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POLICY IMPLICATIONS OF THE MONEY-BASED EXCHANGE RATE EXPECTATIONS

1. Introduction

While it is standard to assume inflationary impact of the money supply, regardless of the type of the country ─ industrialized, developing or transition one, the potentially adverse effect of expansionary monetary stance on the output in the non-industrialized world has been given much less attention. Within a standard IS─LM─BP framework, monetary policy is effective in stimulating output under a floating exchange rate system, while being neutral for the currency peg due to the balance-of payments offset. The rational expectations hypothesis assumes that only unexpected money supply can affect output; in all the cases expansionary monetary policy is supposed to be inflationary, although the effect is weaker for unexpected changes in the money supply [Marston 1985, p.]. Ability to enact monetary surprise used to depend upon price and wage stickiness, imperfect competition, credibility of the central bank, openness of the economy etc. For extremely open transition economies with high inflationary inertia it is natural to suppose low price and wage stickiness so that monetary policy changes may pass quickly through to prices and have little real effect [Starr 2005, p. 442]. Moreover, within the 'dependent' economy theoretical framework it is possible to obtain a restrictionary impact of an increase in money supply even for flexible prices, assuming that exchange rate expectations are money-based [Rojas-Suarez 1992, p.]. The situation is further complicated by a possibility of inconsistency between exchange rate regimes *de facto* and *de jure* [Glick *et al.* 1992, p. 249-273]. It is not ruled out that the money-based exchange rate expectations have a potential to modify the money supply effects under formally declared either fixed, or floating exchange rate systems. In general, it sounds reasonable that the extent to which a given country can use monetary policy to affect output in the short run is an open question [Starr 2005, p. 442].

Empirical results for transition economies are quite heterogeneous on the real effects of monetary policy, while the inflationary effect is established in most of the cases. A neutral monetary policy stance is established for Croatia [Šonje and Skreb 1997, p. 225-226] and Belarus [Starr 2005, p. 455]. In Russia, Ukraine, and Kazachstan, the money supply affects output in the fashion of fast and transitory monetary 'surprise' [Starr 2005, p. 455], which is consistent with the rational expectations hypothesis. Similar result is obtained for Ukraine by Ghosh [1996] in that initial output growth is followed by an inflationary build-up and long-run output decline; however, an inflationary permanent increase in the nominal credit does contribute to the output growth. Recently arguments in favor of a short-lived monetary ‘surprise’ are found for Belarus [Horvath and Maino 2006, p. 8─9] and Armenia [Dabla-Davis and Floerkemeier 2006, p. 15]. Contrary to the results obtained by Starr [2005, p. 441─461], an earlier study for Russia revealed than monetary growth hindered industrial output with a month lag, while contributing to the growth for longer lags; a distributed lag effect was negative and highly inflationary [Korhonen 1998, p. 43]. A very strong relationship between excessive monetary expansion measured by the broad money/output ratio and consumer prices is found for 26 transition economies in a pooled regression [Hernandez-Cata 1999, pp. 8─11]. However, studies by Lissovolik [2003], Siliverstovs and Bilan [2005], and Starr [2005, p. 456] have not found any significant relationship between money supply and inflation for Ukraine.

In the paper factors behind the output and inflationary dynamics are studied in accordance with the concept of theories consistent expectations (TCE)[1]. This approach relaxes some of the more stringent aspects of rational expectations, while retaining its basic theoretical assumptions, as well as providing with better estimation results [Papell 1997, p. 445-460]. Assuming the importance of monetary shocks in a transition economy, we implemented TCE to assess the impact of anticipated and unanticipated changes in the money supply based on different nominal exchange rate assumptions within the familiar rational expectations framework. The ultimate purpose of this paper is to test hypotheses regarding the output and inflationary effects of monetary disturbances across competitive nominal exchange rate regimes. Time-varying parameter (TVP) estimators were used for empirical estimations.

Main conclusions are summarized in the following way: first, support for the money-based exchange rate expectations is found in the Czech Republic, Poland, Romania, and Ukraine, as the anticipated increase in the money supply has a contractionary impact upon the industrial output growth. In Lithuania and Slovenia, a neutral monetary stance has become expansionary one since 2004 and 2001, respectively, which is consistent with the fixed exchange rate system. Second, unanticipated permanent increase in money supply has a weak restrictionary effect in the Czech Republic, while being expansionary in Romania, Ukraine, Lithuania, and Slovenia; in Poland, it is neutral in respect to industrial output growth. Evidences in favor of an expansionary monetary “surprise” are strongest in Romania and Lithuania, to lesser extent in Slovenia, while in Poland and Ukraine such a phenomenon is present only for certain periods of time. Third, anticipated permanent increase in money supply is inflationary in all countries, except Lithuania. Inflationary impact of unanticipated

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[1] As cited in (Papell 1997, p. 454), “agents are said to hold theories consistent expectations is their forecasting functions contain variables appearing with the same algebraic signs as in the reduced form of at least one of the existent models. The reduced forms of the models are defined to be the reduced forms obtained when using the rational expectations solution technique”.

components of money supply is much weaker. In the case of the consumer inflation, anti-inflationary impact of unanticipated temporary increase in money supply is well established for Ukraine, while episodic evidences are found in a few other cases.

The paper is organized as follows. Section 1 explains the basic theoretical framework, which is then used for explanation of empirical results. Section 2 estimates a Kalman filter model of industrial output and inflation determinants, with a focus upon permanent and temporary components of money supply. The concluding section summarizes the main results of the paper and discusses the policy implications of the analysis.

2. Theoretical framework

A useful background framework for our empirical analysis of the effects of permanent and transitory monetary shocks on industrial output and inflation is the rational expectations variant of a ‘dependent’ economy model, as developed by Rojas-Suarez (1992, p. 594–613). The model consists of the following equations[2]:

$$\left(Q_s^T\right)_t = s_0 + s_1(m_t - E_{t-1}p_t^N) + s_2\gamma E_{t-1}(e_t + p_t^T - p_t^N) + u_t, \tag{1}$$

$$\left(Q_s^N\right)_t = s_0 + s_1(m_t - E_{t-1}p_t) - s_2(1-\gamma)E_{t-1}(e_t + p_t^T - p_t^N) + u_t, \tag{2}$$

$$\left(Q_d^T\right)_t = a_0 - \beta E_t(e_{t+1} + p_{t+1}^T - p_{t+1}^N) + a_1(m_t - E_t(e_{t+1} + p_{t+1}^T)) +$$
$$+ a_2(E_t i_{t+1} - e_t - p_t^T) - a_3(r_t^* + E_t e_{t+1} - e_t - (E_t i_{t+1} - i_t)) + a_4 g_t + \varepsilon_t, \tag{3}$$

$$\left(Q_d^N\right)_t = b_0 + \beta E_t(e_{t+1} + p_{t+1}^T - p_{t+1}^N) + b_1(m_t - E_t p_{t+1}^N) +$$
$$+ b_2(E_t i_{t+1} - p_t^N) - b_3(r_t^* + E_t e_{t+1} - e_t - (E_t i_{t+1} - i_t)) + b_4 g_t + \varepsilon_t, \tag{4}$$

$$i_t = \gamma p_t^N + (1-\gamma)(e_t + p_t^T), \tag{5}$$

$$m_t = y_t + p_t^N - l_1(r_t^* + E_t e_{t+1} - e_t), \tag{6}$$

$$m_t = \phi h_t + (1-\phi)(e_t + f_{t-1}), \tag{7}$$

$$h_t = h_0 + \rho v_{t-1} + w_t, \tag{8}$$

where y_t is the aggregate supply; Q_s^T and Q_s^N, Q_d^T and Q_d^N are the supply and demand of tradable and non-tradable goods, respectively, expressed as deviations from their trend levels; p_t^T and p_t^N are the logs of tradable and non-tradable goods price levels; i_t is the aggregate price level; e_t is the log of the nominal exchange rate; u_t and ε_t are random supply and demand shocks; m_t is the aggregate money supply, h_t is the money supply by the central bank, with the anticipated permanent, unanticipated permanent, unanticipated stochastic components, h_0, ν_t, w_t, respectively; i_t is the aggregate price level; r_t and r_t^* are the domestic and foreign nominal interest rates, respectively; f_t is the foreign exchange assets of the private sector. All variables, except r_t and r_t^*, are in logs

[2] Original model has been supplemented with money-market equilibrium condition.

of the levels. E_t and $E_{t\text{-}1}$ denote the expectations conditional on information available at time t and t–1, respectively; their use reflects the assumption of rational expectations.

Equilibrium conditions for the balance-of-payments are defined for both exchange rate systems ─ floating and fixed ─ in the following way:

$$Q_t^T = D_t^T, \tag{9}$$

$$R_t = Q_t^T - D_t^T + (1-\lambda)(e_t + p_t^T) + \lambda R_{t-1}, \tag{10}$$

where R_t is the foreign exchange reserves.

Internal equilibrium is determined by the non-tradable goods:

$$Q_t^N = D_t^N. \tag{11}$$

Equations (1) and (2) specify expectational aggregate supply for tradable and non-tradable goods, respectively, which is based on a contract lag of one period. The second term on the right-hand side of both equations reflects the assumption of a financial constraint, while the third one captures the impact of expected real exchange rate. Expectations of the RER are instrumental in demand substitution between tradable and non-tradable goods, as it is implicit in the aggregate demand equations (3) and (4). The substitution effect β implies price asymmetry in the demand for Q^N and Q^T. In addition, the demand for both goods is sensitive to the wealth effect, real interest rate, and fiscal position. The real interest rate satisfies the uncovered interest rate parity. There are also random shocks to either aggregate supply, or aggregate demand. Equation (5) defines the aggregate price level. Equation (6) is a semi-log money demand equation, with unitary income elasticity. In equation (7), the money supply is defined as a linear combination of domestic and foreign money denominated components. The former is a sum of deterministic and stochastic terms, as it is modeled in equation (8). As explained in Marston (1985, p.), the stochastic term has an autoregressive component ρv_{t-1}. If the innovation is temporary, $\rho = 0$; if it is permanent, $\rho = 1$.

Equations (9) and (10) represent equilibrium conditions for floating and fixed exchange rate systems, respectively. In both cases the equilibrium is determined by the supply and demand for tradable goods. Finally, equation (11) requires equilibrium in the market for non-tradable goods, as it customary for the 'dependent' economy models. Determination of the current account balance by the demand and supply of Q^T does not rule out simultaneous output growth and worsening of the external balance. Assuming stability of relative prices, an increase in income contributes to larger exports, but with an accelerating demand for imports, so that the current account worsens. The 'dependent' economy model can explain almost all combinations of the money supply and relative prices effects upon income and current account, except of import substitution resulting from a decrease in excessive domestic absorption.

The system (1)─(11) can be solved for current values of output, price level, and exchange rate (floating exchange rate system), or foreign exchange reserves (fixed exchange rate system), as functions of the money supply process. Assuming for the simplicity l_1=0, a_2=b_2=0, and a_3=b_3, the reduced-form solutions to the (1)–(11) system for different exchange rate assumptions are as follows:

a) floating exchange rate;

$$y_t = \bar{y} + \left[1 - \frac{(a_1 - s_1)V_{23} + (b_1 - s_1)V_{24}}{\Omega_{11}}\right]\phi\rho v_{t-1} + \left[\frac{1}{1-\phi} + \frac{(2\beta + b_1 + s_2)\rho\phi s_1}{(1-\phi)\Omega_{11}} + \right.$$
$$+ \frac{\rho s_1((a_1 - s_1)(\beta + b_1 + (1-\gamma)s_2 - \gamma s_1) + (b_1 - s_1)(\beta + \gamma(s_1 + s_2))}{\gamma a_3 \Omega_{11}} - \qquad (12)$$
$$\left. - \frac{\rho\phi((a_1 + b_1)\rho\beta + (\rho b_1 + s_2)a_1 + ((1-\rho)\gamma a_3 - \gamma(s_1 + s_2))(a_1 - b_1)}{(1-\phi)\Omega_{11}}\right]\phi w_t + \frac{1}{\gamma a_3}(u_t - \varepsilon_t),$$

$$p_t = \bar{p} + \phi h_0 + (1-\phi) f_{t-1} + \frac{(1-\rho)(b_1 - a_1)s_1}{\Omega_{11}}\rho\phi v_{t-1} +$$
$$\left[\frac{\rho(a_1 - s_1)(b_1 - s_1)((1-\gamma)s_1 - \gamma s_2)b_1 - (\gamma s_1 - (1-\gamma)s_2)a_1}{(1-\phi)(b_1 - a_1)\gamma a_3 \Omega_{11}} + \right. \qquad (13)$$
$$\left. + \frac{\rho((b_1 - s_1)^2(\beta s_1 + (s_1 + s_2)\gamma a_1) - (a_1 - s_1)^2(\beta s_1 + (1-\gamma)(s_1 + s_2)b_1)}{(1-\phi)(b_1 - a_1)\gamma a_3 \Omega_{11}}\right]\phi w_t +$$
$$+ \frac{1}{\gamma a_3}(u_t - \varepsilon_t),$$

$$e_t = \bar{e} + \phi h_0 + (1-\phi) f_{t-1} + \left(\frac{\phi}{\Omega_{11}}\right)\left[(a_1 - s_1)((1-\rho)\gamma b_3 + \rho(\beta + b_1) + \gamma s_1 - (1-\gamma s_2)) + \right.$$
$$\left. + (b_1 - s_1)(\rho\beta + \gamma(s_1 + s_2) - (1-\rho)\gamma a_3))\right]\rho\phi v_{t-1} +$$
$$+ \left[\frac{\rho(a_1 - s_1)(b_1 - s_1)((1-\gamma)s_1 - \gamma s_2)b_1 - (\gamma s_1 - (1-\gamma)s_2)a_1}{(1-\phi)(b_1 - a_1)\gamma a_3 \Omega_{11}} + \right. \qquad (14)$$
$$\left. + \frac{\rho((b_1 - s_1)^2(\beta s_1 + (s_1 + s_2)\gamma a_1) - (a_1 - s_1)^2(\beta s_1 + (1-\gamma)(s_1 + s_2)b_1)}{(1-\phi)(b_1 - a_1)\gamma a_3 \Omega_{11}}\right]\phi w_t + \frac{1}{\gamma a_3}(u_t - \varepsilon_t),$$

b) fixed exchange rate;

$$y_t = y_0 + \left[1 - \frac{b_1 - s_1}{\Omega_{12}}\right](\phi h_0 + (1-\phi) f_{t-1}) + \left[1 - \frac{b_1 - s_1}{\Omega_{13}}\right]\phi\rho v_{t-1} + \left[1 - \frac{b_1 - s_1}{\gamma a_3}\right]\phi w_t +$$
$$+ \frac{1}{\gamma a_3}(u_t - \varepsilon_t), \qquad (15)$$

$$p_t^N = \bar{p} + \left(\frac{1}{\Omega_{12}}\right)\left[(b_1 - s_1)(\phi h_0 + (1-\phi) f_{t-1})\right] + \frac{b_1 - s_1}{\Omega_{13}}\phi\rho v_{t-1} + \frac{b_1 - s_1}{\gamma a_3}\phi w_t -$$
$$- \frac{1}{\gamma a_3}(u_t - \varepsilon_t), \qquad (16)$$

c) money-based exchange rate expectations[3];

$$y_t = y_0 + \left(\frac{1}{\Omega_{14}}\right)\Big\{\left[(1-\phi)(a_1 - s_1)s_1 + \gamma a_3(2\beta + a_1 + \gamma s_2)\right](1-\phi) f_{t-1} -$$
$$-\left[(1-\phi)(1-\gamma)s_2(\beta + a_1 + \gamma s_2 - (1-\gamma)s_1) - \gamma a_3((1-\phi)(2\beta + a_1 + \gamma s_2) - (1-\gamma)s_2)\right]\phi h_0 +$$
$$+\frac{1}{\gamma a_3}(u_t - \varepsilon_t), \tag{17}$$

$$e_t = e_0 + \left(\frac{1}{\Omega_{14}}\right)\Big\{\left[\gamma a_3(2\beta + b_1 + \gamma s_2) - (\beta + \gamma(s_1 + s_2))(1-\gamma)s_2\right]\phi h_0 -$$
$$-\left[(a_1 - s_1)(\beta + b_1 - \gamma s_1) + (b_1 - s_1)(\beta + \gamma(s_1 + s_2))\right](1-\phi) f_{t-1}\Big\}, \tag{18}$$

$$p_t = p_0 + \left(\frac{1}{\Omega_{14}}\right)\Big\{(1-\phi)(b_1 - s_1))(\beta + \gamma(s_1 + s_2))\phi h_0 - (1-\phi)(a_1 - b_1)\gamma a_3 f_{t-1}\Big\} +$$
$$+\frac{1}{\gamma a_3}(u_t - \varepsilon_t), \tag{19}$$

where:

$\bar{y}$, $\bar{p}$, $\bar{e}$ are constants, which are functions of the non-stochastic terms in equations,

$$\Omega_{11} = (\rho\beta + (1-\rho)\gamma a_3 + (1-\gamma)s_2 - \gamma s_1(\phi(a_1 - s_1) - (1-\rho)a_1) +$$
$$+\rho b_1(\phi(a_1 - s_1) + \rho\beta + \gamma(s_1 + s_2) - (1-\rho)(a_1 + \gamma a_3) +$$
$$+(\rho\beta + \gamma(s_1 + s_2 - (1-\rho)a_3)(\phi(b_1 - s_1) - b_1);$$
$$\Omega_{12} = \beta + b_1 + (1-\gamma)s_2 - \gamma s_1;$$
$$\Omega_{13} = \beta + b_1 + (1-\gamma)s_2 + (1-\rho)\gamma b_3 - \gamma s_1;$$
$$\Omega_{14} = (1-\phi)((a_1 - s_1)(\beta + b_1 - \gamma s_1) + (b_1 - s_1)(\beta + \gamma(s_1 + s_2))) + \gamma a_3(2\beta + \gamma s_2 + b_1);$$
$$V_{23} = \phi(\rho(\beta + b_1) + (1-\rho)\gamma a_3 + (1-\gamma)s_2 - \gamma s_1) + s_1 - \rho b_1;$$
$$V_{24} = \phi(\rho\beta + \gamma(s_1 + s_2) - (1-\rho)\gamma a_3) + \rho a_1 - s_1.$$

Альтернативні системи обмінного курсу по-різному визначають вплив різноманітних змін у пропозиції грошової маси. Для плаваючого обмінного курсу передбачувані зміни грошової маси h_0 або валютних активів f_{t-1} не впливають на дохід і RER. За умов фіксованого обмінного курсу компоненти грошової маси h_0 і f_{t-1} поліпшують динаміку доходу (рівняння (6.38)) і знижують RER (рівняння (6.39)), але коштом втрати валютних резервів. У цьому аспекті немає жодних відмінностей з моделлю (6.1)─(6.16).

Макроекономічні шоки u_t і ε_t зберігають інтуїтивно зрозумілий вплив. У всіх випадках з тією чи іншою ймовірністю слід очікувати, що технологічні інновації u_t збільшать доход і знизять RER. Якщо прийняти відмінності у шоках

[3] As expressions for unanticipated components of the money supply are quite cumbersome and intractable, they are not presented in the text.

для секторів Q^T і Q^N, неважко показати, що прискорене зростання продуктивності праці у секторі Q^T ($u_t^T > u_t^N$) веде до підвищення RER; тобто справджується ефект Баласси─Самуельсона (Шевчук 2002, с. 27─34). Подібне стверджує динамічна модель для двох країн (Begum 2000). Окрім того, отримані емпіричні результати показують, що секторальні відмінності в продуктивності праці відіграють помітне значення в сучасному світі. Протилежними є наслідки стохастичного збільшення сукупного попиту ε_t. Якщо знехтувати інфляційним ефектом (a_2=b_2=0), вплив u_t і ε_t не залежить від вибору системи обмінного курсу ─ плаваючого чи фіксованого.

3. Data analysis and estimation results

To estimate the money supply effects upon output and inflation, monthly data for six transition economies, namely the Czech Republic, Lithuania, Poland, Slovenia, Romania, and Ukraine, are used. The data set covers time series for Poland (1990:M1 to 2005:M12), Romania (1990:M1 to 2006:M6), the Czech Republic, Lithuania, Slovenia (1993:M1 to 2006:M6), and Ukraine (1994:M1 to 2006:M12). The money supply is measured by the aggregate *M2*. Output is measured as real GDP. As the measure of general price index, either producers, or consumer price levels are used. Among exogenous variables, industrial output in Germany and LIBOR six-month interest rate were utilized. All data were obtained from the IMF's *International Financial Statistics* (IFS).

Along the theoretical lines of the model (1)─(11), the money supply was decomposed by a two-step procedure. First, the deseasonalised *M2* series was detrended by the Hodrik-Prescott filter to obtain the anticipated permanent component h_0. Second, unanticipated stochastic component w_t was extracted from the *M2* series by the Beveradge─Nelson decomposition. The unit root tests (Table 1) support a visual picture of w_t series to resemble white noise (Figure 3). This component of the money supply is stationary both in the level and first differences, as it is expected to be. While it is customary in the studies of developed economies to base forecasts of money supply on interest rates, inflation, full-employment budget surplus, unemployment rate etc. (Bohara and Sauer 1992, p. 391; Kim and Nelson 1989, p. 434), in the study of the developing economies (Edwards 1999, pp. 142─146) a univariate ARIMA process was implemented to decompose series on expected and unexpected monetary variables. The latter looks reasonable, assuming a less complicated picture of the information feedbacks in unstable economic environment. Unanticipated permanent component of the money supply v_t was obtained by substracting h_0 and w_t from the original *M2* series. It seems to be stationary by the ADF test, but this outcome is not supported by the PP test, as more credible in this particular case[4]. According to the PP test, the levels of v_t are I(1), but first differences are stationary.

Instead of estimating structural coefficients of the model (1)–(12), direct estimation of the reduced-form equations has been used, as it is implied by the TCE approach. There are several reasons for using of Kalman filtering. First, the TVP approach seems intuitively appropriate for the economy in transition subject to numerous monetary and real shocks. Second, using of TVP model for unanticipated money shocks is consistent with the rationality principle. It is assumed that economic agents know the 'correct' impact of unanticipated shocks captured by the appropriate weights. As mentioned in (Kim and Nelson 1989, p. 437), a fixed-coefficient model understates the degree of learning by economic agents. The TVP approach is not only consistent with the rationality principle, but in an unstable environment it helps to avoid an important source of misspecification (Bohara and Sauer 1992, pp. 390-391). Finally, TVP models are preferable to the popular VAR models in studying unanticipated money supply shocks, because the latter capture history of the average values and they are not particularly suited for monetary shocks which are not followed by the customary further expansion of money (Cochrane 1998, p. 278)[5]. The Kalman filter allows to revise the estimates of the coefficients, if there is a changing policy regime. This is especially useful modelling tool for a limited information rational expectations framework, where standard IMF definitions are not appropriate for empirical purposes (Glick *et al.* 1995, pp. 256-257).

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[4] While the ADF test is very popular among researchers, the PP test is prefered in many empirical studies on the ground that it allows for general dependence in the error process, including conditional heteroscedascity and serial correlation (Moscos and Stournaras 1998, p. 147; Thacker 1995, p. 478).

[5] A TVP model with the Kalman filtering is used in Bohara and Sauer (1992, pp. 389–399) to estimate unanticipated money growth as residuals from the money growth equation (however, its impact upon the output is estimated with the fixed-coefficient model). In Kim and Nelson (1989, pp. 433–440) a combination of fixed and time-varying coefficients is used in studying the impact of independent monetary and non-monetary factors upon the output.

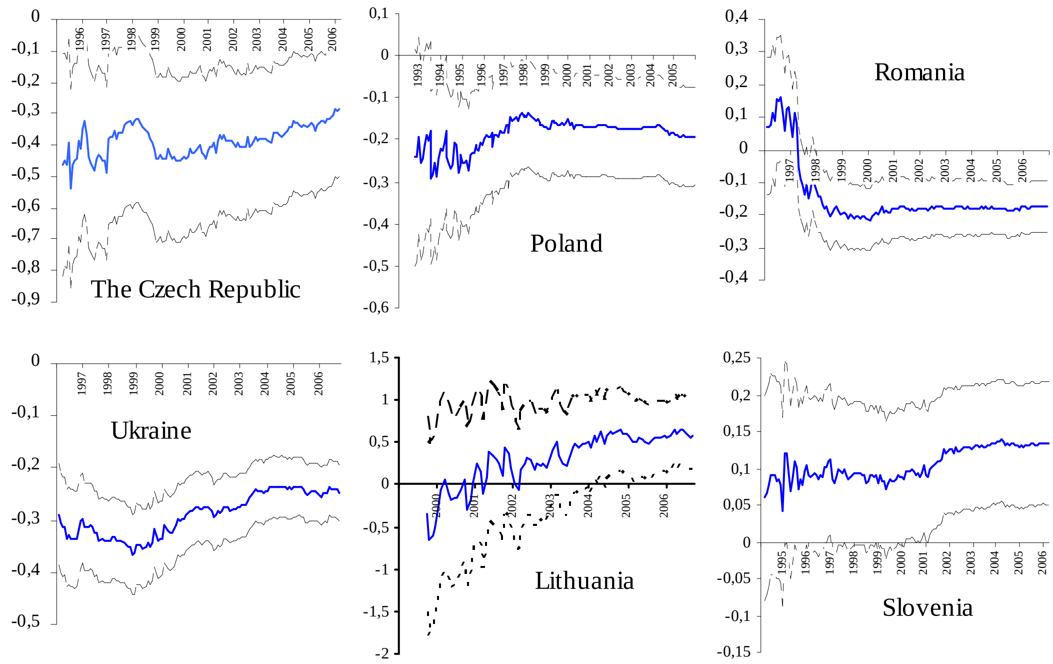

Fig. 1. The impact of anticipated money supply upon the industrial output dynamics

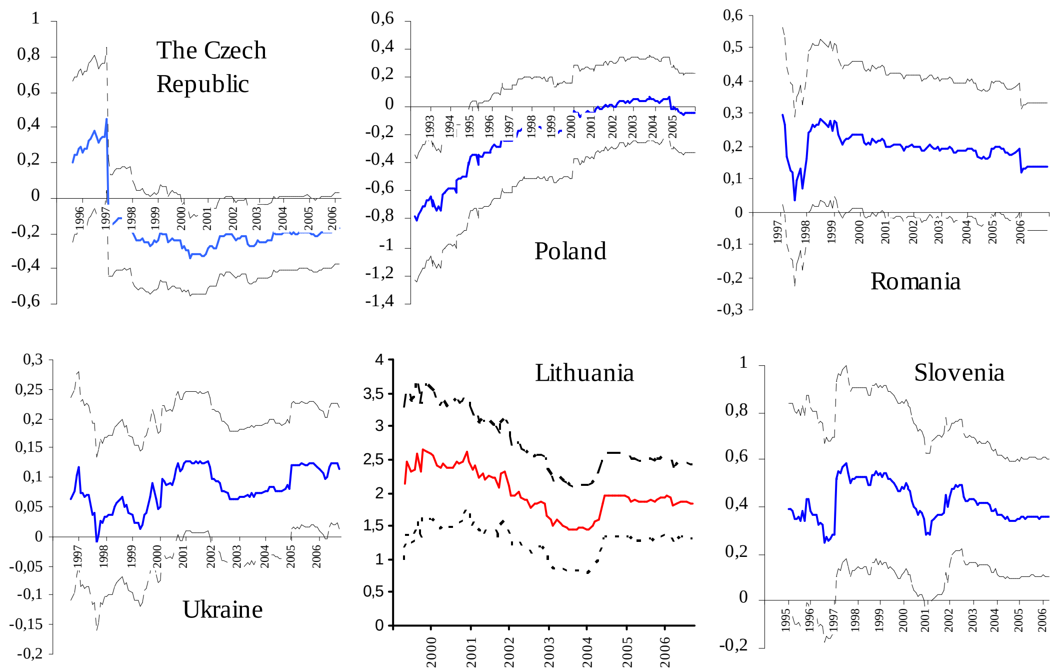

Fig. 2. The impact of anticipated money supply upon the industrial output dynamics

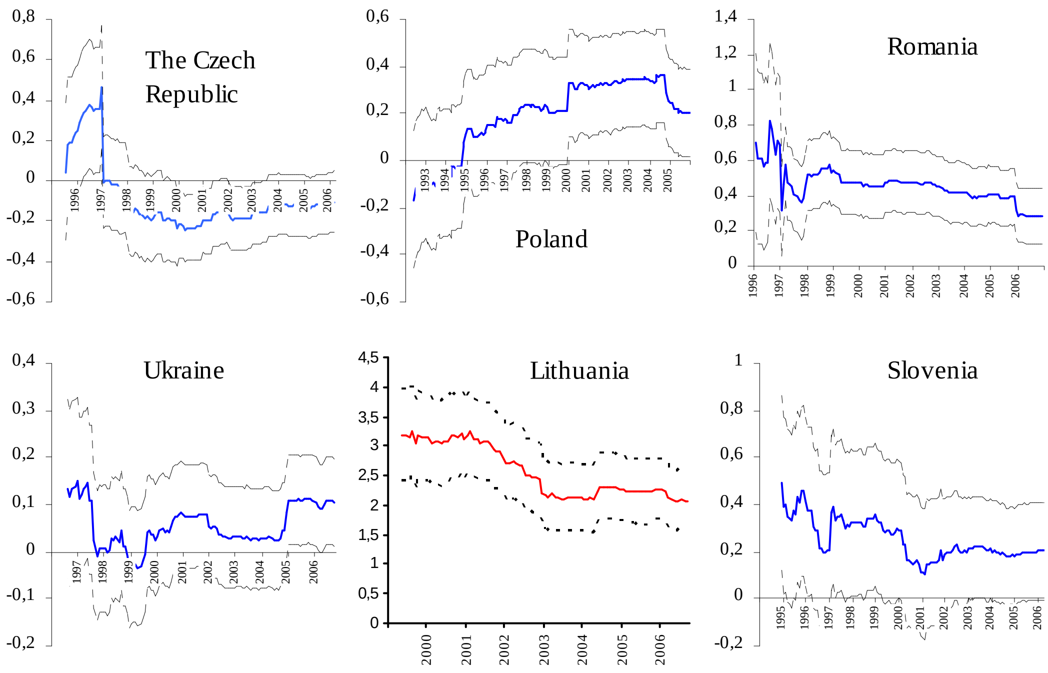

Fig. 3. The impact of unanticipated money supply upon the industrial output dynamics

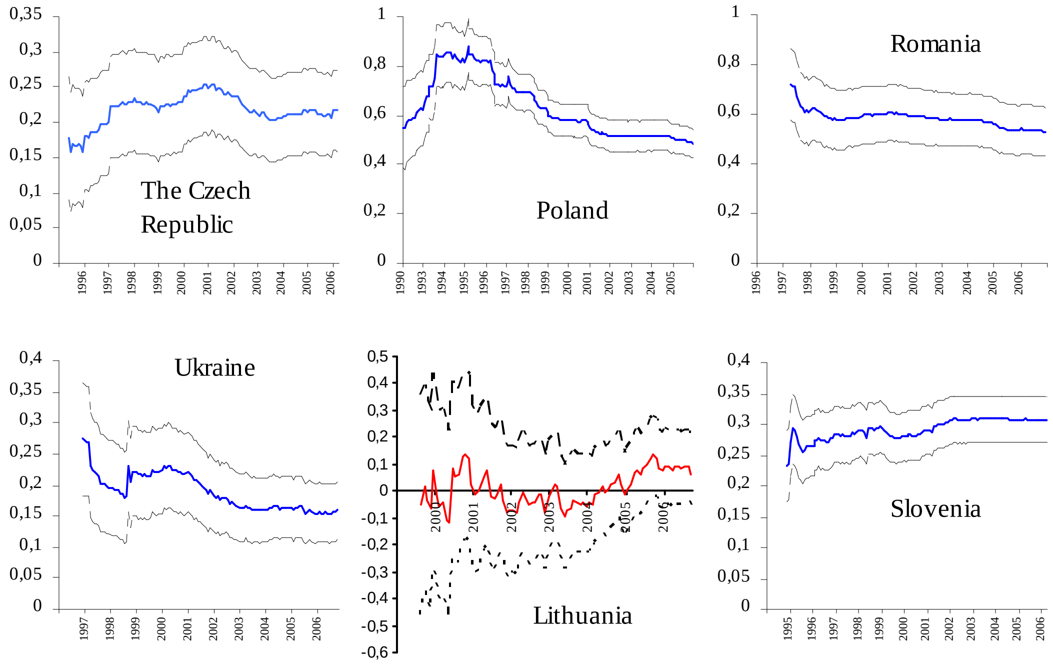

Fig. 4. The impact of anticipated money supply upon the wholesale inflation

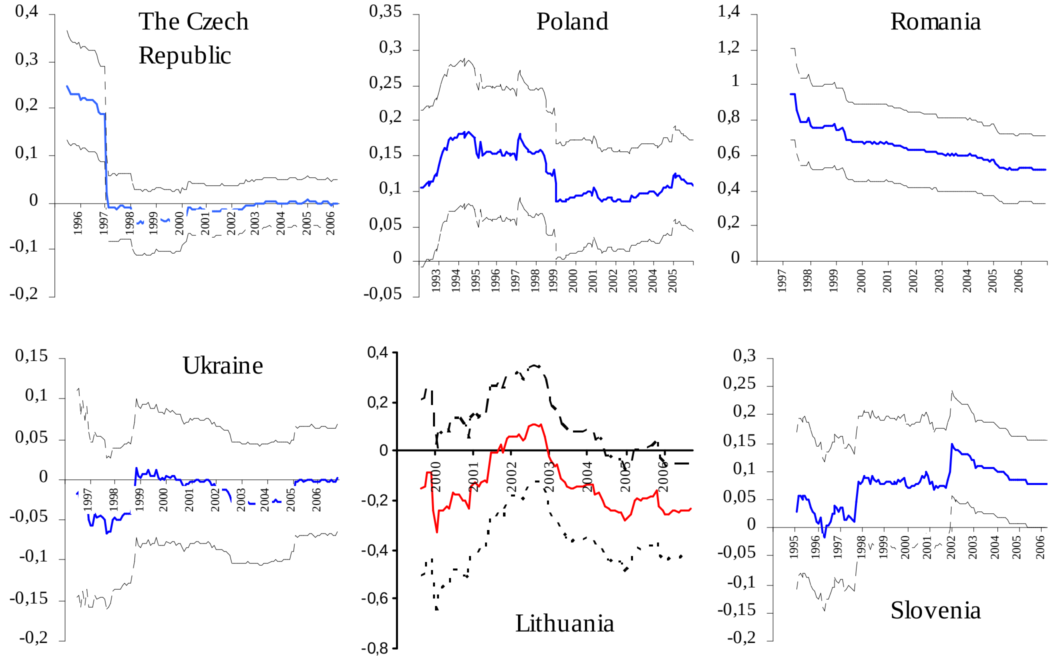

Fig. 5. The impact of anticipated money supply upon the wholesale inflation

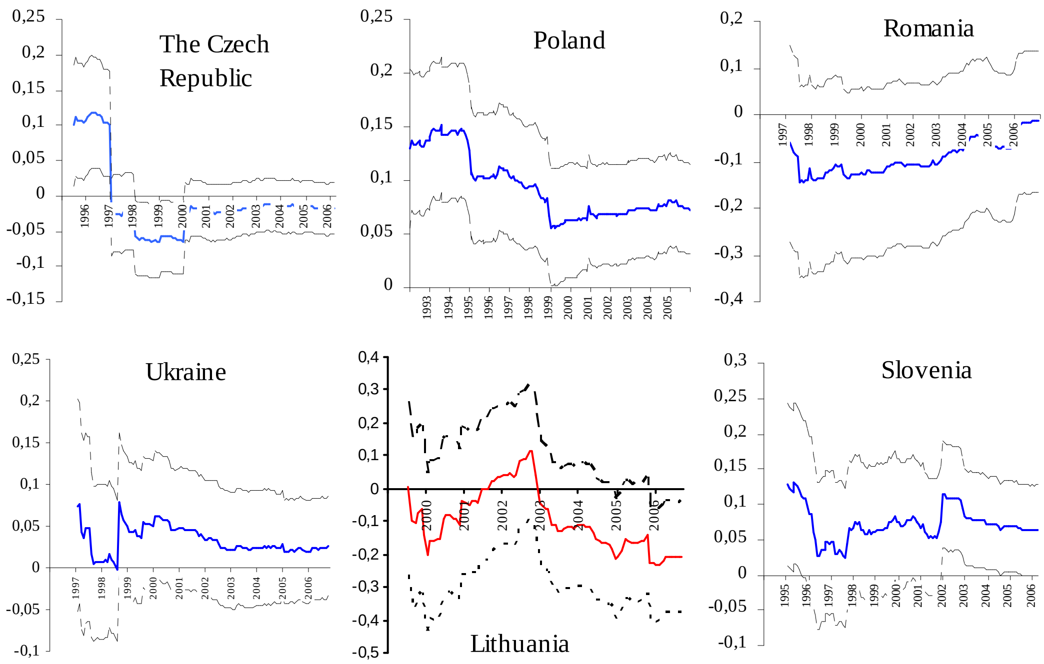

Fig. 6. The impact of unanticipated money supply upon the wholesale inflation

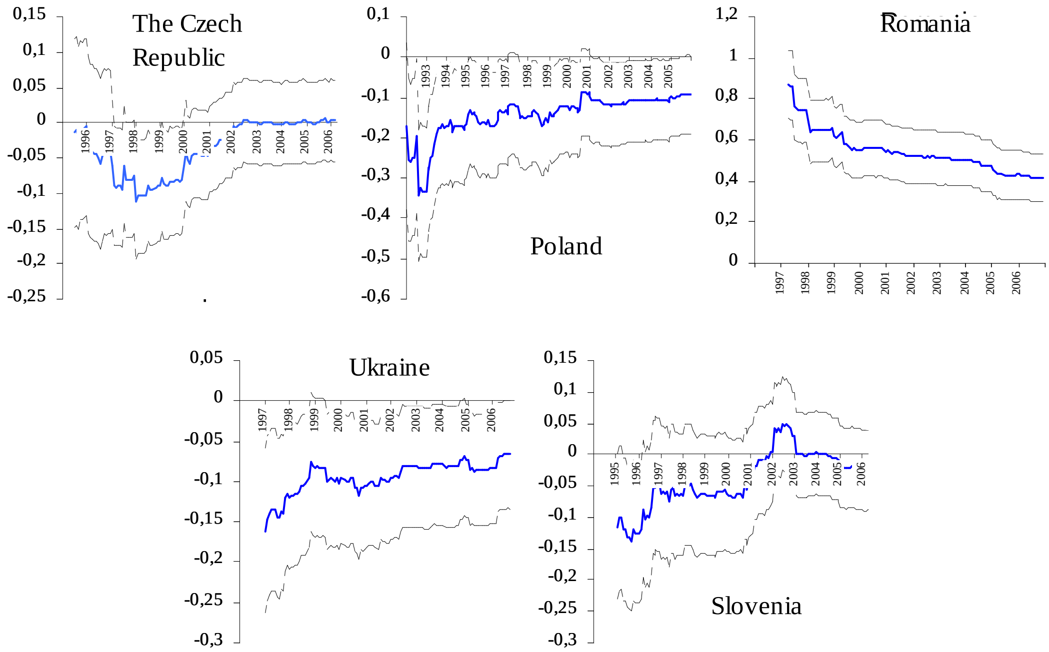

Fig. 7. The impact of anticipated money supply upon the consumer inflation

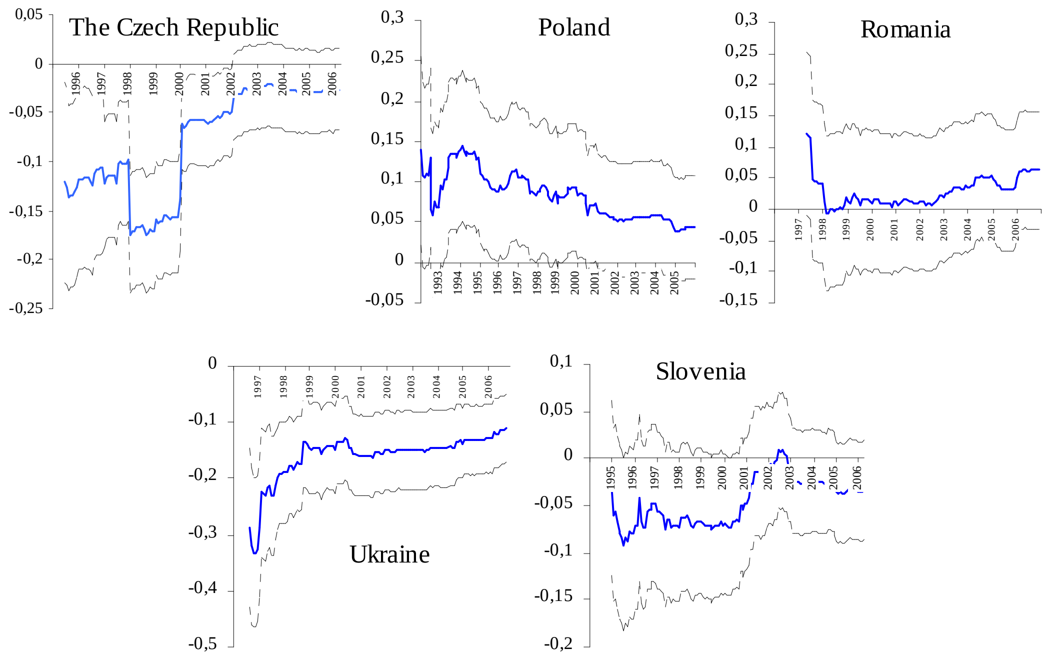

Fig. 8. The impact of unanticipated money supply upon the consumer inflation

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