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Sources of inflation and output movements in Poland and Hungary: Policy implications for accession to the economic and monetary union

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Abstract

The paper examines the sources of fluctuations in inflation and output in Poland and Hungary. Using a rational expectations, dynamic open economy aggregate supply–aggregate demand model and considering several disturbances, it is found that balance of payments shocks are important in price level movements in Hungary while nominal shocks are dominant in affecting prices in Poland. Monetary shocks affect output in the short run in Hungary while supply shocks dominate output movements in Poland. A major component of inflation is demand driven, "core" inflation. Finally, the paper discusses policy implications of findings regarding membership in the Economic and Monetary Union.
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1. Introduction

A significant economic and political challenge facing the transition economies of Central and Eastern Europe is to join the Exchange Rate Mechanism (ERM II) of the Economic and Monetary Union (EMU). Ten of these countries have recently joined the European Union (EU) in 2004. The successful accession to EMU by the current transition-economy applicants, the Czech Republic, Hungary, the Slovak Republic, Slovenia and Poland, will depend to a large extent on their ability to align themselves with the macroeconomic policies of the EU. Thus, an important task for the policymakers in the accession countries is to lower the inflation rate and, at the same time, to raise output per capita to a level approaching EU average. Although all transition economies have made a substantial progress in lowering inflation over time, their current inflation levels can be best described as "moderate", ranging between 10% and 20%, still well above the average EU level. [1] On the other hand, the output growth rate in the candidate countries has been somewhat faster than that of the EU, but these economies need to exceed the average EU growth level by a large amount for a sustained period of time if their living standards are to approach EU standards.

The purpose of this paper is to investigate the sources of movements in inflation and output in two leading candidate economies in transition, Hungary and Poland. [2] Understanding the forces underlying inflation and output growth can help policymakers become better prepared for full membership in the EU and also allow them to design credible policies before they establish any formal link to the Euro. Among the performance measures that most observers would view as important markers of credibility for joining the EMS are inflation and output growth. In addition, some leading transition economies, such as the Czech Republic, Hungary, and Poland, have been pursuing a policy of inflation targeting to better control and reduce inflation. Therefore, an empirical analysis of inflation rate movements in such countries can be more useful for their monetary authorities to better target desired inflation rates, and their experience may provide important lessons for other candidate transition economies.

Price stability has been an important policy goal for all transition policymakers since the beginning of transition efforts in early 1990s. Inflation is often blamed for major distortions in the economy, lack of foreign direct investment, appreciation of the real exchange rate, and worsening of the income distribution. Hence, it is par-

[1] For an excellent review of price dynamics in the accession transition economies, see Backe et al. (2003).

[2] Other transition economies, including the Czech Republic, are not included due to insufficient observations for empirical analysis.

ticularly important to better understand the extent to which inflation is a demand driven, "core inflation." In this paper, we construct a measure of core inflation for Poland and Hungary. If a substantial portion of total inflation is demand driven or core inflation, then there is room for policies aimed at limiting discretionary demand to bring down inflation and stabilize the economy. Looking forward, our results suggest that a major component of inflation in the two countries has been demand driven. This finding has important implications for the success of the inflation targeting policy recently announced by the National Bank of Hungary and the Bank of Poland.

Brada (1998) and Desai (1997, 1998) argue that different initial conditions and different starting times of stabilization programs result in different paths for macroeconomic variables, such as output, prices, and real exchange rates. Different approaches to monetary policy may also lead to different behavior in these variables. Hungary began implementing stabilization programs much earlier than Poland and these two countries have also adapted different monetary policy stance and had different initial conditions. Jakab and Kovács (1999) provide empirical evidence that real exchange movements in Hungary during 1990s were affected by both supply and demand shocks. Dibooglu and Kutan (2001) examined real exchange movements in Poland and Hungary during 1990–1999 and found that different factors were responsible for real exchange rate fluctuations in these countries. In this paper, we also extend the literature on this issue by further testing the validity of arguments made by Brada (1998) and Desai (1997, 1998) about the behavior of prices and output in leading transition economies of Hungary and Poland.

The rest of the paper is organized as follows. In the next section, we provide an overview of macroeconomic policy in Hungary and Poland. Section 3 describes our methodology. In Section 4, we describe data employed and present our empirical results. Section 5 discusses policy implications of our findings and concludes.

2. An overview of macroeconomic policy in Hungary and Poland

2.1. Hungary

Initially, at the beginning of the 1990's, Hungary followed a gradualist macroeconomic policy as the authorities sought to balance the desire for reducing inflation with the need to control the government deficit and to service a large external debt. Too large a reduction in inflation would have reduced government revenues and increased expenditures on the social safety net, thus increasing the government's need to borrow abroad. Monetary policy included active exchange rate management based on a currency peg with a narrow band of permitted fluctuations (Kutan and Brada, 2000).

The initial exchange rate policy, which aimed at a real appreciation of the forint to help combat domestic inflation, was found to be too costly because of the declining competitiveness of Hungarian exports and sluggish growth. Moreover, it failed to provide a nominal exchange rate anchor to reduce inflationary expectations. These costs began to appear in 1993, when the current account deficit reached 9% of GDP and then increased to 9.4% the following year. At the same time, the government's budget deficit remained unacceptably high (Table 1). The fact that the foreign debt was also growing steadily put Hungary at risk of insolvency. This macroeconomic situation was certainly not sustainable.

During 1990–1994 period, a loose fiscal policy lead to growing budget deficits and a high level of foreign debt. Financing this deficit required monetary expansion as well as high interest rates so that commercial banks would find government securities attractive, thus fueling the inflation that the strong forint policy had sought to reduce. The disinflation policy combined with a fixed exchange rate resulted in continuous real appreciation, causing a loss of competitiveness and high current account deficits. The persistence of these twin deficits (Table 1) created uncertainty among Hungary's foreign creditors as well as concerns about the stability of the forint.

The two conflicting priorities of the government, the control of inflation and improving international competitiveness, led to speculation against the forint, which undermined the credibility of the exchange rate regime. Liberalization of foreign exchange operations and the continuous real appreciation of the forint, resulting in significant capital inflows, gradually narrowed the ability of the monetary authorities to control the money supply. Moreover, during this period, there was no coordination between monetary and fiscal policy (Nemenyi, 1997).

The 1994 Mexican crisis further worsened Hungary's ability to borrow in international markets as the risk premium increased for emerging markets. The government realized that it could not sustain the dual objectives of controlling inflation and

Table 1
Hungary: macroeconomic indicators; 1991–2001

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Real GDP growth (%)	−11.9	−3.1	−0.6	2.9	1.5	1.4	4.6	4.9	4.2	5.2	3.8
CPI rate of inflation (%)	34.2	23.0	22.5	18.9	28.3	23.5	18.3	14.3	10.0	9.8	9.2
In % of GDP:											
Current account balance	0.8	0.9	−9.0	−9.4	−5.6	−3.7	−2.1	−4.8	−4.3	−2.8	−2.1
Government deficit[a]	3.0	7.0	6.5	8.4	6.7	3.1	4.9	4.8	3.7	3.7	3.0
Public debt											
Consolidated[b]	66.9	65.0	84.3	83.2	85.4	71.7	63.6	63.5	66.6	62.1	57.1
Non-consolidated[c]	74.7	79.0	90.8	88.3	86.5	72.6	63.7	62.1	61.1	56.0	52.8

Note: Figures for 2001 are preliminary.

[a] Based on official data reported in Kiss and Szapáry (Table 2, 2000), which includes transactions of the central government, the social security funds, the local authorities, and the extra-budgetary funds. For details, see Kiss and Szapáry (2000).

[b] Government and National Bank of Hungary, excluding the sterilization instruments of the central bank, see Kiss and Szapáry (Table 1, 2000).

[c] Non-consolidated with the National Bank of Hungary. For details, see Kiss and Szapáry (Table 1, 2000).

improving international competitiveness at the same time and, as a result, announced a major fiscal adjustment program in March 1995 (Szapáry and Jakab, 1998). Fiscal policy was tightened to reduce the twin deficits through lower government expenditures, higher import tariffs, and reduced government borrowing. Price stability was declared the key goal of monetary policy in the long run.

The March 1995 measures included a major change in the nominal exchange rate regime that was intended to create credibility for economic policy and reduce the uncertainty associated with future policy measures so as to restore investors' confidence in the system (Nemenyi, 1997). Following a 9% devaluation of the official exchange rate, a preannounced crawling band exchange rate system was introduced in March 1995. The band of permitted fluctuations was set at 2.25% on either side of the parity, and thus has been maintained until May 2001, and since then, the new band was raised to ±15%. The rate of crawl was set according to an inflation target. The initial monthly rate was 1.9% and it was gradually reduced to 0.3% in April 2000. In January 2000, the exchange rate was completely tied to the Euro. Crawling devaluations have exerted inflationary pressures on the economy and the inflation rate exceeded that of Poland. In addition, the National Bank of Hungary faced growing problems regarding the large capital inflows (Orlowski, 2003). In the face of these increasing problems, the Bank announced a policy of inflation targeting as of June 2001. Initial evidence indicates that inflation targeting has met with success so far. Year-on-year CPI inflation declined steadily from about 10% in 2001 to 5.9% in March 2002 (IMF, 2002a). Inflation fell further to 3.9% in April 2003. However, lower inflation might have also reflected declining food and fuel prices, besides the policy stance.

In sum, the post-1995 exchange rate regime in Hungary focused on the stability of the nominal exchange rate as a tool of disinflation and on preventing significant real appreciation of the forint in order to sustain the current account balance and to control capital inflows (Orlowski, 2000). In addition, Hungary experienced some shock therapy, e.g. the bankruptcy legislation introduced in the early 1990s. It received a significant amount of foreign direct investment. As a result, supply shocks should play a key role in output and price movements. The 1995 Bokros package also contained elements of shock therapy, including drastic cuts in budget spending, devaluation of the forint, change to a crawling peg and the introduction of import surcharges. Finally, the National Bank of Hungary has recently moved to put more emphasis on price stability and less emphasis on exchange rate stabilization. To this end it widened the exchange rate band in May 2001. Ability to sustain the wide band will depend upon on the success of inflation targeting regime and policies that are consistent with the band itself.

2.2. Poland

The stabilization of the Polish economy began under much less favorable conditions than those found in Hungary. In 1989, inflation peaked at 54.8% per month, the government deficit was nearly 8% of GDP and both loss-making Polish firms and the government deficit were financed by rapid expansion of money and credit.

Although the government began to deal with the crisis in late 1989, the major stabilization program began on January 1, 1990 with the Balcerowicz Plan. The zloty (zl) was devalued from 5560 zl/US$ to 9500 zl/US$ and pegged at the latter rate. Monetary and fiscal policies were tightened, enabling the government to achieve a surplus equivalent to 2.8% of GDP in 1990 (Table 2) and credit creation was sharply curtailed (Brada and Kutan, 1999). The consequences of stabilization and liberalization were sufficiently virulent, both in the upsurge in prices and in the decline in production, to lead to an easing of macroeconomic policy late in 1990. However, the effects of this policy change were felt more in an acceleration of inflation than in real output growth (Wellisz, 1997) and the government soon abandoned this effort. As the recession deepened in 1991, the fiscal deficit reappeared and high inflation reduced the competitiveness of Polish exports. The zloty was devalued by 17% in May 1991, and its peg was shifted to a basket of currencies.

Policy priorities gradually shifted from stabilization to stimulating growth (Krzak, 1996). Although the fiscal deficit was cut from 4.9% of GDP in 1992 to 2.7% in 1993 (Table 2), a level around which it has fluctuated since, monetary policy was relatively expansionary. While real interest rates remained positive, money supply and credit growth consistently outpaced the targets set by the National Bank of Poland (NBP). The zloty's peg was abandoned in October of 1991, replaced by a crawling peg in the same month with a preannounced devaluation of 1.8% per month against a basket of currencies (Nuti, 2000). Over time, the rate of depreciation has been reduced and there have also been on–off devaluations and revaluations to accommodate exogenous shocks. In 1995, the band within which the zloty could fluctuate was widened to ±7%. Poland's exchange rate policy was sufficiently credible to foreign investors that short-term capital inflows began to be a problem for the NBP by 1995 when, even with some NBP sterilization, capital inflows accounted for 59% of the growth of the money supply (Krzak, 1996). As a result, controlling the money supply became more difficult for the monetary authorities. On April 12, 2000, Poland announced a full float exchange rate arrangement.

Although Poland has had a higher rate of inflation than Hungary in the 1990s, it has also had a faster rate of growth of real GDP (Table 2). Relatively higher growth in Poland may be due as much to an earlier start in implementing economic reforms as to better economic policy. Analogously, Poland's higher rate of inflation may reflect its more severe initial macroeconomic disequilibrium rather than an inability to restrain the growth of the money supply. Recently, output growth has slowed somewhat due to a fall in exports to Russia and the Ukraine caused by the financial crises in those countries. As inflation has slackened and as the nominal anchor of the crawling peg has decreased in importance with a further widening of the bands, Poland has adopted inflation targeting in January 1999 (Brada and Kutan, 1999). In 1998, the Monetary Policy Council set a goal of lowering Polish inflation to 6.8–7.8% in 1999 and 4% as measured by the CPI by the year 2003. As shown in Table 2, the inflation rate for 1999 and 2000 was 10% and 9.8%, respectively, which are much higher than the estimates made by the Council for 1999.

However, recent data shows that Poland has been successful with inflation targeting so far. The headline inflation rate turned out to be 3.5% at the end of 2001, below

Table 2
Poland: macroeconomic indicators; 1990–2001

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
GDP real growth rate	−11.6	−7.0	2.6	3.8	5.2	7.0	6.1	6.9	4.8	4.1	4.1	1.0
CPI rate of inflation	249	60.4	44.3	37.6	29.5	21.6	18.5	13.2	8.6	9.8	8.5	3.6
In % of GDP:												
Current account balance	5.2	−2.8	−3.7	−2.7	−1	4.3	−0.9	−3	−4.3	−7.5	−6.1	−4.6
General government balance[a]	2.8	−1.8	−4.9	−2.3	−2.7	−2.6	−2.5	−1.3	−2.4	−2.0	−2.2	−5.6
Public debt	na	na	147.3	108.6	69.0	59.0	53.6	49.4	43.0	41.0	42.0	41.9

Sources: EBRD Transition Report, various issues, EIU and national statistics.

[a] General government includes the state, municipalities and extra-budgetary funds. General government balance includes privatization receipts. Figures for 2001 are preliminary.

the end-2003 target range of 4%. Seasonally inflation rate during the first quarter of 2002 was less than 1%. This figure was due to favorable harvest and decline in fuel prices; but inflation excluding these prices was about only 4% annually during 2002. In the first quarter of 2002, the economy even experienced deflation of 0.5% (IMF, 2002b).

In summary, Poland moved gradually from a rigid fixed exchange rate targeting regime to a more flexible system with wide bands over time before a fully flexible exchange rate regime in April 2000. Monetary policy in Hungary was geared to nominal exchange rate stability and radical measures were taken that generated substantial real shocks to the economy.

3. The dynamic effects of the shocks: An illustrative model

This section presents a dynamic aggregate supply–aggregate demand model that incorporates some important elements of an economy in transition, namely balance of payments problems and finite capital mobility. The model is consistent with a vertical long-run Phillips curve, and represents a middle ground between market clearing approaches and models based on short run nominal inertia and nominal rigidities. Models of this nature have been applied extensively to explain macroeconomic fluctuations (Karras, 1994; Ahmed and Park, 1994) and real exchange rate fluctuations (Weber, 1997). A similar small, open economy model based on household optimization can be found in Clarida et al. (2001). Moreover, Quah and Vahey (1995) propose a technique for measuring core inflation based on aggregate demand neutrality: Core inflation is defined as that component of measured inflation that has no long-run impact on real output, a notion consistent with the vertical long-run Phillips curve. Recently, Wehinger (2000) use this aggregate demand neutrality to derive core inflation for the G7 countries and we follow a similar strategy in this paper.

In order to motivate the restrictions embedded in the structural VAR model, consider a dynamic, open economy aggregate supply–aggregate demand model:

$$h_t = h_{t-1} + \epsilon_t^h, \quad \text{Evolution of terms of trade,} \tag{1}$$

$$y_t^s = \breve{y}_t + \theta h_t, \quad \text{Aggregate supply,} \tag{2}$$

$$\breve{y}_t = \breve{y}_{t-1} + \epsilon_t^s, \quad \text{Evolution of capacity output,} \tag{3}$$

$$k[i_t - i_t^* - (E_t s_{t+1} - s_t) - \rho_t] + \eta_1(s_t - p_t) - \eta_2 y_t + b_t = 0, \quad \text{Balance of Payments (BOP),} \tag{4}$$

$$i_t = (E_t s_{t+1} - s_t) - (\eta_1/k)(s_t - p_t) + (\eta_2/k)y_t + [i_t^* + \rho_t - (1/k)b_t], \tag{4$'$}$$

$$z_t = [i_t^* + \rho_t - (1/k)b_t], \quad \text{BOP shock,} \tag{5}$$

$$z_t = z_{t-1} + \epsilon_t^z, \quad \text{Evolution of BOP shock,} \tag{5$'$}$$

$$y_t^d = d_t - \gamma[i_t - E_t(p_{t+1} - p_t)] + \eta_1(s_t - p_t) - \eta_2 y_t, \quad \text{Aggregate demand/IS,} \tag{6}$$

$$d_t = d_{t-1} + \epsilon_t^d, \quad \text{Aggregate demand shock,} \tag{7}$$

$$m_t^d = p_t + y_t - \lambda i_t - \mu z_t, \quad \text{Money demand,} \tag{8}$$

$$m_t^s = m_{t-1}^s + \epsilon_t^m, \quad \text{Money supply,} \tag{9}$$

$$y_t^s = y_t^d = y_t, \quad \text{Goods market equilibrium,} \tag{10}$$

$$m_t^s = m_t^d = m_t, \quad \text{Money market equilibrium,} \tag{11}$$

where h is the terms of trade, y is domestic output, $\breve{y}$ is capacity output, i is domestic nominal interest rate, i^* is the foreign interest rate, s is the exchange rate expressed as the domestic currency price of foreign currency, p is the domestic price level, m is the money stock, d is autonomous aggregate demand, ρ is a risk premium on domestic currency investments, b represents an exogenous shift in net exports due to e.g., a change in competitiveness, z represents exogenous elements in the balance of payments equation, ϵ^j are stochastic disturbances, E_t is the expectations operator conditional on information available at time t, all variables except interest rates are in logarithms, and the remaining Greek letters designate parameters which are assumed positive.

Eq. (1) is the evolution of the terms of trade, which is assumed to follow a random walk. Eq. (2) is an aggregate supply equation, where aggregate supply depends on capacity output and terms of trade. Capacity output is a function of the productive capacity of the economy (e.g., capital stock and employment), and for simplicity, it is assumed to follow a random walk. Supply shocks are interpreted broadly to include productivity enhancing developments such as increases in the capital stock and improvements in technology as well as "cost-push" elements stemming from input markets.

A distinguishing feature of the model is that, it can accommodate non-instantaneous adjustment in the balance of payments. Capital inflows are a function of the net domestic rate of return adjusted for a risk premium. Note that the parameter k represents the degree of capital mobility and large values of k indicate higher levels of capital mobility. The trade balance is a function of the real exchange rate [3] $(s_t - p_t)$ and domestic income. Moreover, due to exogenous changes in terms of trade, b_t represents exogenous increases in net exports. Although Eq. (4) may seem to impose a zero balance of payments, the existence of the shift term b_t provides a more general specification. For example, one can view b_t as an exogenous level for the balance of payments. Eq. (4′) rewrites Eq. (4) in terms of the domestic nominal interest rate while Eq. (5) pools all the exogenous elements in the balance of

[3] For simplicity, foreign prices are normalized to unity. In the empirical analysis we will use the real effective exchange rate, which does not assume unit foreign prices.

payments equation to define z_t. Eq. (5′) specifies the evolution of z_t as a non-stationary stochastic process. [4]

Eq. (6) is an aggregate demand (IS) equation where aggregate spending depends on the expected real interest rate and net exports. The autonomous portion of aggregate demand, d_t, is assumed to follow a random walk in Eq. (7). Eq. (8) is a conventional money demand equation. In order to obtain a simple solution, money demand is assumed to have unitary income elasticity. Money demand is also a function of the exogenous elements in the balance of payments. This specification allows for reductions in money demand when there are exogenous shifts in the balance of payments which may necessitate a depreciation of domestic currency. Moreover, when there is a risk premium associated with domestic currency or self-fulfilling fads in exchange rate expectations, z_t will be positive. In such cases, money demand is reduced by μz_t.

Eq. (9) is the evolution of money supply, which for simplicity, is assumed to follow a random walk. [5] Finally we close the model by postulating goods and money market equilibrium relationships (Eqs. (10) and (11)) and proceed to solve the model for the rational expectations equilibrium.

In order to solve the model, we eliminate the interest rate from Eqs. (6) and (8) using Eq. (4′) to obtain the following system:

$$\begin{vmatrix} \lambda\left(1+\dfrac{\eta_1}{k}\right) & 1-\dfrac{\lambda\eta_1}{k} \\ \gamma\left(1+\dfrac{\eta_1}{k}\right)+\eta_1 & -\gamma\left(1+\dfrac{\eta_1}{k}\right)-\eta_1 \end{vmatrix}\begin{vmatrix} s_t \\ p_t \end{vmatrix} = \begin{vmatrix} \lambda & 0 \\ \gamma & -\gamma \end{vmatrix}\begin{vmatrix} E_t s_{t+1} \\ E_t p_{t+1} \end{vmatrix} + \begin{vmatrix} m_t - \left(\dfrac{\lambda\eta_2}{k}-1\right)y_t + (\mu-\lambda)z_t \\ \left(1+\eta_2+\dfrac{\eta_2\gamma}{k}\right)y_t - d_t - \gamma z_t \end{vmatrix}. \tag{12}$$

The system can be written compactly as $AY_t = BE_tY_{t+1} + W_t$, or $Y_t = \Pi E_tY_{t+1} + CW_t$ where $C = A^{-1}$ and $\Pi = A^{-1}B$. The eigenvalues of the matrix Π are $\{1/(1+\lambda);\ \gamma k/(\gamma k + \gamma\eta_1 + k\eta_1)\}$. The eigenvalues are both within the unit circle for finite values of the parameters, hence the forward looking solution is convergent. The forward looking solution to the system in (12) is

$$E_tY_{t+1} = C\sum_{i=0}^{\infty} \Pi^i E_tW_{t+i+1}. \tag{13}$$

Given the stochastic processes for the exogenous variables, it is evident that $E_tW_{t+i} = W_t$ for $i = 1,2,\ldots$ Then the solutions for the real exchange rate, real money balances, and the price level in terms of the exogenous variables are:

---

[4] Although ϵ_t^z is labeled a "balance of payments shock", it is evident that it captures foreign interest rate shocks, risk premium shocks, and competitiveness shocks. Without further structure, it is impossible to disentangle ϵ_t^z into its constituent parts. To keep the dimensions of the VAR tractable, ϵ_t^z will be a composite shock of the above.

[5] In the empirical model, we do not restrict "exogenous variables" to follow any particular process; the assumption of random walk is to illustrate the identification restrictions.

$$s_t - p_t = \left[\frac{k}{\eta_1(\gamma+k)} + \frac{\eta_2}{\eta_1}\right] y_t - \frac{\gamma k}{\eta_1(\gamma+k)} z_t - \frac{k}{\eta_1(\gamma+k)} d_t, \tag{14}$$

$$\begin{gathered} m_t - p_t = c_1 y_t + c_2 z_t + c_3 d_t \\ c_1 \equiv \frac{2\lambda\eta_2 + \lambda k}{k(\gamma+k)} - 1, \quad c_2 \equiv \frac{\lambda k}{\gamma+k} - \mu, \quad c_3 \equiv -\frac{\lambda}{\gamma+k}, \end{gathered} \tag{15}$$

$$p_t = m_t - c_1 y_t - c_2 z_t - c_3 d_t. \tag{16}$$

The observed movements in the vector of variables $X_t = [h_t\ y_t\ (m_t - p_t)\ (s_t - p_t)\ p_t]'$ are due to five mutually uncorrelated "structural" shocks with finite variances, $\epsilon_t = [\epsilon_t^h\ \ \epsilon_t^s\ \ \epsilon_t^z\ \ \epsilon_t^d\ \ \epsilon_t^m]$. These are terms of trade shocks, ϵ_t^h; aggregate supply shocks, ϵ_t^s; BOP shocks, ϵ_t^z; aggregate demand shocks, ϵ_t^d; and monetary/nominal shocks, [6] ϵ_t^m.

It can be shown that the long run impact of the structural shocks on the endogenous variables has a peculiar structure. In order to show the long run effect of structural shocks, ϵ_t, on X_t we express the solution to the model in first differences:

$$\Delta h_t = \epsilon_t^h, \tag{17}$$

$$\Delta y_t = \theta\epsilon_t^h + \epsilon_t^s, \tag{18}$$

$$\Delta(m_t - p_t) = c_1(\epsilon_t^s + \theta\epsilon_t^h) + c_2\epsilon_t^z + c_3\epsilon_t^d, \tag{19}$$

$$\Delta(s_t - p_t) = \left[\frac{k}{\eta_1(\gamma+k)} + \frac{\eta_2}{\eta_1}\right](\epsilon_t^s + \theta\epsilon_t^h) - \frac{\gamma k}{\eta_1(\gamma+k)}\epsilon_t^z - \frac{k}{\eta_1(\gamma+k)}\epsilon_t^d, \tag{20}$$

$$\Delta p_t = -c_1\theta\epsilon_t^h - c_1\epsilon_t^s - c_2\epsilon_t^z - c_3\epsilon_t^d + \epsilon_t^m. \tag{21}$$

Note from Eqs. (15) and (21) that the long run effect of a BOP shock on the price level depends on the degree of capital mobility and on the magnitude of the semi-interest elasticity of money, λ, relative to the elasticity of money demand with respect to a BOP deterioration, μ. Assuming k is sufficiently large, the coefficient c_2 in Eq. (21) reduces to $\lambda - \mu$. When $\mu < \lambda$ ($\mu > \lambda$), the predicted effect of a BOP shock on the price level is positive (negative). Consequently, the long run effect of a BOP shock on the price level is an empirical question. Similarly the long run effect of a supply shock on the price level can be of either sign. Notice that although all endogenous variables are unit root stochastic processes, the vector X_t is difference stationary. Finally, the long run impact of the structural shocks on the endogenous variables is "near-triangular", which we show in the next section.

3.1. Identification of the shocks

Since the vector ΔX_t is covariance stationary, it can be written as an infinite moving average process in the structural shocks:

[6] Both Poland and Hungary have had a managed exchange rate system; as such the money supply is more likely to be endogenous. Hence, it is more appropriate to interpret monetary shocks ϵ_t^m broadly to include policy shocks on the exchange rate.

$$\Delta X_t = \sum_{i=0}^{\infty} A_i \epsilon_{t-i} = A(L)\epsilon_t, \tag{22}$$

where $A(L)$ is a matrix whose elements are polynomials in the lag operator L. Denote the elements of $A(L)$ by $a_{ij}(L)$. The time path of the effects of a shock in ϵ_j on variable i after k periods can be denoted $\omega_{ij}(k)$. We also adopt the notation such that $A(1)$ is the matrix of long run effects whose elements are denoted $a_{ij}(1)$; each element gives the cumulative effect of a shock in ϵ_j on variable i over time. Similarly, A_0 is the matrix of the contemporaneous impact effects. The objective of identification is to discern the 25 elements of A_0. Given the model structure above, the *long run* effects of the shocks on the endogenous variables are given by

$$\begin{vmatrix} \Delta h_t \\ \Delta y_t \\ \Delta(m_t - p_t) \\ \Delta(s_t - p_t) \\ \Delta p_t \end{vmatrix} = \begin{vmatrix} a_{11}(1) & 0 & 0 & 0 & 0 \\ a_{21}(1) & a_{22}(1) & 0 & 0 & 0 \\ a_{31}(1) & a_{32}(1) & a_{33}(1) & a_{34}(1) & 0 \\ a_{41}(1) & a_{42}(1) & a_{43}(1) & a_{44}(1) & 0 \\ a_{51}(1) & a_{52}(1) & a_{53}(1) & a_{54}(1) & a_{55}(1) \end{vmatrix} \begin{vmatrix} \epsilon_t^h \\ \epsilon_t^s \\ \epsilon_t^z \\ \epsilon_t^d \\ \epsilon_t^m \end{vmatrix}. \tag{23}$$

Note that the matrix of long run effects is lower triangular except that $a_{34}(1)$ is not zero. However in the limit, the model yields convenient restrictions for identification depending on the degree of capital mobility. For example, if one assumes perfect capital mobility so that $k \to \infty$, aggregate demand shocks have no long run effect on real money balances. An aggregate demand shock in this case has no effect on real interest rates; any autonomous changes in aggregate demand have to be offset by a nominal and real appreciation of domestic currency. As a result, net exports decline and aggregate demand shocks have no *long run* effect on real money balances under perfect capital mobility. Perfect capital mobility implies that the coefficient $c_3 = -\lambda/(\gamma + k)$ in Eqs. (15) and (19) and the long run response, $a_{34}(1)$ in Eq. (23), are zero.

If capital is completely immobile so that $k \to 0$, the model has recursive long run impact multipliers. This can be seen by using the definition of z_t in Eq. (5) and taking the limit of Eq. (14) as $k \to 0$:

$$s_t - p_t = \frac{\eta_2}{\eta_1} y_t - \frac{1}{\eta_1} b_t. \tag{14$'$}$$

In this case, the long run effects of the shocks on the endogenous variables are:

$$\begin{vmatrix} \Delta h_t \\ \Delta y_t \\ \Delta(s_t - p_t) \\ \Delta(m_t - p_t) \\ \Delta p_t \end{vmatrix} = \begin{vmatrix} a_{11}(1) & 0 & 0 & 0 & 0 \\ a_{21}(1) & a_{22}(1) & 0 & 0 & 0 \\ a_{31}(1) & a_{32}(1) & a_{33}(1) & 0 & 0 \\ a_{41}(1) & a_{42}(1) & a_{43}(1) & a_{44}(1) & 0 \\ a_{51}(1) & a_{52}(1) & a_{53}(1) & a_{54}(1) & a_{55}(1) \end{vmatrix} \begin{vmatrix} \epsilon_t^h \\ \epsilon_t^s \\ \epsilon_t^b \\ \epsilon_t^d \\ \epsilon_t^m \end{vmatrix}. \tag{23$'$}$$

Note that the new trade balance shock, ϵ_t^b, is a pure exogenous shift in the balance of payments, as opposed to ϵ_t^z in Eq. (5′), which is a composite shock that includes exogenous changes in the foreign interest rate, changes in the currency risk premium, as well as exogenous changes in the balance of payments.

4. Empirical results

Our benchmark model consists of the system in (23) with "perfect capital mobility" where $a_{34}(1) = 0$. After estimating the model, we perform variance decompositions and impulse response analysis to study the dynamic effects of terms of trade, aggregate supply, balance of payments, real demand, and monetary shocks on the price level and output. We then use simulations based on historical realizations of the orthogonal shocks to construct estimates of "core" inflation. The data are monthly from January 1991 through September 2001. The measures of the variables are: $h_t =$ terms of trade (the relative price of exports in terms of imports), $y_t =$ industrial production index, $q_t =$ real effective exchange rate, $p_t =$ consumer price index, $m_t = M3$ for Hungary, and $M2$ for Poland. All series are from CD ROM edition of the *International Financial Statistics*, except that industrial production in Poland is updated using the Plan Econ Inc. database after 1996:1, and $M3$ in Hungary is from the National Bank of Hungary. Data for the terms of trade on a monthly basis is not available for Hungary; we extracted monthly data from quarterly series using the cubic spline method. In this case the results are not sensitive to the extrapolation methods as the results are similar when a linear interpolation method is used. All data are seasonally adjusted using the Census X-11 additive technique. However, the results are not sensitive to seasonal adjustment, as the multiplicative method yields similar results. We realize that using industrial production for domestic output ignores important components of domestic output such as services, but data and sample limitations preclude using GDP in such disaggregated framework; hence the results should be interpreted with some caution.

In order to pretest variables of stationarity, we present Augmented Dickey–Fuller (ADF) and KPSS tests for the levels and first differences of the variables in Table 3. The ADF test statistics seem to be sensitive to the lag length, hence we present sample autocorrelation coefficients for the series. The sample ADF test statistics indicate that all variables are stationary in the first differences at the 5% significance level. A unit root cannot be rejected for all series in levels except for the terms of trade series for Poland. However in this case, the sample autocorrelation function exhibits slow decay. The KPSS tests indicate stationarity is rejected for all series in levels except for the real exchange rate in Poland, which is on the borderline at the 5% significance level. The KPSS test indicates that stationarity for the first differences of the variables is not clear cut as the test statistics are on the borderline. For the empirical model, we proceed with the assumption that all variables are unit root processes in levels, and stationary in first differences.

After specifying the vector of endogenous variables as $\Delta X_t = [\Delta h_t \ \Delta y_t \ \Delta(m_t - p_t) \ \Delta(s_t - p_t) \ \Delta p_t]'$, we estimate the VAR for Poland and Hungary. Starting with a maximum lag of 6, the Akaike Information Criterion indicates 6 lags are appropriate. The transition process by its very nature involves structural change. Moreover,

Table 3
Unit root tests

	q_t	p_t	$m_t - p_t$	y_t	h_t	Δq_t	Δp_t	$\Delta(m_t - p_t)$	Δy_t	Δh_t
Poland										
Autocorrelations (ρ_k)										
$k = 1$	0.98	0.99	0.99	0.98	0.86	0.25	0.67	0.06	−0.43	0.65
$k = 6$	0.92	0.98	0.98	0.97	0.64	0.03	0.49	0.01	0.37	−0.10
$k = 12$	0.81	0.93	0.93	0.90	0.57	−0.26	0.45	−0.23	0.13	0.34
ADF τ_τ statistics										
	−3.08	−2.22	−2.30	−1.38	−4.48	−8.13	−5.69	−9.56	−4.92	−6.41
Lags	2	6	2	9	5	1	5	1	10	7
KPSS statistics										
	0.15	0.67	0.51	0.32	0.38	0.08	0.22	0.18	0.16	0.15
Hungary										
Autocorrelations (ρ_k)										
$k = 1$	0.97	0.99	0.98	0.98	0.90	0.13	0.46	0.14	−0.45	0.65
$k = 6$	0.80	0.98	0.85	0.95	0.16	−0.14	0.38	−0.01	0.29	−0.11
$k = 12$	0.62	0.94	0.60	0.87	0.50	−0.13	0.30	−0.07	0.15	0.34
ADF τ_τ statistics										
	−2.64	0.64	−0.95	−1.98	−0.26	−4.67	−6.16	−4.26	−3.33	−6.04
Lags	10	2	3	9	12	6	1	2	8	12
KPSS statistics										
	0.18	0.65	0.53	0.48	0.35	0.17	0.13	0.16	0.14	0.02

Notes: Both ADF and KPSS tests include an intercept and a deterministic trend. The critical value of the ADF τ_τ test at the 5% significance level is −3.45. The maximum lag for the ADF test is selected by the Akaike Criterion. The lag truncation for the KPSS test is set at 4. The KPSS critical values at 5% and 1% are 0.15 and 0.22 respectively.

Hungary introduced a major stabilization program in 1995. In order to test for structural change, we divide the sample into two sub-periods: 1991.1–1994.12 and 1995.1–2001.9. We then test for structural change using a multivariate version of the Chow test. The estimated test statistic yields $\chi^2(155) = 448.72$ for Hungary and $\chi^2(155) = 478.23$ for Poland. Both statistics strongly reject the null hypothesis of no structural change. In order to account for the structural change, we include a dummy variable for both countries ($d_1 = 1$ for $t \geqslant 1995{:}1$ and zero otherwise) in the VAR. Moreover, we test for the significance of a dummy variable for the initial phase of the transition. We define $d_2 = 1$ for $t \geqslant 1992{:}1$ and zero otherwise. The estimated test statistics $\chi^2(5) = 16.81$ (Hungary) and $\chi^2(5) = 57.14$ (Poland) strongly reject the null hypothesis that the dummy coefficients are zero. Hence we include the two dummy variables to allow for shifts in the means of the variables in all VARs.

In order to properly specify the VAR, we investigate the cointegration properties of the data. However, asymptotic distributions for cointegration tests are sensitive to the inclusion of dummy variables. In order to test for cointegration, we follow the Engle–Granger, two step procedure (Engle and Granger, 1987). This involves regressing one variable on the other variables in the system and testing the residual for unit roots using an ADF test. However the critical values are sensitive to the lag length in the ADF test in small samples (see Engle and Yoo, 1987). Since our model contains five variables and two dummies, we calculate critical values of the cointegration test for a sample of the same size as in this paper by simulation. Our methodology is described in Appendix A and the critical values are reported in Table A1.

In order to test for cointegration, we regress q_t on p_t, $(m_t - p_t)$, y_t, h_t, d_1, d_2 and a linear trend using OLS, and test the residuals for unit roots using an ADF test. The Akaike information criterion indicates that three lags are appropriate in the ADF test for Poland and 1 lag is appropriate for Hungary. The estimated test statistics for the null hypothesis of a unit root (non-cointegration) is -3.09 for Poland and -4.15 for Hungary. Both test statistics are smaller in absolute value than the corresponding critical values at the 5% significance level (-4.99 and -5.27 respectively). Hence we conclude that the evidence supports non-cointegration and the VAR in first differences is appropriate. We then estimate the VARs with 6 lags and impose the long run identification restrictions implied by the model under perfect capital mobility (Eq. (23) with $a_{34}(1) = 0$). Innovation accounting typical of VARs are presented below.

4.1. Impulse response functions

Fig. 1 presents responses of the price level to each shock (terms of trade, supply, balance of payments, demand, and monetary) for Poland and Hungary. We present both median responses and a 90% confidence band based on bootstrapping with 1000 draws for the impulse response functions. The figure indicates that the response of the price level to a terms of trade shock is insignificant in both countries. An aggregate supply shock raises the price level in Poland and reduces it in Hungary where the latter response is not significant. Recall that according to the theoretical model, the effect of a supply shock on the price level can be of either sign. The effect of a BOP shock is negative but mostly insignificant in Poland. This indicates that a BOP shock has a significant demand deflating effect in Hungary.

The effect of an aggregate demand shock on prices is initially positive and significant in both countries. Prices gradually rise in response to a monetary shock suggesting some nominal inertia in both Poland and Hungary. Prices level off after a year in both countries.

The response of output to various shocks is given in Fig. 2. Output falls slightly in response to a terms of trade shock in Poland and rises in Hungary although the responses are mostly statistically insignificant. Output effects of supply shocks are positive and significant as expected. A BOP shock has some demand deflating effect, and output initially falls in response to a BOP deterioration. However, the response is statistically insignificant. A real demand shock is expansionary in both countries even though the response is not significant except for the impact effect. Output responses to a monetary shock are not significant in Poland. The monetary shock seems to have an output expansionary effect in Hungary but the responses are mostly insignificant. Overall, the results are broadly consistent with the implications of the aggregate supply–aggregate demand model.

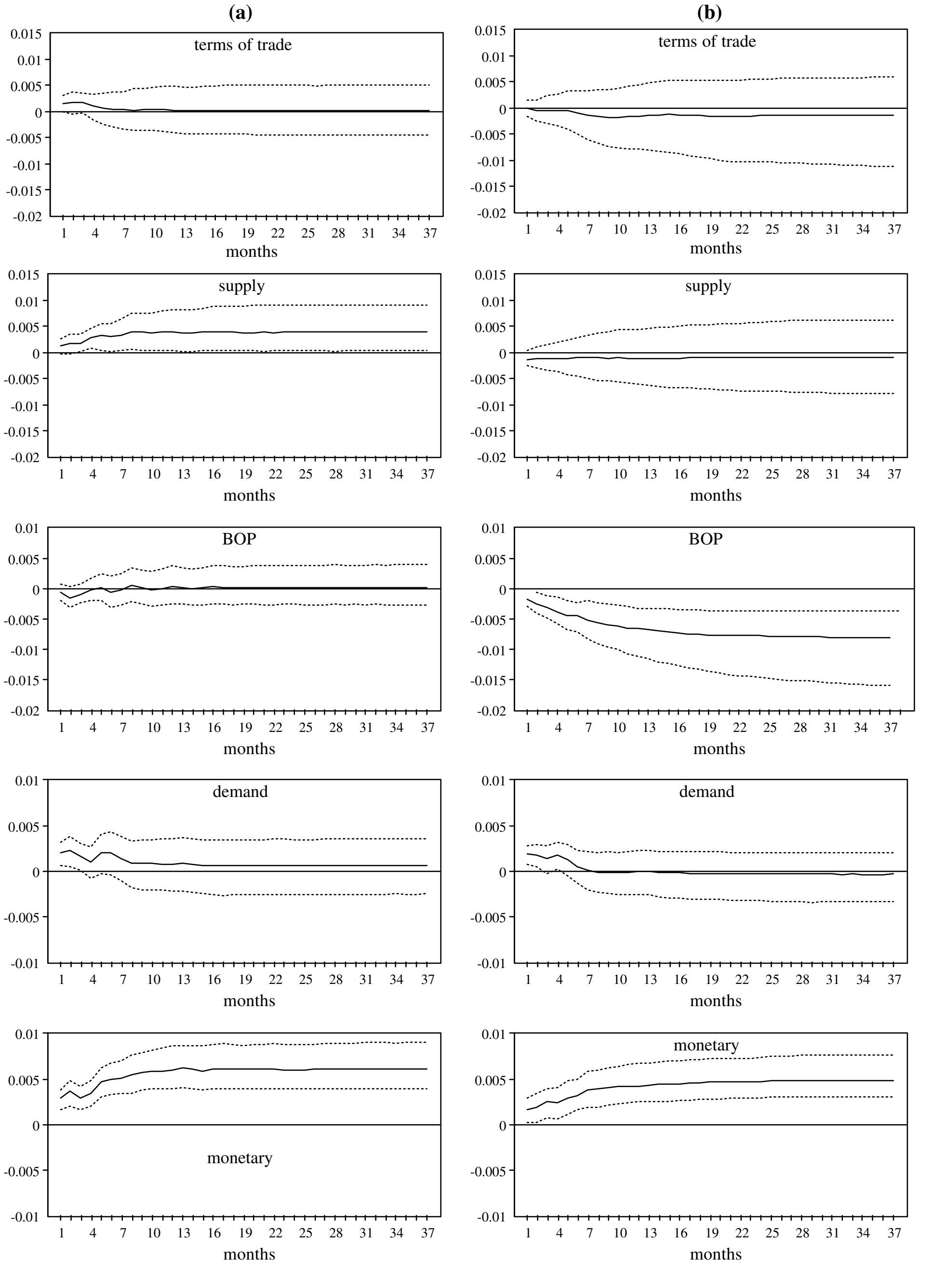

Fig. 1. Response of the price level: (a) Poland and (b) Hungary.

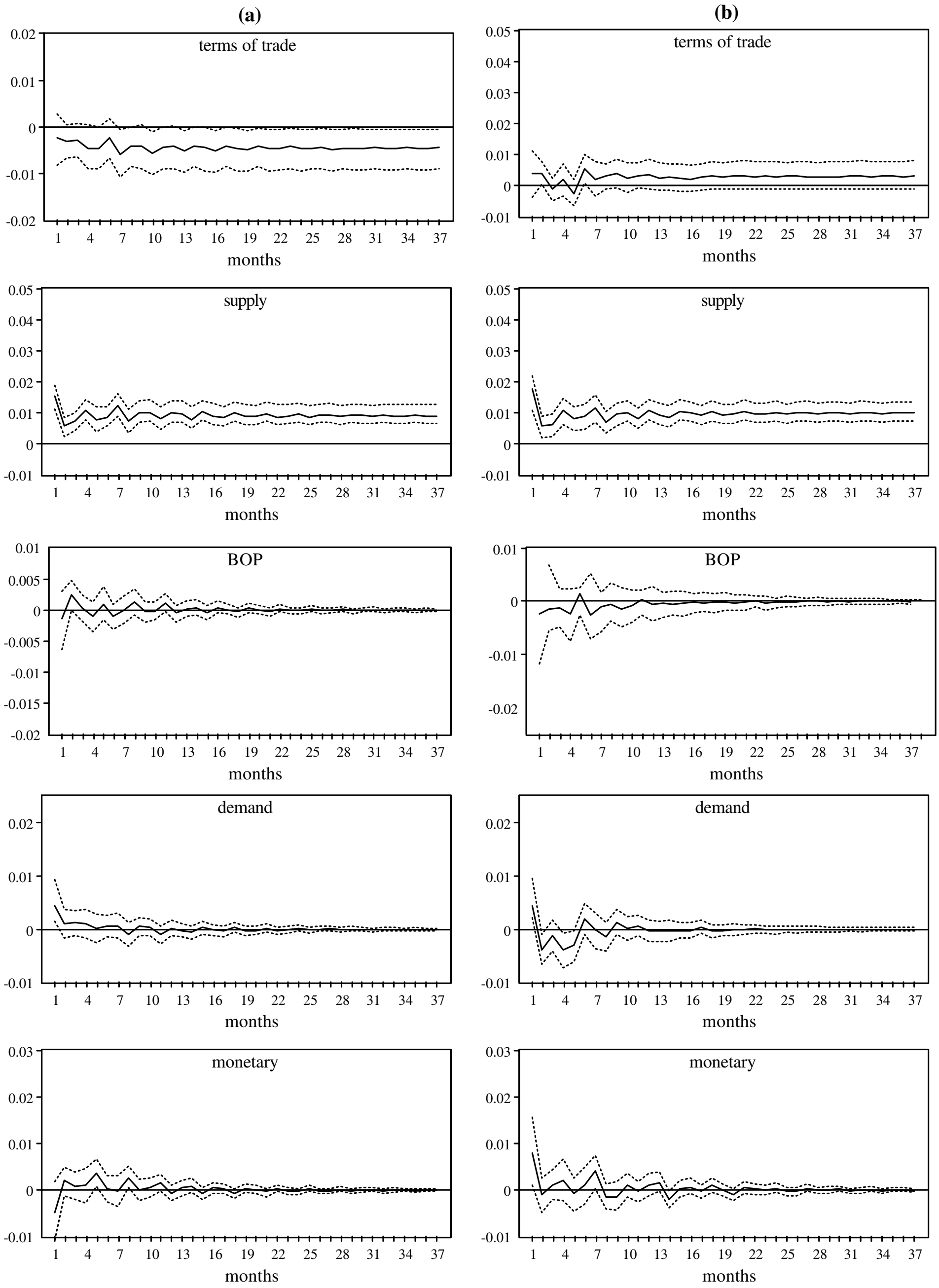

Fig. 2. Responses of output: (a) Poland and (b) Hungary.

4.2. Variance decompositions

Table 4 presents variance decompositions of the price level and output under the assumption of perfect capital mobility. At short term forecasting horizons, apart from monetary shocks, real demand shocks play an important role in explaining the price level in Poland, followed by supply and terms of trade shocks. In Hungary, all shocks except those of terms of trade seem to play an important role in price level movements in the short run.

In the long run, supply, and monetary shocks are dominant for Poland while BOP, monetary and supply shocks seem to dominate the price level in Hungary. Notice the absence of any major role for terms of trade shocks in influencing price level movements in both countries. In that sense terms of trade shocks have minimum direct effect on the price level but they can have secondary effects via shifts in output and the balance of payments. Moreover, monetary shocks explain a sizable proportion of price level movements in Poland rather than Hungary. This may be attributed to the fact that inflation was much larger in Poland at the beginning of transition than in Hungary and monetary policy shocks were more significant in Poland and played a larger role in bringing inflation down. Hungary began implementing stabilization programs much earlier than Poland and these two countries had also adapted different monetary policy stance at the beginning of the transition process.

Variance decompositions of output reveal interesting patterns. First, supply shocks explain a sizable proportion of output movements in both countries. Second, balance of payments are negligible in both countries. Although terms of trade shocks are not restricted in any particular way, they seem to have a moderate effect on out-

Table 4
Variance decomposition of the price level and output: perfect capital mobility

k	Poland					Hungary				
	ϵ^h	ϵ^s	ϵ^z	ϵ^d	ϵ^m	ϵ^h	ϵ^s	ϵ^z	ϵ^d	ϵ^m
Price level										
1	10.8	14.2	0.9	19.2	54.9	4.2	32.5	16.9	31.8	14.5
6	3.6	25.0	1.3	8.8	61.4	6.9	25.8	37.1	9.9	20.4
12	1.1	28.2	1.4	3.0	66.2	5.1	24.0	43.5	2.6	24.8
18	0.7	27.8	1.6	1.6	68.4	5.5	23.5	44.5	1.2	25.4
24	0.5	27.4	1.7	1.1	69.3	5.4	23.1	45.2	0.7	25.6
30	0.4	27.2	1.8	0.8	69.8	5.5	22.8	45.5	0.5	25.7
36	0.4	27.1	1.8	0.6	70.1	5.5	22.7	45.7	0.4	25.8
Output										
1	2.6	76.2	1.5	7.5	12.1	17.7	41.2	7.0	3.4	30.8
6	10.5	76.3	2.2	3.8	7.2	21.0	44.8	6.9	8.8	18.5
12	14.7	77.0	1.5	2.2	4.7	19.3	54.0	5.5	5.8	15.4
18	16.5	77.3	1.1	1.6	3.5	17.5	60.7	4.6	4.5	12.8
24	17.5	77.6	0.9	1.2	2.8	16.6	65.7	3.8	3.5	10.4
30	18.1	77.8	0.7	1.0	2.3	15.7	69.5	3.1	2.9	8.7
36	18.5	78.0	0.6	0.9	2.0	15.1	72.4	2.7	2.5	7.4

Percent of forecast error variance attributable to ϵ^h, ϵ^s, ϵ^z, ϵ^d and ϵ^m.

put in Poland and Hungary. On the other hand, aggregate demand shocks in the broad sense (real demand and monetary shocks) seem to play a different role in explaining output movements in each country. While both types of demand shocks are constrained to have no long run effect on output, the short run effect can be substantial. Indeed, monetary shocks seem to have a sizable effect on output movements in Hungary in the short run while real demand shocks appear to be modest. In Poland, monetary shocks play a moderate role in output movements in the short run while real demand shocks are negligible. This finding supports the arguments made by Brada (1998) and Desai (1997, 1998) that different initial conditions and macroeconomic policy between the two countries are likely to yield different outcomes for the behavior of output and other key macroeconomic variables.

4.3. Imperfect capital mobility and alternative specifications

For transition economies, it may not be reasonable to assume perfect capital mobility particularly in the initial stages of transition since institutional infrastructure was in its infancy and there was currency as well as political risk. However, the leading transition economies today possess almost prefect capital mobility as currency convertibility in both current and capital accounts is introduced.

In order to assess the sensitivity of the results to the assumption of perfect capital mobility, we identify the shocks assuming zero capital mobility. We let $k \to 0$, and impose the triangular long run impact matrix in Eq. (23′). Variance decompositions from this model are summarized in Table 5.

Zero capital mobility evidently has no bearing on the relative importance of terms of trade, supply, or monetary shocks in explaining the price level or output. The effects of no capital mobility can be summarized as follows: The importance of real demand shocks in explaining the price level in Hungary increases in the long run. In Poland, there is a reverse tendency: the effect of real demand shocks on the price level is diminished. As for output, real demand (BOP) shocks explain a higher proportion of output movements in Hungary (Poland) under zero capital mobility.

4.4. Core inflation

Following Quah and Vahey (1995), we construct "core inflation" by eliminating supply side influences (terms of trade shocks and supply shocks). The remaining "demand driven inflation" based on historical realizations of balance of payments shocks, real demand shocks, and monetary shocks gives an idea about the extent of policy induced inflation. [7] If a substantial portion of total inflation is demand driven or "core inflation", there is room for policies aimed at limiting discretionary demand policies to bring down inflation and stabilize the economy. A decomposition of inflation based on historical realizations of the shocks is given in Fig. 3. The figure

[7] Demand driven inflation is only an approximation to policy induced inflation, as not all broadly defined demand shocks are policy related.

Table 5
Variance decomposition of the price level and output: no capital mobility

k	Poland					Hungary				
	ϵ^h	ϵ^s	ϵ^b	ϵ^d	ϵ^m	ϵ^h	ϵ^s	ϵ^b	ϵ^d	ϵ^m
Price level										
1	10.8	14.2	19.0	1.0	55.0	4.2	32.5	2.3	46.4	14.5
6	3.6	25.0	8.5	1.5	61.4	6.9	25.8	5.4	41.5	20.5
12	1.1	28.2	2.7	1.7	66.2	5.1	24.0	14.8	31.2	24.8
18	0.7	27.8	1.5	1.6	68.4	5.5	23.5	16.8	28.9	25.4
24	0.5	27.4	1.2	1.6	69.3	5.4	23.1	18.2	27.7	25.6
30	0.4	27.2	1.0	1.6	69.8	5.5	22.8	19.0	27.0	25.7
36	0.4	27.1	0.9	1.6	70.1	5.5	22.7	19.5	26.6	25.8
Output										
1	2.6	76.2	9.1	0.0	12.1	17.7	41.2	0.1	10.2	30.8
6	10.5	76.3	4.4	1.5	7.2	21.0	44.8	8.6	7.1	18.5
12	14.7	77.0	2.8	0.9	4.7	19.3	54.0	5.7	5.6	15.4
18	16.5	77.3	2.0	0.7	3.5	17.5	60.7	4.7	4.3	12.8
24	17.5	77.6	1.6	0.5	2.8	16.6	65.7	3.8	3.5	10.4
30	18.1	77.8	1.3	0.4	2.3	15.7	69.5	3.2	2.9	8.7
36	18.5	78.0	1.1	0.4	2.0	15.1	72.4	2.7	2.5	7.4

Percent of forecast error variance attributable to ϵ^h, ϵ^s, ϵ^z, ϵ^d and ϵ^m.

presents detrended core and actual inflation series. A core inflation measure higher than total inflation indicates that favorable supply side effects featured strongly to bring down inflation.

Fig. 3 reveals several interesting features of the inflation period in Poland and Hungary. First, in both countries core inflation was never far below total inflation during the entire sample period. As a matter of fact, there is a moderating effect of favorable supply shocks on total inflation in recent years. One can conjecture that the upgrading of old technologies through foreign direct investment, increase in product quality and structure, decline in unit labor costs, and introduction of the post-1995 measures have been some of the main driving forces of the observed increase in output and decline in inflation in Hungary.

Given the negligible non-core inflation and often times moderating supply side influences on inflation, the historical decomposition of inflation has important policy implications. If we assume that core inflation is mostly induced by discretionary demand policies, commitment mechanisms that limit discretionary policies have a good chance of stabilizing inflation.This finding has important policy implications for the success of the inflation targeting policies implemented by both countries.

5. Conclusions

Using a rational expectations, dynamic aggregate supply–aggregate demand model and structural VARs, we have attempted to decompose inflation and output movements into those attributable to terms of trade, supply, balance of payments,

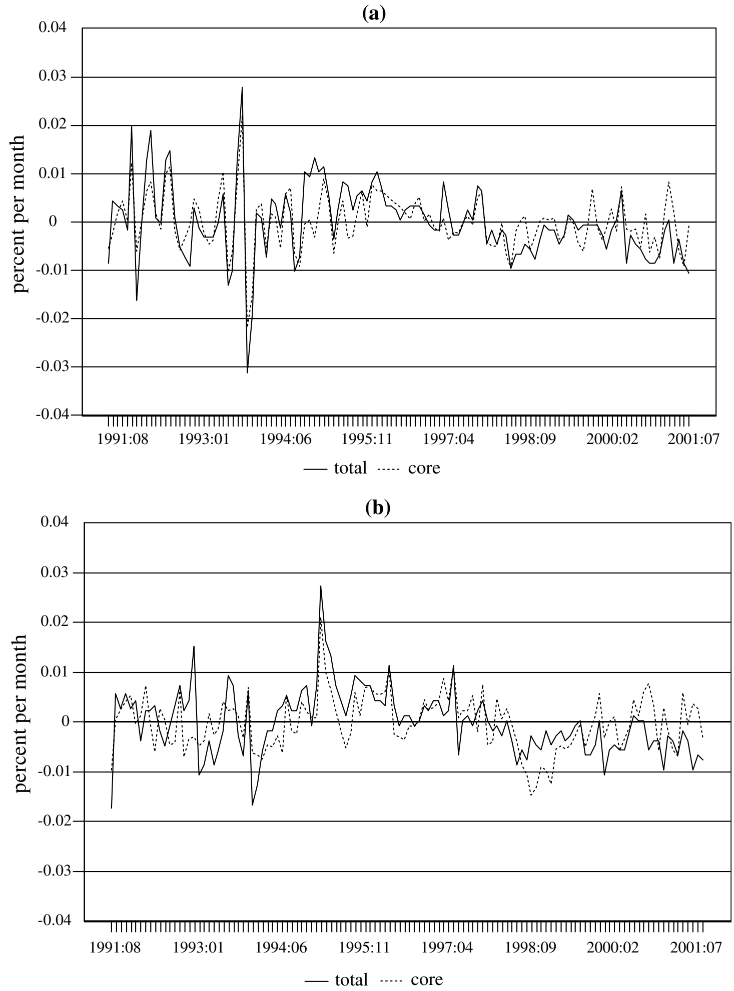

Fig. 3. Core and non-core inflation: (a) Poland and (b) Hungary.

real demand, and monetary shocks. Variance decompositions results have indicated that supply and demand shocks figure prominently in price level movements in Hungary while monetary shocks are dominant in price level movements in Poland. On the other hand, monetary shocks are an important source of output fluctuations in the short run in Hungary suggesting nominal inertia. In Poland, supply shocks affect output, while demand shocks are negligible. Moreover, the results are not overly sensitive to the assumption regarding capital mobility. It is likely that different initial conditions and different starting times of stabilization programs, as well as, different approaches to monetary and exchange rate policy in Poland and Hungary have resulted in different factors driving output and inflation (Brada, 1998; Desai, 1997, 1998). Estimates of core inflation based on historical realizations of the shocks have indicated a significant component of inflation has been demand driven, core inflation. Therefore, it is important that policymakers restrain discretionary demand policies to lower inflation.

Our results are useful for the euro-area preparations of Hungary and Poland and may also provide lessons for other new EU members and candidate countries. The finding that a major component of inflation in the two countries has been demand driven has important policy implication for the success of the inflation targeting policy recently announced by the National Bank of Hungary and the Bank of Poland. By carefully designing efficient and stable aggregate demand policies, our results suggest that policymakers can be effective in controlling inflation and may reach their inflation targets.

Besides lower inflation, the candidate countries also need to raise their per capita real income to EU standards. A critical element in this effort is the reform of the agricultural sector in Poland and foreign direct investment in both countries. The fact that both countries now follow a more flexible exchange rate policy indicates that the relative effect of demand polices may not be as large under such regime than would be under fixed rates. There is evidence that floating rates steepen the short run Phillips curve trade-off (Dornbusch and Krugman, 1976). Accordingly, even if demand policies are not stable, fixed rates would provide a framework that stabilizes their effects. For example, an expansionary policy adopted in response to an imminent decline in economic activity under fixed exchange rates is more likely to raise output and employment rather than wages if it is not expected to persist (Alogoskoufis and Smith, 1991; Eichengreen, 1993). Moreover, expansionary demand policies produce larger increases in output and employment under credible fixed exchange rates when inflation is not expected to persist, as compared to flexible exchange rates. Therefore, expansionary demand policies are likely to result in inflation under increased exchange rate flexibility. In that regard, it is important for policymakers in these countries to continue to have some form of inflation targeting in order to stabilize the economy, and, at the same time, avoid large exchange rate changes.

Finally, a mix of fiscal and monetary policy will play a larger role in the future to accommodate various non-monetary factors that affect inflation. Authorities in these countries must deal with other pressures such as growing unemployment as the candidate countries further lower inflation to the EU standards. Instead of resorting to short-run expansionary aggregate demand policies to deal with unemployment pressures, authorities can focus on creating an environment conducive to long run economic growth. A significant coordination between the government and central banks will hence be even more important to successfully deal with such accession and long run growth issues and also cope with other shocks during the interim period before a formal and final link to the euro.

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Appendix A. Critical values of the cointegration test

In order to calculate the critical values of the Engle–Granger cointegration test, we generated 50,000 random-walk processes of the form

$$x_{it} = x_{it-1} + v_{it}, \quad i = 1, \ldots, 5, \ t = 1, \ldots, T. \tag{A.1}$$

For $T = 129$, five sets of T normally distributed and uncorrelated pseudo-random numbers with standard deviation equal to unity were drawn to represent the $\{v_{it}\}$ sequences. Randomizing the initial values of $\{x_{it}\}$, the next T values of each were generated using (A.1). For each of the 50,000 series, an OLS model of the form

$$x_{1t} = \beta_0 + \delta_0 t + \delta_1 d_1 + \delta_2 d_2 + \sum_{i=2}^{5} \beta_i x_{it} + \mu_t \tag{A.2}$$

was estimated, where $d_1 = \{1 \text{ for } t > 12, \text{ zero otherwise}\}$ and $d_2 = \{1 \text{ for } t > 48, \text{ zero otherwise}\}$ are binary variables. For each estimated equation, we estimated the Augmented Dickey–Fuller equation:

$$\Delta\mu_t = \rho\mu_{t-1} + \sum_{i=1}^{p} \beta_i \Delta\mu_{t-i} + \epsilon_t. \tag{A.3}$$

The distribution of the Dickey–Fuller t-statistic for the hypothesis $\rho = 0$ is reported in Table A1 for various lag lengths, p. Table A1 shows that the ADF-statistic for the null hypothesis $\rho = 0$ indicating non-cointegration exceeded -5.275 in approximately 5% of the 50,000 trials using a model augmented with 1 lagged change in $\{\mu_t\}$.

Table A1
Critical values of the cointegration test

Lags, p	1%	5%	10%	90%	95%	99%
1	−5.886	−5.275	−4.962	−2.941	−2.673	−2.168
2	−5.707	−5.102	−4.789	−2.834	−2.574	−2.075
3	−5.584	−4.995	−4.685	−2.751	−2.502	−2.006
4	−5.435	−4.823	−4.521	−2.648	−2.407	−1.935
5	−5.252	−4.704	−4.406	−2.574	−2.346	−1.875
6	−5.112	−4.556	−4.271	−2.494	−2.262	−1.809
7	−4.976	−4.438	−4.163	−2.422	−2.197	−1.762
8	−4.854	−4.313	−4.041	−2.350	−2.127	−1.688
9	−4.783	−4.255	−3.985	−2.300	−2.078	−1.679
10	−4.756	−4.231	−3.964	−2.321	−2.116	−1.688
11	−4.716	−4.175	−3.912	−2.284	−2.074	−1.682
12	−4.610	−4.098	−3.840	−2.232	−2.035	−1.641

References

Ahmed, S., Park, J.H., 1994. Sources of macroeconomic fluctuations in small open economies. Journal of Macroeconomics 16, 1–36.

Alogoskoufis, G.S., Smith, R., 1991. The Phillips curve, the persistence of inflation, and the Lucas critique: Evidence from exchange rate regimes. American Economic Review 81, 1254–1275.

Backe, P., Fidrmuc, J., Reininger, T., Schardax, F., 2003. Price dynamics in Central and Eastern European EU accession countries. Emerging Markets Finance and Trade 39 (3), 42–78.

Brada, J.C., 1998. Introduction: Exchange rates, capital flows and commercial policies in transition economies. Journal of Comparative Economics 26, 613–620.

Brada, J.C., Kutan, A.M., 1999. The end of moderate inflation in three transition economies? Research Department Working Paper No. 99-003A, Federal Reserve Bank of St. Louis.

Clarida, R., Gali, J., Gertler, M., 2001. Optimal monetary policy in open versus closed economies: An integrated approach. National Bureau of Economic Research Working Paper 8604.

Desai, P., 1997. Introduction. In: Desai, P. (Ed.), Going Global: Transition from Plan to Market in the World Economy. MIT Press, Cambridge, MA.

Desai, P., 1998. Macroeconomic fragility and exchange rate vulnerability: A cautionary record of transition economies. Journal of Comparative Economics 26, 621–641.

Dibooglu, S., Kutan, A.M., 2001. Sources of real exchange rate fluctuations in transition economies: The case of Poland and Hungary. Journal of Comparative Economics 21, 1–19.

Dornbusch, R., Krugman, P., 1976. Flexible exchange rates in the short run. Brookings Papers on Economic Activity, 537–575.

Eichengreen, B., 1993. Epilogue. In: Eichengreen, B., Bordo, M. (Eds.), A Retrospective on the Bretton Woods System. University of Chicago Press, Chicago.

Engle, R.F., Granger, C.W.J., 1987. Cointegration and error correction: Representation, estimation, and testing. Econometrica 55, 251–276.

Engle, R.F., Yoo, B.S., 1987. Forecasting and testing in cointegrated systems. Journal of Econometrics 35, 143–159.

International Monetary Fund, 2002a. Hungary: Selected Issues and Statistical Appendix, IMF Country Report No. 02/109, June 2002.

International Monetary Fund, 2002b. Poland: Selected Issues and Statistical Appendix, IMF Country Report No. 02/127, June 2002.

Jakab, Z.M., Kovács, M.A., 1999. The determinants of real exchange rate fluctuations in Hungary. National Bank of Hungary Working Paper, No. 1999/6.

Karras, G., 1994. Sources of business cycles in Europe, 1960–1988: Evidence from France, Germany, and the United Kingdom. European Economic Review 38, 1763–1778.

Kiss, G.P., Szapáry, G., 2000. Fiscal adjustment in the transition process: Hungary, 1990–1999. Post-Soviet Geography and Economics 41, 233–264.

Krzak, M., 1996. Persistent moderate inflation in Poland and Hungary. Focus on Transition, Oesterreichische Nationalbank 2, 28–57.

Kutan, A.M., Brada, J.C., 2000. The evolution of monetary policy in transition economies. Federal Reserve Bank of St. Louis Review 82 (2), 31–40.

Nemenyi, J., 1997. Monetary policy in Hungary: Strategies, instruments and transmission mechanism. Focus on Transition, Oesterreichische Nationalbank 2, 131–161.

Nuti, D.M., 2000. The Polish zloty, 1990–1999: Success and under-performance. American Economic Review 90, 53–58.

Orlowski, L.T., 2000. Monetary policy regimes and real exchange rates in central Europe's transition economies. Economic Systems 24, 145–169.

Orlowski, L.T., 2003. Monetary convergence and risk premiums in the EU accession countries. Open Economies Review 14 (3), 251–267.

Quah, D., Vahey, S.P., 1995. Measuring core inflation. Economic Journal 105, 1130–1144.

Szapáry, G., Jakab, Z.M., 1998. Exchange rate policy in transition economies: The case of Hungary. Journal of Comparative Economics 26, 691–717.

Weber, A.A., 1997. Sources of purchasing power disparities between the G3 economies. Journal of the Japanese and International Economies 11, 548–583.

Wehinger, G.D., 2000. Causes of inflation in Europe, the United States and Japan: Some lessons for maintaining price stability in the EMU from a structural VAR approach. Empirica 27, 83–107.

Wellisz, S., 1997. Inflation and stabilization in Poland, 1990–1995. In: Blejer, M.I., Mkreb, M. (Eds.), Macroeconomic Stabilization in Transition Economies. Cambridge University Press, Cambridge.