2) increase of fiscal expenditures by 10% for 1 quarter; (3) increase of the domestic short-term interest rate by 1 pp for 4 quarters; (4) increase of the domestic short-term interest rate permanently; (5) increase of oil prices in international markets by 10% for 4 quarters; (6) increase of the copper price by 10% for 4 quarters; (7) increase of the gold price by 10% for 4 quarters; (8) increase of Chinese inflation by 1 pp for 4 quarters; (9) increase of the RMB/USD exchange rate by 1% for 1 quarter; (10) increase of the US inflation by 1 pp for 4 quarters; (11) increase of the q-o-q food inflation by 1 pp for 1 quarter; (12) increase of the foreign short-term interest rate by 1 pp for 4 quarters.

(1) Domestic interest rate impulse, temporary

(2) Domestic interest rate impulse, permanent

(3) Chinese growth impulse

(4) Fiscal expenditure impulse

(5) Oil price impulse

(6) Copper price impulse

(7) Gold price impulse

(8) Chinese inflation impulse
V. FORECASTING ACCURACY

We checked the forecasting accuracy of the SIMOM in the following way:

- We started by cutting our sample and preparing a forecast of endogenous variables starting from 2002Q1. We assumed that all the exogenous variables have their true values (perfect forecast of exogenous variables). Having true data of annual inflation and our forecast, we calculated forecast errors for the first quarter projected (t+1) and for the successive quarters (t+2,...,t+12).

- We repeated the same procedure starting our forecast exercise in 2002Q2, 2002Q3 ... and 2008Q1. We obtained a matrix of forecast errors from all runs for different forecast horizons.

- Then we averaged the, calculating mean error (ME), mean absolute error (MAE) and mean absolute percentage error (MAPE).

Because of the role food price play in determining inflation in Mongolia and inability to forecast them well with the use of our statistical approximating equation, we repeated the procedure described above with food prices assumed exogenous (perfect forecast).

Figures 4 and 5 present the results of the all forecasting runs relative to true inflation with food inflation treated as exogenous and endogenous respectively. It occurs that food price shocks deteriorate forecasting properties of the model in 2004-2005, when the peak of inflation is not able to be predicted by the model.

**Figure 4. True inflation and inflation forecasts, food prices exogenous**

![Graph showing true inflation and inflation forecasts with food prices exogenous](image-url)
The results of our exercise (Figure 6 and 7) suggest that in the case of food prices treated as exogenous the forecasting errors of the endogenous part of the model are relatively small.

- Mean absolute errors (MAE) increase from approximately 0.5 pp in the first quarter projected to approximately 1.5 pp in the sixth quarter projected and then stabilize.
- Mean absolute percentage errors (MAPE) do not exceed 20% of the value of true annual inflation.

However, if we treat food prices as endogenous, the forecasting accuracy of the model deteriorates significantly (MAE increases to 4.5 pp and MAPE reaches 110% of true inflation), even with statistical properties of the equation for food price changes being satisfactory. It is due to huge shocks to food prices, which are not possible to be predicted with a purely statistical approach.
VI. CONCLUSIONS AND RECOMENDATIONS

The results of the model simulations and forecasting exercises presented in this paper lead to some conclusions, which may be important for the monetary policy making in Mongolia:

- CPI inflation in Mongolia is driven by a large number of shocks, both internal (fiscal expenditure shocks, food price shocks) and external (Chinese GDP shocks, US inflation shocks, copper, gold and oil price shocks).
- At the same time the effectiveness of the monetary transmission mechanism is relatively weak (although stronger than previously perceived). The exchange rate channel seems to be the most efficient channel of the monetary transmission mechanism in Mongolia.

- Net inflation, excluding food prices and fuel prices, seems to be useful in modeling inflation in Mongolia and analyzing the link between monetary policy actions and prices in the economy.

- Forecasting properties of the quarterly forecasting model SIMOM are relatively good. However, food price shocks may significantly undermine the forecasting accuracy.

REFERENCES


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Fic T., Kolasa M., Kot A., Murawski K., Rubaszek M., Tarnicka M. (2005), *ECMOD model of the Polish Economy*, Paper No 36, the National Bank of Poland


Pagan A. (2002), *What is a good macroeconomic model for central bank to use?*, Australian National University, mimeo

ANNEX 1. DATA SOURCES

**Quarterly real GDP**
*Definition:* Gross domestic product (2005 reference prices).
*Source:* National Statistical Office, unpublished data

**Output gap**
*Definition:* The data was obtained by subtracting from a seasonally adjusted quarterly real GDP data the potential output estimated using the Hodrick-Prescott (HP) filter.
*Source:* author’s estimation

**Nominal exchange rate (USD/MNT)**
*Definition:* Nominal exchange rate of US dollar against Mongolian Togrog (USD/MNT).
*Source:* Bank of Mongolia, Monthly Bulletin

**Headline consumer price index (CPI)**
*Definition:* Acquisitions consumer price index (December 2005 = 100).
*Source:* National Statistical Office, Monthly Bulletin

**Food price index**
*Definition:* Acquisitions food price index (December 2005 = 100).
*Source:* National Statistical Office, Monthly Bulletin

**Fuel price index**
*Definition:* Acquisitions fuel price index (December 2005 = 100).
*Source:* National Statistical Office, Monthly Bulletin and author’s calculation

**Nominal domestic currency loan rate**
*Definition:* Weighted average lending rate of commercial banks (loans in Togrog)
*Source:* Bank of Mongolia, Monthly Bulletin

**Reserve money**
*Definition:* Reserve money or sum of outside banks currency and commercial banks’ reserves.
*Source:* Bank of Mongolia, Monthly Bulletin

**Short term central bank bill rate (monetary policy rate)**
*Definition:* 1-week central bank bill rate
*Source:* Bank of Mongolia, Monthly Bulletin

**Nominal foreign currency loan rate**
*Definition:* Weighted average lending rate of commercial banks (loans in foreign currency).
*Source:* Bank of Mongolia, Monthly Bulletin

**Foreign interest rate**
*Definition:* USD LIBOR 3M.
*Source:* Bloomberg

**Chinese economic growth**
*Definition:* Annual growth of Chinese real GDP.
*Source:* Bloomberg

**Chinese inflation**
*Definition:* Chinese annual CPI inflation.
*Source:* Bloomberg
Exchange rate RMB/USD
*Definition:* Nominal exchange rate of Chinese Yuan against US dollar.
*Source:* Bloomberg

US inflation and CPI
*Definition:* Annual US inflation and US consumer price index
*Source:* Bloomberg

Oil price
*Definition:* USD price of crude oil per barrel.
*Source:* Energy Information Administration of US government

Copper price
*Definition:* USD price of crude copper per 1 ton.
*Source:* Bloomberg

Gold price
*Definition:* USD price of crude gold per 1 ounce.
*Source:* Bloomberg

Weight of foreign currency loans in total loans
*Definition:* Foreign currency loans to total loans.
*Source:* Balance sheet of Commercial bank

Copper weight used for the weighted average price of copper and gold
*Definition:* Copper weight in total trade of copper and gold.
*Source:* author’s calculation

Fiscal expenditure
*Definition:* Fiscal expenditure of the total budget account.
*Source:* Bank of Mongolia, Monthly Bulletin

Wage in the public sector
*Definition:* Average wage in the public sector (monthly).
*Source:* National Statistical Office, Monthly Bulletin

Weight of food in the CPI basket
*Definition:* Weight of food items in the CPI basket.
*Source:* National Statistical Office, unpublished data

Weight of fuel in the CPI basket
*Definition:* Weight of fuel items in the CPI basket.
*Source:* National Statistical Office, unpublished data

Chinese RMB weight used for the calculation of the nominal effective exchange rate
*Definition:* Share of trade in RMB in total trade.
*Source:* Bank of Mongolia, International Department, unpublished data
ANNEX 2. ESTIMATION RESULTS OF EQUATIONS OF THE SIMOM

(1) Domestic currency loan rate equation

Dependent Variable: D(LR)
Method: Least Squares
Sample: 2001:1 2008:1
Included observations: 29
Convergence achieved after 5 iterations
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

\[ D(LR) = C(1)*(LR(-1)+0*I(-1)+C(3)*M0_L(-1))+C(4)*D(I(-2))+C(6) \]
\[ +@SEAS(2)+C(7)+@SEAS(3)+C(8) \]

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
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<tbody>
<tr>
<td>C(1)</td>
<td>-0.619242</td>
<td>0.114901</td>
<td>-5.389342</td>
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<td>C(3)</td>
<td>0.141984</td>
<td>0.010956</td>
<td>12.96001</td>
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<td>C(4)</td>
<td>0.119251</td>
<td>0.046726</td>
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<td>C(6)</td>
<td>-0.021461</td>
<td>0.010774</td>
<td>-1.991976</td>
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<tr>
<td>C(7)</td>
<td>0.013223</td>
<td>0.006430</td>
<td>2.056612</td>
</tr>
<tr>
<td>C(8)</td>
<td>1.276916</td>
<td>0.225927</td>
<td>5.651895</td>
</tr>
</tbody>
</table>

R-squared 0.568933
Adjusted R-squared 0.475223
S.E. of regression 0.017070
Akaike info criterion -5.121021
Schwarz criterion -4.838132
Log likelihood 80.25480

(2) Foreign currency loan rate equation

Dependent Variable: D(LR_F)
Method: Least Squares
Sample: 2001Q1 2008Q1
Included observations: 29
Convergence achieved after 8 iterations
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

\[ D(LR_F) = C(1)*(LR_F(-1)+0*I(-1)+C(3)*M0_L(-1))+C(4)*D(I(-1))+C(6) \]
\[ +@SEAS(2)+C(7)+@SEAS(3)+C(8) \]

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
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<td>2.080092</td>
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<tr>
<td>C(8)</td>
<td>0.727983</td>
<td>0.125707</td>
<td>5.791127</td>
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</table>

R-squared 0.615310
Adjusted R-squared 0.551195
S.E. of regression 0.012294
Akaike info criterion -5.803826
Schwarz criterion -5.568086
Log likelihood 89.15548
(3) IS curve
Dependent Variable: GAP
Method: Least Squares
Sample: 2002:3 2008:1
Included observations: 23
Newey-West HAC Standard Errors & Covariance (lag truncation=2)
GAP=C(1)+C(3)*LR_AV_R_Q(-1)-0.15*REER_L(-4)+C(5)*CHI_G(-2)
+C(6)*(P_COP_L(-3)-P_COP_L(-4))+C(7)*(P_GOLD_L(-1))
-P_GOLD_L(-1)+C(9)*D2+0*(GAP(-1)-GAP(-2))+C(11)*(LOG(M0(-3))-LOG(M0(-4)))

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<th>Coefficient</th>
<th>Std. Error</th>
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<td>C(3)</td>
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<td>5.296021</td>
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<td>0.025057</td>
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<td>C(7)</td>
<td>-0.258858</td>
<td>0.076508</td>
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<td>C(9)</td>
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<td>0.011445</td>
<td>-3.255294</td>
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<tr>
<td>C(11)</td>
<td>0.136201</td>
<td>0.053316</td>
<td>2.554608</td>
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R-squared 0.763180
Adjusted R-squared 0.674372
S.E. of regression 0.023685
Akaike info criterion 4.402163
Sum squared resid 0.008976
Log likelihood 57.62487

(4) LM curve
Dependent Variable: M0_L
Method: Least Squares
Sample: 1999Q1 2008Q1
Included observations: 37
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

<table>
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<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
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<td>0.0000</td>
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<td>@SEAS(4)</td>
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<tr>
<td>FEXP_L</td>
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<td>LOG(GDP)</td>
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<td>0.1600</td>
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</table>

R-squared 0.975275
Adjusted R-squared 0.971288
S.E. of regression 0.087617
Akaike info criterion 1.884301
Sum squared resid 0.237976
Log likelihood 40.85956
(5) Exchange rate equation
Dependent Variable: USDTG_L
Method: Least Squares
Sample: 2000:1 2008:1
Included observations: 33

Newey-West HAC Standard Errors & Covariance (lag truncation=3)
USDTG_L=C(2)*USDTG_L(-1)+C(3)*(LR_I_F)+C(4)*DEV_PPP(-1)+C(8)
  *D(P_GOLD_L(-2))+C(10)*FEXP_REL(-3)+C(11)*USDTG_L(-2)
  +C(13)*RMBUSD_L(-1)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
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<tbody>
<tr>
<td>C(2)</td>
<td>0.496323</td>
<td>0.128171</td>
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<tr>
<td>C(3)</td>
<td>0.092922</td>
<td>0.042348</td>
<td>2.194251</td>
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<td>C(4)</td>
<td>0.062959</td>
<td>0.026729</td>
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<td>C(8)</td>
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<td>2.934580</td>
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<td>C(13)</td>
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<td>-2.575452</td>
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R-squared 0.946518    Mean dependent var -7.045582
Adjusted R-squared 0.934177    S.D. dependent var 0.038963
S.E. of regression 0.009996    Akaike info criterion -6.187334
Sum squared resid 0.002598    Schwarz criterion -5.869893
Log likelihood 109.0910    Durbin-Watson stat 2.143098

(6) Phillips curve (net inflation equation)
Dependent Variable: QNINF
Method: Least Squares
Sample: 2002Q1 2008Q1
Included observations: 25

Newey-West HAC Standard Errors & Covariance (lag truncation=2)
QNINF=C(1)*QOINF+C(2)*QNINF(-1)+C(4)*GAP(-3)+C(5)
  *D(IMP_CPI_D_L(-2))+C(6)*D(LOG(W_P(-2)))+C(8)*@SEAS(2)
  +C(9)

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
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<td>C(1)</td>
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<td>3.278269</td>
</tr>
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<td>C(2)</td>
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<td>-2.961766</td>
</tr>
<tr>
<td>C(4)</td>
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<td>0.046447</td>
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<td>C(5)</td>
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<td>1.630383</td>
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<td>C(6)</td>
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<td>C(8)</td>
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<tr>
<td>C(9)</td>
<td>0.013176</td>
<td>0.004831</td>
<td>2.727269</td>
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</table>

R-squared 0.787783    Mean dependent var 0.012242
Adjusted R-squared 0.717045    S.D. dependent var 0.021766
S.E. of regression 0.011578    Akaike info criterion -5.847951
Sum squared resid 0.002413    Schwarz criterion -5.506665
(7) **Food price dynamics**

Dependent Variable: QFINF  
Method: Least Squares  
Sample: 2003:1 2008:1  
Included observations: 21  
Newey-West HAC Standard Errors & Covariance (lag truncation=2) 

\[
QFINF = C(1) \cdot QFINF(-2) + C(2) \cdot QINFINF(-1) + C(3) \cdot (\text{LOG(FCPI(-1))} - \text{CPI}_L(-1)) + C(7) \cdot @SEAS(2) + C(8) \cdot DUM0703 + C(11) \cdot DUM0801 + C(12)
\]

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(1)</td>
<td>-0.427864</td>
<td>0.099380</td>
<td>-4.305315</td>
</tr>
<tr>
<td>C(2)</td>
<td>1.186077</td>
<td>0.505999</td>
<td>2.344028</td>
</tr>
<tr>
<td>C(3)</td>
<td>-0.410402</td>
<td>0.130924</td>
<td>-3.134667</td>
</tr>
<tr>
<td>C(7)</td>
<td>0.108950</td>
<td>0.024246</td>
<td>4.493514</td>
</tr>
<tr>
<td>C(8)</td>
<td>0.113494</td>
<td>0.018783</td>
<td>6.042253</td>
</tr>
<tr>
<td>C(11)</td>
<td>0.175425</td>
<td>0.011735</td>
<td>14.94827</td>
</tr>
<tr>
<td>C(12)</td>
<td>-1.897643</td>
<td>0.602882</td>
<td>-3.147619</td>
</tr>
</tbody>
</table>

R-squared: 0.816770  
Mean dependent var: 0.039755  
Adjusted R-squared: 0.738243  
S.D. dependent var: 0.076972  
S.E. of regression: 0.039380  
Akaike info criterion: -3.369893  
Schwarz criterion: -3.021719  
Log likelihood: 42.38388

(8) **Fuel price dynamics**

Dependent Variable: QOINF  
Method: Least Squares  
Sample: 2001Q2 2008Q1  
Included observations: 28  
Newey-West HAC Standard Errors & Covariance (lag truncation=3) 

\[
QOINF = C(1) + C(2) \cdot D(\text{LOG(OIL(-2)))} + C(4) \cdot D(\text{LOG(OIL(-0)))} + C(5) \cdot D(\text{USD(TG}_L(-3))) + C(7) \cdot @SEAS(1)
\]

<table>
<thead>
<tr>
<th>Coefficient</th>
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<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(1)</td>
<td>0.037370</td>
<td>0.008924</td>
<td>4.187585</td>
</tr>
<tr>
<td>C(2)</td>
<td>0.414751</td>
<td>0.098680</td>
<td>4.202975</td>
</tr>
<tr>
<td>C(4)</td>
<td>0.183016</td>
<td>0.104120</td>
<td>1.757743</td>
</tr>
<tr>
<td>C(5)</td>
<td>-2.051152</td>
<td>0.779133</td>
<td>-2.632607</td>
</tr>
<tr>
<td>C(7)</td>
<td>-0.084149</td>
<td>0.025458</td>
<td>-3.305394</td>
</tr>
</tbody>
</table>

R-squared: 0.452516  
Mean dependent var: 0.046059  
Adjusted R-squared: 0.357301  
S.D. dependent var: 0.096959  
S.E. of regression: 0.077730  
Akaike info criterion: -2.110709  
Schwarz criterion: -1.872815  
Log likelihood: 34.54992
(9) Real GDP equation (approximation, ad-hoc specification)

Dependent Variable: LOG(GDP)
Method: Least Squares
Sample: 2002Q1 2008Q1
Included observations: 25

\[
\text{LOG}(\text{GDP}) = \text{LOG}(\text{GDP}(-1)) + C(3) \times \text{GAP} + C(4) \times \text{@SEAS}(1) + C(5) \times \text{@SEAS}(2) + C(6) \times \text{@SEAS}(4)
\]

<table>
<thead>
<tr>
<th>Coefficient</th>
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<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(3)</td>
<td>0.838282</td>
<td>0.273912</td>
<td>3.060405</td>
</tr>
<tr>
<td>C(4)</td>
<td>-0.402544</td>
<td>0.020863</td>
<td>-19.29442</td>
</tr>
<tr>
<td>C(5)</td>
<td>0.437864</td>
<td>0.022714</td>
<td>19.27757</td>
</tr>
<tr>
<td>C(6)</td>
<td>0.084676</td>
<td>0.022540</td>
<td>3.756676</td>
</tr>
</tbody>
</table>

R-squared: 0.952921
Mean dependent var: 13.39495

Adjusted R-squared: 0.946195
S.D. dependent var: 0.237929

S.E. of regression: 0.055190
Akaike info criterion: -2.810430

Sum squared resid: 0.063964
Schwarz criterion: -2.615410
Log likelihood: 39.13037

(10) Public wage equation

Dependent Variable: LOG(W_P)
Method: Least Squares
Sample: 2002:2 2008:1
Included observations: 24

\[
\text{LOG}(\text{W_P}) = C(1) + C(2) \times \text{LOG}(\text{GDP}) + C(3) \times \text{@SEAS}(1) + C(4) \times \text{@SEAS}(2) + C(5) \times \text{@SEAS}(3) + C(6) \times \text{LOG}(\text{W_P}(-1)) + C(7) \times \text{DUM_WP} + C(8) \times \text{WP_COPGOLD_L}(-1)
\]

<table>
<thead>
<tr>
<th>Coefficient</th>
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<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(1)</td>
<td>-6.055365</td>
<td>1.817289</td>
<td>-3.332087</td>
</tr>
<tr>
<td>C(2)</td>
<td>0.517032</td>
<td>0.156447</td>
<td>3.304835</td>
</tr>
<tr>
<td>C(3)</td>
<td>0.216022</td>
<td>0.073904</td>
<td>2.923022</td>
</tr>
<tr>
<td>C(4)</td>
<td>0.071210</td>
<td>0.021050</td>
<td>3.382908</td>
</tr>
<tr>
<td>C(5)</td>
<td>-0.109433</td>
<td>0.028925</td>
<td>-3.783396</td>
</tr>
<tr>
<td>C(6)</td>
<td>0.739546</td>
<td>0.072916</td>
<td>10.14244</td>
</tr>
<tr>
<td>C(7)</td>
<td>0.139165</td>
<td>0.034176</td>
<td>4.072002</td>
</tr>
<tr>
<td>C(8)</td>
<td>0.041178</td>
<td>0.022894</td>
<td>1.798606</td>
</tr>
</tbody>
</table>

R-squared: 0.994207
Mean dependent var: 4.612799

Adjusted R-squared: 0.991672
S.D. dependent var: 0.380068

S.E. of regression: 0.034684
Akaike info criterion: -3.623868

Sum squared resid: 0.019248
Schwarz criterion: -3.231183
Log likelihood: 51.48642
F-statistic: 392.2543

Durbin-Watson stat: 2.663098
Prob(F-statistic): 0.000000