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HUNGARIAN MACROECONOMIC VARIABLES – REFLECTIONS ON CAUSAL RELATIONSHIPS

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The paper investigates the relationship among macroeconomic variables for a transition country: Hungary. The purpose of this paper is to measure the dynamic interrelationship among macroeconomic variables such as money supply, output, interest rates, inflation and exchange rates. For the empirical analysis of this investigation, quarterly data have been used for the period from 1980 to 2000, and the Johansen multivariate cointegration technique and the Granger causality tests have been applied. The results provide evidence of the existence of important causal relationships between variables that describe macroeconomic activity in Hungary.

Keywords: macroeconomic variables, cointegration, Granger causality, Hungary

JEL classification index: E5

1. INTRODUCTION

The transformation of the Central European economies over the past decade has been radical. The private sector's share of the GDP has increased to 60% or more. Two-thirds of these countries' exports are sold in EU markets. External debt is decreasing continually. The goal of these successful countries is macroeconomic and structural adjustment through the imposition of hard budget constraints on firms, the freeing of prices, the opening up of trade and the reform of the financial sector (Feldman – Watson 2000).

Hungary is one of the most advanced transition economies. After joining the NATO in March 1999, Hungary has continued its intense efforts in the course of the European Union accession procedure. Accession to the EU means accepting values held by all in common on the one hand and guaranteeing the country's own security in economic and social terms on the other. Diplomatic relations

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between Hungary and the European Union were established in August 1988, this having been followed by the Europe Agreement signed in Brussels on 16 December 1991 – defining an associated status for Hungary related to the EC. The Community's programmes *(PHARE, SAPARD, ISPA)* gave important financial assistance to economic growth, R&D, environmental investments, and the agricultural and rural development of Hungary. The Europe Agreement provided legal foundations for the First Pillar of close co-operation between Hungary and the EU. The agreed schedule, facilitating market access, has led to an increasing volume of bilateral trade and EU investments.

As a result of following consistent economic strategies in recent years, the Hungarian economy has become stabilised, and the conditions for a sustainable economic development have been created.[1] Macroeconomic indicators – such as inflation, unemployment, interest rates, exchange rate, money supply and exports – have specified the framework of the economic policy most appropriate to adopt. The annual growth of GDP has been over 4% since 2001, and unemployment is below 8% – both figures being better than the EU average. The competitiveness of domestic production has grown by 20%, inflation has fallen below 11%, the budget deficit has not shown further spectacular growth, while exports have increased more rapidly than imports, and have exceeded the world trade average growth for the period 1997–2001. By the end of the 1990s, the share of the EU in Hungary's external trade relations had reached 75%.

The ultimate goal of Hungarian monetary policy has been the sustainable reduction of inflation. Exchange-rate and interest-rate policies are instruments of the National Bank of Hungary (NBH), which need to achieve this goal. In an open economy, monetary policy, through the interest-rate channel, by an increase in interest rates, can reduce inflation by reducing aggregate demand and by influencing expectations of inflation, which in turn affect wage- and price-setting mechanisms. Through the credit channel, two effects are generally distinguished: the impact of a tighter monetary policy on the supply of loans by banks (the lending channel) and the effect on the liquidity of borrowers (the balance-sheet channel). The direct exchange-rate channel entails a passing-through of exchange-rate changes (with an appreciation in case of tighter monetary policy) on to tradeable goods prices, as well as having indirect effects on the prices of domestically produced goods via the price of imported intermediate inputs.[2]

[1] Relations between Hungary and European Union, http://www.kum.hu/euint/huneu_rel.html (2001).

[2] For a detailed discussion of these channels useful references are Bernanke – Gertler (1995), Bondt (1998), Meltzer (1995), Mishkin (1995), Svensson (1998).

The exchange rate is the dominant channel for monetary policy transmission, though the NBH's ability to influence the exchange rate is limited. Benczúr (2002) has highlighted the importance of the direct exchange-rate channel in the disinflation process in Hungary. An appreciating nominal exchange rate is not only the central, but also the quickest channel of monetary policy transmission in this regard (NBH 2001, p. 35). Nevertheless, the main instrument of the NBH via which to influence the exchange rate is limited to its policy interest rate[3]. In addition, many other factors which cannot be foreseen and which involve expectations in financial markets over a range of domestic and external variables play a critical role. Interest-rate policy also has to ensure that capital inflows can be kept within reasonable limits.

The crawling-peg system that was introduced in March 1995 and abolished in 2002 gave a degree of predictability of exchange-rate fluctuations, and, at the same time, maintained the necessary flexibility against external shocks. It also helped to consolidate the external economic equilibrium and improved competitiveness. This was reflected in the dynamic growth of exports and a favourable movement in the real effective exchange-rate indices. Reflecting the high degree of economic integration with the EU (76.5% of Hungarian exports going to the EU), the composition of the currency basket used for the establishment of the exchange rate has been changed, and since 1 January 2000 it comprises the euro only.

In order to enter the EU's EMU and also the Exchange Rate Mechanism (ERM-2), Hungary must implement the convergence criteria of the Maastricht Treaty. The fundamental convergence criteria of the EMU are the curbing of inflation to constant levels, a limitation of fiscal deficit and the reducing of public debt as a percentage of GDP as well as a reduction of government intervention into the private sector. The goal of the Hungarian government is the adoption of the single currency in the medium term after a transition period of convergence with the EU, so that the initial goal of economic integration with the EU can be achieved. So as to eventually withdraw the national currency and to substitute it with euro, Hungary was forced to adopt a new economic system based on a fixed exchange rate in relation to the euro with a relatively wide deviation (±15%). According to statistical data the inflation rate, while going up to 28.2% in 1995, was on a downward trend – to 11% – in 2000; public debt dropped from 84.3% in 1995 to 60% in 2000; the fiscal deficit in 1995 was 6.4%, and had decreased to 3.5% in 2000; long-term interest rates went down to 8.1%; and, finally, the average devaluation

[3] While foreign exchange-rate intervention cannot be ruled out, the NBH has refrained from intervening since the band widening, and it has signaled that it would resort to intervention only in emergency situations.

of the national currency in relation to the euro fell from 26.8% in 1995 to just 4% in 2000 (NBH 2002).

Hungary's output growth performance has been relatively modest compared to that of neighbouring transition economies in recent years. By 1997, official data indicated that the real GDP in Hungary was still around 9% below its 1988 level. This can be contrasted with the cases of the Czech Republic and Poland, where the real GDP in 1997 was equal to or exceeded the 1988 levels by 12% (Beaumont et al. 1999). Although economic growth slowed down in 2001, the economy showed considerable resilience to the weaker external environment. GDP growth was on a still respectable 3.8%, down from 5.2% in 2000 – though this was higher than in most other countries of the region. Meanwhile, the unemployment rate had dropped to 5.6% by the start of 2002.[4]

In May 2001, the Hungarian government successfully introduced a new monetary regime that widened the exchange rate band to ±15% against the euro, and it adopted an inflation target in June 2001. Notwithstanding a string of interest-rate cuts since the band widening, there was a resultant tightening of monetary conditions.[5] With inflation expectations falling faster than nominal interest rates, real short-term interest rates have increased modestly, and the national currency (HUF) has strengthened against the euro by some 10% points since the band widening. Inflation has decreased markedly. After peaking at 10.8% in May 2001, year-on-year consumer price inflation declined steadily to 5.9% in March 2002 (IMF 2002).

The government hopes that economic growth will accelerate over the next few years: the real GDP will grow by 4% by 2003 (due to a growth in exports), inflation will be reduced to 3.5% and the fiscal deficit limited to 2–3% of the GDP by 2004. The adoption of the common European currency is also among the medium-term goals that the government needs to implement in the EU accession process. The government has announced end-year targets (with band tolerance of ±1%): an inflation of 4.5% for 2002 and 3.5% for 2003 respectively, and it seeks to narrow the budget deficit to 2–3% of GDP by 2004 (ESA-95 base, consistent with the Maastricht fiscal criteria).

It is common that the curbing of the inflation rate should be the primary objective of monetary policy. The achievement of a strong currency in relation to a price-level reduction policy and a decline in inflationary expectations have both contributed to the credibility of the disinflation strategy that the National Bank of Hungary has used. The aim of the National Bank is to continue the rapid

[4] IMF Concludes 2002, Article IV Consultation with Hungary, 5 June 2002.

[5] Effective the day of the NBH Board Meting, raising its policy interest rate by 50 base points, to 9%.

disinflation process. Seeing upward inflationary risks more likely, the NBH has lowered the assumed exchange rate – despite its general forecast – and this measure has led to lower-than-expected inflation. Upward inflationary risks in relation to the initial projections of the National Bank come from uncertainties about regulated prices (especially in 2003), and also about wages behaviour. Nonetheless, the government is hopeful that labour-market flexibility will mitigate the effects here, going with wage pressures on inflation.[6]

The aim of the new monetary regime is to limit inflationary expectations through a restraining of the future wage-growth level, a cautious lowering of interest rates and the stabilisation of a strong currency according to inflationary predictions. The restrictive interest-rate policy is regarded as a necessary measure against intense inflationary pressures, for adoption of a tightening monetary policy cannot contribute to a reduction in inflation by itself. The practice of a relatively strict fiscal policy is an essential presupposition with regard to the credibility of the economic system of the country.

2. THEORETICAL AND EMPIRICAL APPROACHES

The essence of the Keynesian theory was that effective demand determines output. Even if output eventually returns to its natural level in the long run, this process is very slow. In the 1960s debates between Keynesians and Monetarists concerned three issues: the effectiveness of monetary versus fiscal policy, the Phillips curve, and the role played by policy. The Keynesian school of thought emphasised fiscal rather than monetary policy as more important to an economy.

Friedman and Schwarz (1963) studied the practice of monetary policy and the relationship between money supply and output in the USA over the course of a century. According to their conclusion, monetary policy was very powerful and could explain most of the fluctuations in output. Monetarists agreed with the Classicals about the long-run neutrality of money supply and that, in the long run, there is no trade-off between inflation and unemployment. An important development during the 1980s was the emergence of the Real Business Cycle Theory. As opposed to Keynesians and Monetarists, who conclude that business cycles result in changes in Aggregate Demand (AD), RBC theorists ruled out any demand changes as a likely cause of long-lasting changes in real output. Some New Classical economists have hypothesised that business cycles are caused by fac-

[6] Although it is too soon to form firm judgements, technical discussions at the NBH have suggested that December 2001 data on private sector wages may be indicative of labour markets, responding flexibly to the slowdown in growth and the appreciation of the HUF.

tors that disturb the long-run growth trend of aggregate supply. According to this view, real factors such as technology, resource availability and productivity are the main causes of business cycles.

Since the mid-1980s the New Growth Theorists have been discussing the determinants of technological progress and the role played by increasing returns to scale in explaining economic growth. A vast empirical literature has looked at the predictions of the theories involved. Kamas and Joyce (1993) investigated the impact of changes in monetary variables on domestic- and foreign-policy areas in Mexico and India when fixed exchange rates were set in the two economies. The results proved that domestic monetary policy did not affect output in these two economies. Bryant et al. (1988) contrasted and compared simulations in more than 10 empirical macroeconomic models. Karras (1994; 1999), using a simple model, studied the ability of monetary policy to affect output, using a set of 38 countries, and concluded that money supply affects output and has additionally increased influence with regard to inflation. Within the same framework Gordon and King (1982), Masih and Masih (1995; 1996) and Hondroyannis (2000) have all examined the causal relationships between money supply and other macroeconomic environment variables for different countries and time periods. The different results of all these studies make it difficult for policymakers to draw firm conclusions on the relationships of macroeconomic variables. Furthermore, new advances in the time series models have helped to shed light on the question of the interrelations among such macroeconomic variables.

The purpose of this paper is thus to empirically evaluate the dynamic interactions among macroeconomic variables for Hungary – such as output, money supply, inflation, and interest and exchange rates.

The testing of the existing statistical relationships of five variables was undertaken as follows: we initially confirmed the integration order of related variables, and then proceeded with a cointegration test using the Johansen maximum likelihood approach; finally, the Granger causality test was made use of with the vector error correction model preceding it.

3. UNIT ROOT TESTS

The ADF tests for the 5 variables are presented in *Table 1*. The tests for the existence of unit root are based on Dickey and Fuller papers (1979; 1981) and are used to measure the integration order of the variables. For the best structure of ADF equations we made use of the Akaike (1973) and Schwarz (1978) information criteria, while the Lagrange Multiplier LM (4) test was applied for the autocorrelation testing of disturbance terms.

Table 1

DF/ADF for a unit root test

Variables	In levels			1st differences			2nd differences		
	Lag	Test statistic (DF/ADF)*	LM(4)**	Lag	Test statistic (DF/ADF)	LM(4)	Lag	Test statistic (DF/ADF)	LM(4)
LCPI	4	–1.9304	7.0028 [0.126]	4	–1.5344	3.7543 [0.440]	4	–4.7089	3.8352 [0.429]
LEXCH	0	1.3188	3.3538 [0.500]	0	–1.6771	4.7664 [0.312]	2	–9.4529	10.2041 [0.052]
LM	4	1.4167	8.7065 [0.069]	4	–1.4300	2.4558 [0.653]	3	–6.3242	1.8065 [0.771]
LINTER	3	–1.8055	4.2812 [0.369]	2	–2.8353	3.6493 [0.456]	1	–11.7601	6.2024 [0.185]
LGDP	2	–0.86219	8.2885 [0.082]	1	–1.4137	8.8437 [0.065]	4	–8.3486	2.6211 [0.713]

* Critical value: –3.4387.
** The numbers in parentheses show the levels significance.

The results shown in *Table 1* indicate that the variables in their second differences become stationary, so they can be characterised as having an integrated order 2 I (2). Moreover, for all of the variables the LM (4) second difference test shows that there is no serial correlation in the disturbance terms.

4. COINTEGRATION ANALYSIS

Since it has been determined that the variables under examination are of integrated order 2 I (2), we can then proceed by defining the number of cointegrating vectors among variables by using the Johansen (1988) maximum likelihood procedure approach (Johansen – Juselius 1990; 1992). This approach tests for the number of cointegrating vectors among all variables. It treats all variables as endogenous, thus avoiding the arbitrary choice of a dependent variable. Finally, within the framework of the vector error correction model it provides a unified structure for the estimation and testing of cointegration relations. The Johansen and Juselius estimation method presupposes an estimation of the following relationship:

$$\Delta Y_t = \mu + \Gamma_i \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + ... + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-p} + u_t$$

where Y_t is a 5 × 1 vector containing the variables; μ is the 5 × 1 vector of constant terms; Γ_i (i = 1,2…p-1) is the 5 × 5 matrix of coefficients; and u_t is the 5 × 1 vector of the disturbance terms coefficients.

Given the fact that in order to apply the Johansen technique a sufficient number of time "lags" is required, we have made use of a relative procedure based on the calculation LR (Likelihood Ratio) test statistics (Sims 1980). Results here show that the value $\rho = 4$ is an appropriate specification for the above-mentioned relationship. Further on, we shall determine the cointegration vectors of the model, given the condition that matrix Π has an order $r < n$ (n = 5). The procedure of calculating order r is related to an estimation of the characteristic roots (eigenvalues), which are the following:

$$\hat{\lambda}_1 = 0.82316 \qquad \hat{\lambda}_2 = 0.54951 \qquad \hat{\lambda}_3 = 0.17724$$

$$\hat{\lambda}_4 = 0.030481 \qquad \hat{\lambda}_5 = 0.016308$$

Table 2

Johansen and Juselious cointegration tests
Variables LGDP, LM, LCPI, LINTER, LEXCH

Eigenvalues			Critical Values	
Null	Alternative	Eigenvalue	95%	90%
r = 0	r = 1	143.7964	29.9500	27.5700
r = 1	r = 2	66.1854	23.9200	21.5800
r = 2	r = 3	16.1921	17.6800	16.5700
r = 3	r = 4	2.5693	11.0300	9.2800
r = 4	r = 5	1.3647	4.1600	3.0400

Trace statistic			Critical values	
Null	Alternative	Eigenvalue	95%	90%
r = 0	r > 0	230.1079	59.3300	55.4200
r ≤ 1	r > 1	86.3115	39.8100	36.6900
r ≤ 2	r > 2	20.1261	24.0500	21.4600
r ≤ 3	r > 3	3.9340	12.3600	10.2500
r ≤ 4	r > 4	1.3647	4.1600	3.0400

The results that appear in *Table 2* suggest that the number of statistically significant cointegration vectors is equal to two. The results are shown below:

LGDP = – 26.5823LM + 37.1066LCPI – 41.9653LINTER + 24.4358LEXCH (1)

LGDP = 0.20181LM + 0.89243LCPI – 0.090092LINTER + 0.56317LEXCH (2)

According to the signs of the vector cointegration coefficients that form the basis of the economic theory, relationship (1) can be used as an error-correction model in the VAR model.

5. THE VAR MODEL WITH AN ERROR-CORRECTION MODEL

After determining that the logarithms of the model variables are cointegrated, we need to make an estimation of a VAR model with an error-correction model (EC). The error-correction model is based on the long-term cointegration relationship and has the following form:

$$DLX_t = \mu + G_1 DLX_{t-1} + G_2 DLX_{t-2} + G_3 DLX_{t-3} + A\, EC_{t-4} + u_t$$

where DLX_t are the first logarithmic differences of all variables and EC is the error-correction term estimated from the long-term relationship.

Table 3 presents the estimations of error-correction terms for all variables. The negative signs of the coefficients of the EC are consistent with the hypothesis that this term corrects the deviations from the long-term equilibrium relationship. In addition, in *Table 3* we can see that there is significance for the coefficients of the error-correction model in all variables.

Table 3

Estimation of error-correction model coefficients

Endogenous variables	Estimates of EC coefficient terms	*t*-statistic	*P*-value
DLGDP	–0.00450	–82.8109	[0.000]
DLM	–0.041468	–0.83701	[0.405]
DLCPI	–0.081710	–3.4336	[0.001]
DLINTER	–0.059765	–1.0067	[0.317]
DLEXCH	–0.048360	–1.6944	[0.095]

From *Table 3* we can infer that all coefficients of the error correction have the expected signs and are statistically significant at a 5% level in the functions of output and inflation.

6. GRANGER CAUSALITY TESTS

The model that was estimated in the previous section was used to look at the Granger causal relationships among the variables under examination. As a testing criterion, the *F*-statistic was resorted to. With the *F*-statistic, the hypothesis for the statistical significance of specific groups of explanatory variables was put to the test for each of the separate functions. The results relating to the existence of the Granger causal relationships among variables are shown in *Table 4*.

Table 4

Granger causality tests

Dependent variable	Hypothesis tested	F1	F2
DLGDP	DLM there is a unidirectional relationship (DLGDP ⇐ DLM)	9.574	1.515
	DLCPI there is a unidirectional relationship (DLGDP ⇒ DLCPI)	0.287	7.279
	DLINTER there is a unidirectional relationship (DLGDP ⇐ DLINTER)	4.239	0.067
	DLEXCH there is a unidirectional relationship (DLGDP ⇐ DLEXCH)	5.028	0.140
DLM	DLCPI there is a bilateral relationship (DLM ⇔ DLCPI)	10.97	4.289
	DLINTER there is a unidirectional relationship (DLM ⇐ DLINTER)	3.881	0.254
	DLEXCH there is a unidirectional relationship (DLM ⇐ DLEXCH)	3.308	0.756
DLCPI	DLCPI there is a unidirectional relationship (DLCPI ⇒ DLINTER)	1.205	4.840
	DLCPI there is a unidirectional relationship (DLCPI ⇐ DLEXCH)	4.570	1.094
DLINTER	DLINTER there is a unidirectional relationship (DLINTER ⇒ DLEXCH)	1.069	3.052

Critical value: 3.04.

The results depicted in *Table 4* suggest the following for changes in output:

- There is a unidirectional causal relationship between output and money supply, with the direction being from money supply to output.

- There is a unidirectional causal relationship between output and inflation, the direction being from output to inflation.
- There is a unidirectional causal relationship between output and interest, the direction here being from interest to output.
- There is a unidirectional causal relationship between output and exchange rates, with a direction from exchange rates to output.

For money supply we can infer:

- There is bilateral causal relationship between money supply and inflation.
- There is a unidirectional causal relationship between money supply and interest, with the direction being from interest to money supply.
- There is a unidirectional causal relationship between money supply and exchange rates, the direction being from exchange rates to money supply.

For inflation we can claim:

- There is a unidirectional causal relationship between inflation and interest, with the direction being from inflation to interest.
- There is a unidirectional causal relationship between inflation and exchange rates, the direction being from exchange rates to inflation.

Finally, with regard to interest we might say that:

- There is a unidirectional causal relationship between interest and exchange rates, with the direction being from interest to exchange rates.

7. CONCLUSIONS

The main purpose of this paper was to examine, using quarterly data, the dynamic interrelationships among output, money supply, inflation, interest and exchange rates in the case of Hungary. Within the framework of this empirical analysis we have applied the co-integration technique; we have then specified an error-correction model and, finally, we have looked at the existence of causal relationships among the variables in use. The fact that cointegration exists among these variables suggests that there is a long-term equilibrium relationship, which implies that, although these variables may have occasional short-term or transient deviations from their long-term equilibrium because of the existing pressures, they will, in the end, find a direction going towards equilibrium. Further-

more, the existence of cointegration precludes a possibility that the estimated relationship might be spurious, meaning that there must be a Granger causal relationship among such variables.

Our results show that there is a unidirectional causal relationship between money supply and output, the direction being from money supply to output (this being more consistent with Keynesian and Monetarist theory), such as in the case of interest and exchange rates; while there is an opposite causal relationship between output and inflation, with a direction from output towards inflation. Also, there is a bilateral causal relationship between inflation and money supply, with interest and exchange rates directing the money supply. Finally, rates of interest are directed by inflation, exchange rates serve to direct where inflation goes, and are themselves directed by the level of existing interest.

Concluding, the goal of the monetary policy of the National Bank of Hungary, according to the econometric analysis results that have been arrived at (above), will be the sustainable reduction of inflation. Consequently, the reduction of inflation (or a curbing of inflation to low levels) will affect the interest rate level, which will serve to ensure capital inflows. This would, in turn, lead to output growth. Additionally, the devaluation of the HUF against the euro (for the application of exchange-rate policy) will lead to export growth and a growth in competitiveness, too.

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