PARALLEL MOVEMENT OF INFLATION, DOMESTIC AND FOREIGN EQUILIBRIA

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SUMMARY

The paper attempts to reveal the mechanism of the inflationary policy of the Hungarian governments of the transition period. It investigates whether forced inflation is used as a means of improvement of foreign and domestic equilibria. According to the empirical results it can be deduced that the governments were not highly committed in the struggle against inflation, sometimes they even sacrificed the goal of suppressing inflation. There are, however, some indications, for a cyclical alteration of the pattern of inflation but the existence of the four year business cycles corresponding to those of the general elections could not be unequivocally proven.

KEYWORDS: Inflation; Macromodels; Economic dynamics.

The decade of the Hungarian transition has already produced in some areas homogeneous time series of length necessary to analyse the relevancy of certain macroeconomic relations not only theoretically but using empirical tools as well. The investigation of the relevancy of Phillips curve that sets a specific relation between unemployment and inflation is an extremely interesting problem of the transition countries because its validity is a controversial issue even in the developed countries.[2]

Data referring to the last years clearly show that in the Hungarian economy the trade-off between unemployment and inflation does not prevail, instead a positive correlation of these two macro variables could be observed. The reasons, however, contrary to the developed market economies, can not be found either in the rational expectations or in the existence of positive or negative supply shocks but in the business cycles symmetric to those of the foreign trade. Thus an increase in demand did not yield a price increase because it could be absorbed by the growth of the supply of imported goods. Moreover, the imports of means of production increased very often the domestic productive potential, decreasing at the same time the unit costs. On the other hand, the increase of the foreign trade deficit, sooner or later forced the devaluation of the Hungarian currency and the re

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[2] Here we refer to the debate that has lasted for two decades among Keynesian, monetarist and neo-classical economists.

striction of imports. These two impacts jointly led to the decrease of output and to the increase of unemployment and inflation.[3]

The rate of inflation itself is a very important indicator for governments, therefore its control is an extremely vital decision parameter as well. It is well known that a high and increasing inflation means a seigniorage revenue for governments and a non devolvable tax of price hikes for the public. At the same time, rapid inflation costs a lot for the government too. These manifest themselves in higher interests on public debt, in a less favourable position of the current budget balance and in the spread of uncertainty in business life. In spite of these unfavourable effects, under special circumstances, governments resort to a deliberate speeding up of inflation and, later, they are compelled to decrease it. Neither Hungarian governments of the transition period provided an exception to this rule. However, the mechanism of the operating cycle is a bit more complicated than written above. The rate of inflation as planned by the government and the inflationary expectations of the economic agents as well as their dynamic movements also have a role to play. Table 1 illustrates the annual data of observed (actual) and planned inflation, as well as some indicators of the equilibrium position of the Hungarian economy.

Table 1

Some indicators of inflation and macroeconomic equilibrium
(percent)

Year	Planned	Observed	Observed–planned	Balance of state-budget/GDP	Net exports/GDP
	inflation				
1990	19-20	28.9	9	0.3	2.8
1991	35-38	35.0	-1	-3.0	0.8
1992	22-25	23.0	-1	-7.0	0.9
1993	17-19	22.5	4.5	-6.7	-9.0
1994	18-22	18.8	-1.2	-9.6	-9.4
1995	19-20	28.2	8.7	-7.3	-5.6
1996	19-20	23.6	4.1	-4.6	-3.7
1997	18-19	18.3	-0.2	-4.7	-2.2
1998	13-14	14.3	0.8	-4.8	-4.8
1999	10-11	10.0	-1	-4.5	-5.0

Source: Statistical Yearbooks of HCSO and State Budget Provisions of the Ministry of Finance.

In describing the actual mechanism it is assumed that government is basically able to control the extent of inflation and for any period can determine its most acceptable level. Agents of the economy form their inflationary expectations according to their assessment of these processes. What is advantageous for the government if the actual inflation is, to some extent, higher than the planned one. To this statement, however, two restrictions should be added: it is advantageous only in the case of a relatively low rate of expected inflation and if the actual inflation does not become too rapid (does not reach an uncontrollable level). Why is this situation advantageous for the government? Because this way state budget could be balanced more easily, revenues would be higher and expenditures

[3] For more details see *Mellár* (1997).

would be lower and in course of wage bargaining a lower level of real wages could be set, given that the planned inflation serves as a basis of the growth of nominal wages. And, on the other hand, an actual inflation lower than planned would be disadvantageous for the government. However, an inflation which is calibrated more rapid than planned would lead, no doubt, to the increase of inflationary expectations as well as inflation itself and thus the costs of inflation would sooner or later be higher than the mentioned fiscal advantages. The most important factor among the costs of inflation is the increase of interests to be paid for national debt which results in a robust deterioration of the budget balance. This way government is compelled to decrease inflation. Under decreasing inflation when inflationary expectations and the level of planned inflation still remained high, the losses related to a gap between planned and actual inflation already emerge, but they could be temporarily compensated by the gains of decreasing inflation. Nevertheless, when a further reduction of inflation does not offer a considerable surplus, government resorts again to generating an inflation higher than planned. Thus we get back to the starting point of the cycle.

In the next part of this paper a framework and main features of the macromodel describing this process will be explained. Section 2 is about the empirical analysis, and finally, the third part summarises the conclusions.

1. Basic model of inflationary mechanism

In order to study the problem a simple model of two agents has been developed. The first agent is the government and the second one is the rest of all economic agents. The model contains two endogenous variables: expected and planned inflation, two exogenous variables, namely state budget and net exports, and a policy variable (actual or observed inflation). The model consists of a set of two behavioural equations and a loss function which are as follows:

$$\pi_t^e = \alpha_1 \pi_{t-1} + \alpha_2 (\pi_{t-1} - \pi_{t-1}^P) \qquad \alpha_1, \alpha_2 > 0 \qquad /1/$$

$$\pi^P = \beta_1 \pi_{t-1} + \beta_2 D_{t-1} + \beta_3 K_{t-1} \qquad \beta_1, \beta_2, \beta_3 > 0 \qquad /2/$$

$$L_t = \gamma_1 (\pi_t^P - \pi_t) + \gamma_2 \pi_t + \gamma_3 (\pi_t - \pi_t^e) \qquad \gamma_1, \gamma_2, \gamma_3 > 0\,, \qquad /3/$$

where π is the (actual, observed) rate of inflation, superscripts *e* and *P* serve for the expected and planned inflation, respectively, while subscripts indicate time. *D* is the share of balance of state budget in the GDP and *K* denotes the proportion of net exports to GDP. The first equation describes the rule being applied in forming the expectations of the agents. This can be regarded as some kind of adaptive expectations and consists of a weighted sum of two components: inflation rate of the previous period and the gap between the planned and actual rates of inflation in the preceding period. It is easy to see that government is 'punished' by the agents of economy for an inflation higher than planned.

The second equation defines the way of calculating the planned level of inflation. The first term reflects the fact that planned inflation depends to a high degree on the inflation

of the previous period, while the second part indicates that planned inflation is the less when the foreign and domestic equilibrium position of the preceding period is the worst. The positive or negative signs of equilibrium variables *D* and *K* reflect the surplus or the deficit of the state budget or the balance of foreign trade.

The third equation is the government's loss function which consists of three parts. The first one describes the loss resulting from the gap between planned and actual inflation. With the weight parameters being positive, it could clearly be seen that an actual inflation less than planned yields a loss and, on the other hand, an inflation bigger than planned provides gains (i.e. a negative loss) for the government. The second part shows that general loss originated from inflation itself which is well known from literature. The third part means the government's loss of credibility caused by an inflation higher than expected. Using the two behavioural equations, the loss function could be transformed into the following reduced form:

$$L_t = (\gamma_2 + \gamma_3 - \gamma_1)\pi_t + \left[\gamma_1\beta_1 - \gamma_3(\alpha_1 + \alpha_2)\right]\pi_{t-1} + \gamma_3\alpha_2\beta_1\pi_{t-2} + \\ + \gamma_1\beta_2 D_{t-1} + \gamma_3\alpha_2\beta_2 D_{t-2} + \gamma_1\beta_3 K_{t-1} + \gamma_3\alpha_2\beta_3 K_{t-2} \qquad /4/$$

For the sake of convenience, new parameters $c_1, c_2, \ldots, c_7$ are introduced. This way the loss function /4/ takes the following form:

$$L_t = c_1\pi_t + c_2\pi_{t-1} + c_3\pi_{t-2} + c_4 D_{t-1} + c_5 D_{t-2} + c_6 K_{t-1} + c_7 K_{t-2}\,, \\ c_1, c_2 \gtrless 0 \qquad c_3, \ldots c_7 > 0 \qquad /4a/$$

The task of the government is, in order to minimise loss, the setting of π_t, the actual inflation of year *t*. This definition of the problem is based on the assumption that government is able to control inflation by its monetary and fiscal policy. This task, however, could not be fully executed because market forces, domestic and foreign ones as well, have a considerable influence on inflation. Nevertheless, using central measures (on tariffs, taxation rules, wage and income bargaining) the government is able to influence the short term changes of price level. This has obviously been proven by the Hungarian practice and price statistics of the transition period: besides the price changes caused by market forces, price movements generated by central measures had a determining role to play. These types of corrections have been implemented by the instruments of fiscal policy. This way it could justify the following question: why could monetary policies not compensate inflation generating fiscal actions? This hindrance is not due to the lack of will or independence of the National Bank of Hungary. The real issue is that for the time being the financial system of Hungary is not developed enough and the monetary instruments are not powerful enough to set an independent inflationary target and to implement active anti-inflationary measures.[4]

It can clearly be seen from the reduced form objective function that only actual inflation and not the planned one is the real decision parameter for the government. Planned

[4] The crawling peg devaluation system introduced by the National Bank of Hungary serves as a good example for this. This has a very important role in preserving domestic and foreign equilibrium and confidence but, even for this, foreign exchange policy cannot be used for anti-inflationary purposes. As regards the weakness of monetary institutions and implements in three transition-countries further contributions can be seen in the paper of *Brada-Kutan* (1999).

inflation is determined by a behavioural rule and, however, while formulating this rule besides the inflation rate of the previous year the evaluation of the state of equilibrium is already taken into account. Nevertheless, planned inflation cannot be considered as a decision parameter to be optimised. It cannot be taken so because, on the one hand, it should be set for the target period and serves as a basis for wage bargaining and for setting the main quantitative characteristics of the budget of the next year. On the other hand, in order to gain an agreeable confidence of economic agents, planned inflation should be in accord with the general inflationary process and data of previous years.

As far as the loss function is concerned, positive signs of parameters $c_4 \dots c_7$ have to be explained. This positivity implies that an improvement of the equilibrium position (positive balance) increases losses, deteriorates the position of the government. Nonetheless, this is not a real contradiction, and comes from the fact that the loss function is expressed for inflation. As a result of a favourable equilibrium position $(D, K > 0)$ the plan for inflation will not be strained, i.e. planned inflation will be rather high, namely it will expectedly be higher than the actual one, since a bad equilibrium position does not compel government to make a deliberately low plan for inflation. Therefore, government has a loss, because expenditures of the budget adjust to a high planned inflation, while the incomes adjust to an actual lower one.

In order to get a more compact form for the further analysis of the loss function, the equilibrium variables regarded previously as exogenous, shall be endogenize. It is obvious that both domestic and foreign equilibrium depends highly on inflation. Let us assume the following simple relation between equilibrium variables and inflation:[5]

$$D_t = \omega \pi_t \qquad \omega \gtrless 0$$

$$K_t = \phi \pi_t \qquad \phi < 0 \, .$$

Parameter ω may be positive or negative, as the seigniorage and the inflationary tax incomes are greater or smaller than the increase of debt-service. Parameter ϕ is unequivocally negative, because as a consequence of inflation competitiveness is reducing and this yields the deterioration of the balance of foreign trade. Inserting these two equations into /2/ the modified equation of the planned inflation is as follows:

$$\pi_t^P = \beta \pi_{t-1} \, , \qquad \text{where} \qquad \beta = \beta_1 + \beta_2 \omega + \beta_3 \phi \, . \qquad /2a/$$

Following the former arguments β may be positive and negative as well. Taking into account equation /2a/, the reduced form of the loss function is as follows:

$$L_t = c_1 \pi_t + c_2 \pi_{t-1} + c_3 \pi_{t-2} \, , \qquad c_1, c_2, c_3 \gtrless 0. \qquad /4b/$$

Parameters *c* differ from those in /4a/ only because the positive β_1 is replaced here by β of unknown sign.

[5] The relations defined here are simplified ones from many aspects: on the one hand because they describe the relations to the current inflation only, on the other hand because they do not take into account the indirect impacts (since the equilibrium variables have their own effect to the inflation as well). Moreover, these relations disregard further, non inflationary factors.

When analysing loss function /4b/ it is supposed that inflation can not be negative,[6] that is $\pi_t \geq 0$ for any *t*, while minimising the loss function, the following statements can be deduced.

– If all parameters *c* are positive the optimal rate of inflation will be zero for all periods and the cumulated loss will be zero for any period too.

– If $c_1, c_2, c_3 < 0$ then the optimal solution for any period leads to an inflation as high as possible, because this choice minimises the loss function. In this case, however, the equilibrium of the system would be lost and it explodes.

– In any other case a 'mixed solution' i.e. a special mix of periods of zero and positive inflation will be optimal. This is well reflected by the summarised form of the loss function for a finite period of *n*:

$$\sum_{i=1}^{n} L_i = (c_1 + c_2 + c_3)[\pi_1 + \pi_2 + \ldots + \pi_{n-2}] + (c_1 + c_2)\pi_{n-1} + c_1\pi_n .$$

Depending on the signs of expressions $(c_1 + c_2 + c_3)$ and $(c_1 + c_2)$ as well as that of parameter c_1 the inflation of the period in question will be positive or zero.

It is easy to see that parameters of non predetermined signs have a particular importance in the formation of the whole process. This is, of course, not by chance because the signs of the parameters have a particular economic meaning. If $c_1 > 0$, for instance, it means that $\gamma_1 + \gamma_2 > \gamma_3$ and this hints at the situation that the losses of the government originating from inflation itself overcome those ones related to an inflation less than planned. That is, a positive c_1 refers to a government which is seriously committed to fight against inflation while a negative c_1 refers to a not really committed government that takes inflation as an implement of trade-off for other goals. The case $c_2 > 0$ means that $\gamma_1\beta > \gamma_3(\alpha_1 + \alpha_2)$, and this can be interpreted in a way that government gives bigger importance to the negative consequences of the lagged effects of inflation of the previous period than to its positive outcomes. Finally, $c_3 = \gamma_3\alpha_2\beta > 0$ shows that government, based on the inflation of the previous period, is inclined to set planned inflation to a higher level, and so it will have a reduced possibility to get extra revenue by speeding-up inflation.

2. Empirical analysis

Empirical analysis consists of three parts: first we test equation /4a/, that is the reduced form of the original model. This will be followed by testing the simplified equation /4b/ that has been derived from endogenous treatment of the equilibrium variables. Finally, the investigation will be concluded by an empirical verification of the behavioural rule of inflationary expectation deduced from equations /1-2/ and /1-2a/.

Taking into consideration the specific reaction-time of underlying macroeconomic variables, the use of quarterly data seems to be suitable. Quarterly consumer price indices

[6] In general this seems to be a rather strong assumption but actually, regarding the transition period of the Hungarian economy, it is not.

for the period 1989–1998, compared to the corresponding quarter of the previous year and computed by a relatively homogeneous methodology are available. As it is usually done, we regarded the annual consumer price index as the measure of inflation, so in the following empirical parts of this paper the term *inflation* means seasonally adjusted quarterly consumer price indices. Homogeneous quarterly data for the balance of state budget and net exports are available only for the period 1992–1998, so the model could be tested for this rather limited time interval.

Relation among inflation, domestic and foreign equilibria

In order to understand the order of integration of time series of the model, first of all unit root tests are to be implemented. The augmented *Dickey-Fuller* test shows that variables of the Hungarian inflation as well as those of the equilibrium position measured by the balance of the state budget and the net exports are integrated of first order.

Table 2

Augmented Dickey-Fuller unit root tests

Model based on	Inflation		Expected inflation		Balance of state budget		Net exports	
Levels	-2.569	(3)	-2.75	(3)	-1.378	(3)	-2.82	(2)
	-1.014	(4)	-1.45	(4)	-2.100	(2)	-2.63	(1)
First differences	-3.839***	(3)	-3.562**	(3)	-3.767**	(3)	-3.757***	(2)
	-2.827*	(4)	-3.01**	(4)	-6.708***	(2)	-4.42***	(1)

* Significant at 0.1 level.
** Significant at 0.05 level.
*** Significant at 0.01 level.
Note: Optimum lags, selected by using AIC and SBC criteria are in brackets, constants are included.

For testing /4a/ some arrangement of the equation is necessary. Assuming that the loss function takes a constant (time-invariant) characteristic (optimal?) level, then after the substitution of $L_t = b$ the following simplified form is obtained:

$$\pi_t = a_0 + a_1\pi_{t-1} + a_2\pi_{t-2} + a_3 D_{t-1} + a_4 D_{t-2} + a_5 K_{t-1} + a_6 K_{t-2}\,, \qquad /5/$$

where $a_0 = b/c_1$, $a_1 = -c_2/c_1, \ldots a_6 = -c_7/c_1$. Regarding that a reverse relation, i.e. the impact of inflation to equilibrium variables can not theoretically be excluded, the construction and estimation of a VAR model that contains all three variables (inflation, balance of state budget, net exports) seems to be suitable.[7] Results of estimations are shown in Table 3.

Estimates in Table 3 verify the fact that relation with inflation as endogenous variable is the only acceptable one. In the case of the net exports the two period lagged endogenous variable is the only significant explanatory variable, while in the case of the balance of budget no significant regressor could be found.

[7] Given that the variables are not cointegrated, VAR model can be used and consistently estimated even if there are unit roots in the time series.

Table 3

Estimates of the VAR model

Variables	π_t	K_t	D_t
π_{t-1}	1.309	-0.056	0.028
	(7.78)	(-0.55)	(0.34)
π_{t-2}	-0.405	0.054	-0.055
	(-2.66)	(0.58)	(-0.74)
K_{t-1}	0.429	0.145	0.048
	(1.31)	(0.73)	(0.29)
K_{t-2}	-0.675	0.416	0.191
	(-2.20)	(2.23)	(1.27)
D_{t-1}	-1.714	0.518	0.031
	(-3.51)	(1.76)	(0.13)
D_{t-2}	0.480	0.186	0.046
	(0.86)	(0.56)	(0.17)
R^2	0.891	0.306	-0.095
F –statistics	32.92	1.76	-0.34
Log-likelihood	-47.92	-34.80	-29.38

Note: t-statistics in brackets.

A two period lag is desirable from a theoretical point of view, but it is acceptable from a practical view too, since its relevancy was proven by the likelihood ratio test. So the estimated version of /5/ can be written as follows:

$$\pi_t = 1.309\pi_{t-1} - 0.405\pi_{t-2} - 1.734D_{t-1} + 0.48D_{t-2} + 0.43K_{t-1} - 0.675K_{t-2} \qquad /5a/$$

Given that the constant term was not significant on any level, it has been removed from the estimated equation. From an economic aspect this means that the characteristic value of the loss function was 0 in the estimation period, that is the Hungarian governments in the transition period made efforts to minimise their losses. If we assume that parameter c_1 of non predetermined sign is actually positive (this is supported by the estimated value of the objective function, i.e. the assumption that governments evaluate the cost of inflation more than its advantages), then the majority of the signs of the estimated parameters suits the theoretical expectations. Parameters $a_4, a_5 > 0$ are the only exceptions, but, as it can be seen from the *t*-statistics in Table 3, they are insignificant. The negative effect of significant equilibrium variables, following the philosophy of the model indicates that the improving equilibrium moderates the intention of government to speed-up inflation, thus diminishes it. (It should be noted that it actually means that inflation would not rise over the planned level, since plans are realistic and not underestimated.) It is obvious that neither an other interpretation, independent of the philosophy of the model and based upon standard macroeconomic theory, can be excluded. Namely, one could argue that the decrease of the deficit of the budget yields a decreasing excess demand, while the improvement of net exports eases the pressure that tends towards devaluation, and the resultant of these factors decreases inflation.

The dynamic properties of the Hungarian inflation

Testing the reduced loss function /4b/ means at the same time the empirical analysis of the dynamic properties of the Hungarian inflation. As it has been done in the previous section, assuming once again the constant value of the objective function, the equation can be written in a simple form. Thus we get the following equation:

$$\pi_t = a_0 + a_1\pi_{t-1} + a_2\pi_{t-2}\,, \qquad /6/$$

where $a_0 = b/c_1$, $a_1 = -c_2/c_1$, and $a_2 = -c_3/c_1$. From an econometric point of view difference equation /6/ can be regarded as an autoregressive process, which can be tested by standard methodology. After some trials it has been found that an AR(2) process fits very well. So the estimated form of equation /6/ is as follows (*t*-statistics are in parentheses):

$$\pi_t = \underset{(7.1)}{22.356} + \underset{(9.7)}{1.4063}\pi_{t-1} - \underset{(-3.6)}{0.53}\pi_{t-2} \qquad /6a/$$

$$R^2 = 0.86 \qquad D\text{-}W. = 2.18 \qquad F = 111.37$$

The roots of the difference equation can easily be computed as $\lambda_1 = 0{,}70 + 0{,}19i$, and $\lambda_2 = 0{,}70 - 19i$. As it is shown, complex roots have been obtained, so depending on the initial values, the general solution of /6a/ is the following:

$$\pi_t = [0.73^t][(\pi_0 - 179.3)\cos 15^o t + (5.3\pi_1 - 3.7\pi_0 - 283.1)\sin 15^o t] + 179.3 \qquad /6b/$$

Having imputed the initial values π_0 and π_1, the actual level of inflation can be computed. Here the constant term means that in the average of a comparatively long time span the ruling government(s) did not strive for a zero loss. On the contrary, they could not resist the short term temptation which may result in a social loss on a longer time horizon. This statement is in contradiction with the testing results of equations /5/ and /5a/. Nevertheless, if as in course of the former analysis, here we suppose again that $c_1 > 0$, then we get from the estimated parameters that $c_2 < 0$ and $c_3 > 0$, which is fully consistent with the previous results. The endogenous treatment of the domestic and foreign equilibria, however, slightly modifies the conclusion that can be drawn from the policies of governments. While in the case of exogenous equilibrium indicators estimation clearly reveals a committed-against-inflation behaviour, now the picture of much less committed governments emerges an the scene. The positive value of the loss function and the cyclical path of inflation show that it is possible that governments sometimes accelerate inflation. Basically, the behaviour is the same, since it remains true that governments in their preferences attributed a bigger value to the costs of inflation than to its gains. This statement is approved of by some results coming from the general solution of /6b/. Since the square root of the conjugated roots is less than one (equals to 0.728) it follows that the process is a stable one and tends to its equilibrium level of 179.27.

The trigonometric function, within square brackets, in the second factor of the particular solution of /6b/ indicates that there is a fluctuating and periodic time path of infla

tion. The length of a period has been found to be 24 intervals (360/15) i.e. 6 years (since quarterly data were used). This longitude, however, does not approve of the convincing introductory assumption that the four-year interval between general elections could be taken as a basis of periodicity. It seems to be quite clear that the first two years after the general elections could be taken as an equilibrium oriented and an inflation accelerating period. While, on the other hand, those two years before the coming elections used to be of concessions in fiscal policy and, consequently, of decelerated inflation.

A disturbing factor in following up the whole inflationary process could be attributed to the period about the beginning of the transition when, as a consequence of different shocks, there was a very rapid growth of inflation. Omitting this period and re-estimating the equation for the period 1992 -1999 the following results can be obtained:

$$\pi_t = \underset{(7.8)}{19.96} + \underset{(7.2)}{1.28}\pi_{t-1} - \underset{(-2.8)}{0.47}\pi_{t-2} \qquad /6c/$$

$$R^2 = 0.79 \qquad D\text{-}W. = 1.95 \qquad F = 49.23$$

In this case the complex roots are $\lambda = 0.64 \pm 0.24i$ indicating a period of 4.3 years.[8] This may verify our previous hypotheses regarding the existence of political business cycles. Nonetheless, these results can be evaluated carefully, because on the one hand the model is based upon an endogenous treatment of some variables, which is not supported fully by economic theory. On the other hand, the periodicity computed from the estimated parameters is extremely uncertain (the modification of parameters, even if they remain within the corresponding confidence interval, may radically change the dynamic properties of the process, e.g. it loses even its cyclical pattern). Furthermore, it should be added that the sample of empirical investigations is very small (it spans only two periods, and makes it very difficult to draw stable behavioural rules).

Quantification of inflationary expectations

For further empirical analyses what is left, is the task of testing equations /1/-/2/ and /1/-/2a/ which refer to the expected and planned inflation. Equations /2/ and /2a/ describe planned inflation and if we substitute them into /1/, the equations of the expected inflation can be obtained as

$$\pi_t^e = (\alpha_1 + \alpha_2)\pi_{t-1} - \alpha_2\beta_1\pi_{t-2} - \alpha_2\beta_2 D_{t-2} - \alpha_2\beta_3 K_{t-2}$$

$$\pi_t^e = a_1\pi_{t-1} + a_2\pi_{t-2} + a_3 D_{t-2} + a_4 K_{t-2} \qquad a_1 > 0\,,\ a_2, a_3, a_4 < 0 \qquad /7/$$

and for the simplified case

$$\pi_t^e = (\alpha_1 + \alpha_2)\pi_{t-1} - \alpha_2\beta\pi_{t-2}$$

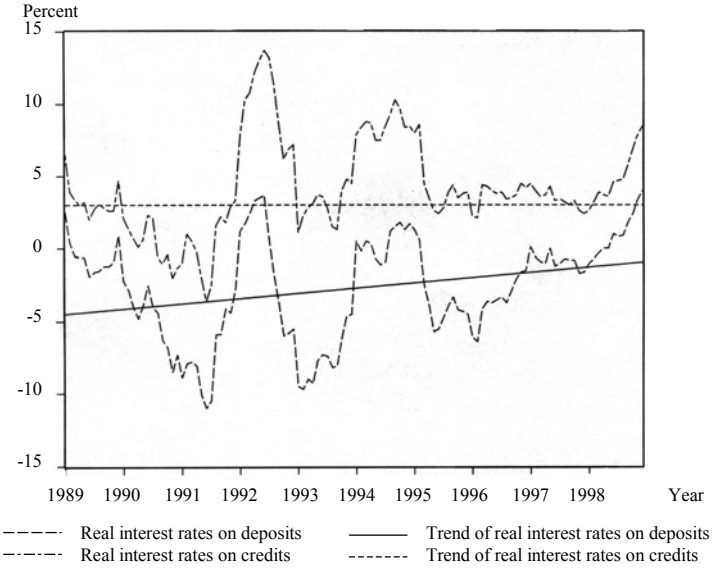
$$\pi_t^e = a_1\pi_{t-1} + a_2\pi_{t-2} \qquad a_1 > 0\,,\ a_2 < 0 \qquad /7a/$$

[8] Since *cos* α = $0.64 / \sqrt{0.64+0.24}$ =0.9363, and this refers to 20º30' and 360/20.5 = 4.3 years.

So the relevancy of these two groups of equations should be tested. The basic difficulty of an econometric analysis regarding inflationary expectations lies in that fact that there are no data for expected inflation available. This was the first obstacle to be surmounted by means of estimating expected inflation.[9]

The changes in real interest rates were used as a tool of approximation of expected inflation. Calculating real interest rates based on annual inflation rates and nominal interest rates on deposits and loans of less than one year term, it could be seen that these values are of high volatility.

Figure 1. Short term real interest rates and long term real yields



According to the *Fisher identity* real interest rate in the average of a longer period used to be relatively stable and the nominal interest rate reflects inflationary expectations. This is shown by the following formula:

$$R_t = \hat{r}_t + \pi_t^e ,$$

where R_t is the nominal interest rate and $\hat{r}_t$ is the real interest rate which is relatively stable in time. Since real interest rates are obtained by reducing the nominal interest rate by the rate of inflation

$$r_t = R_t - \pi_t ,$$

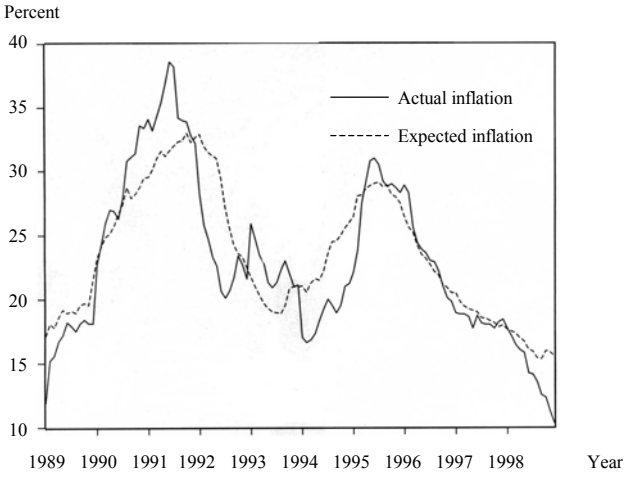
it is easy to obtain the following equation for inflationary expectations:

$$\pi_t^e = \pi_t + r_t - \hat{r}_t . \qquad /8/$$

[9] In literature the estimation technique of adaptive and rational expectation models is well-known, but this method evades the determination of inflationary expectations, which is, however, the inherent element of our investigation.

So, if we knew the long term real yield, it would be easy to determine the expected inflation by using equation /8/. We assume that the constant real rate of interest can be regarded as an average or a trend value. According to this assumption a trend has been fitted to real interest rates fluctuating in time. This trend reflects the tendencies of real yield, prevailing itself for a long term. So the expected inflation can be determined. Equation /8/ could be interpreted as follows: the existence and the extent of differences between real interest rates and long term real yield requirements could be attributed to the fact that the expectations of inflation were inappropriate and as well as to how they deviated from the actual inflation. Having implemented calculations for the returns of both deposits and loans, the expected inflation has been determined as a simple arithmetic mean of the two results.[10] The time series of expected and actual inflation are illustrated in Figure 2.

Figure 2. Actual and expected inflation



We begin testing by the simpler equation /7a/ in which the rule of adaptive expectation is expressed, regarding that current expectations on inflation are determined by a weighted sum of actual inflations of previous periods. First of all the order of integration of expected inflation should be found. Table 2 contains the results of the unit root test. It is clearly seen that the expected inflation like the actual one is a process integrated of first order. Consequently, in a direct way, by fitting a regression equation, testing cannot be validly done. There is, however no obstacle to analyse the cointegrating relation between the two variables. The *Johansen* cointegration test shows that based on the likelihood ratios at 5 percent level of significance, at most one cointegrating relation can be taken into account. The error correction model based on the cointegrating coefficients is as follows:

$$\Delta\pi_t^e = \underset{(-0.40)}{-0.026}\left(\pi_{t-1}^e - \underset{(-34.7)}{1.017}\pi_{t-1}\right) + \underset{(5.33)}{0.704}\Delta\pi_{t-1}^e + \underset{(0.58)}{0.050}\Delta\pi_{t-1}$$

R^2 =0.589 F-statistic = 25.1 Log-likelihood = -55.7

[10] The calculations have been made on the basis of monthly time series of interest rate thus inflation expectations of monthly frequencies (for 12 months) have been obtained. Quarterly indices have been calculated by simple arithmetic means.

The results show that the convergence to the equilibrium level given by the cointegrating relation is rather uncertain, simply because the corresponding parameter is insignificant. Neither parameter expressing the impact of the change of the lagged inflation is significant, which, however would be very important to verify the relevancy of /7a/. Studying these results it is still questionable, whether there exists any relation between the expected and actual inflation. Results of the *Granger* causality test are summarised in Table 4.

Table 4

Granger causality tests
(p – values)

H_0	Number of lags				
	1	2	3	4	5
π is not the cause of π^e	0.284	0.585	0.550	0.715	0.184
π^e is not the cause of π	0.461	0.106	0.091	0.021	0.015
$\Delta\pi$ is not the cause of $\Delta\pi^e$	0.596	0.804	0.740	0.274	0.260
$\Delta\pi^e$ is not the cause of $\Delta\pi$	0.500	0.654	0.535	0.015	0.048

The causality analysis unequivocally indicates that actual inflation could not be taken as a cause of expected inflation while a much higher probability could be attributed to the reverse causal relation. From an economic point of view it means that adaptive type of expectations cannot be taken as a typical one in the case of inflationary expectations. On the other hand, there is a definite influence of the expected inflation on the actual one. Thus the Phillips-curve augmented by expectations holds for the Hungarian economy too.

After rejecting the hypothesis of adaptive expectations it has been worth-while to make reverse proof to investigate that whether or not rational expectations were present in the inflationary process. According to the definition of rational expectations this can easily be done. Since in the case of these expectations a systematic forecasting error does not occure, the following equation should hold:

$$E(\pi_t^e - \pi_t) = 0 \quad \text{and} \quad \pi_t^e - \pi_t = \varepsilon_t\,, \qquad /9/$$

where ε_t is a normally distributed random variable of constant variance. This way it should be tested whether the difference between the two variables followed a normal distribution with zero mean or not. The results of the corresponding normality test indicated that the *Jarque - Bera* value was equal to 0.45 and the empirical level of significance was equal to 0.79. Thus the hypothesis of rational expectation can not be rejected.

Nevertheless, this does not mean that there is no empirical proof for equations /1/-/2/ and the reduced one /7/. Given that equation /2/ contains the change of equilibrium too, and the agents of the economy who behave rationally take into account these changes in forming their rational expectations, this is not a model of pure adaptive expectations. That

is why it seems to be suitable to augment the previous error correction model by the exogenous variables of the balance of the state budget and net exports.

After trying different lag-structures the following estimates have been obtained:

$$\Delta\pi_t^e = \underset{(1.46)}{0.10}\left(\pi_{t-1}^e - \underset{(-51.2)}{1.046}\pi_{t-1}\right) + \underset{(5.53)}{0.627}\Delta\pi_{t-1}^e + \underset{(0.46)}{0.041}\Delta\pi_{t-1} - \underset{(-1.32)}{0.236}\Delta D_{t-1} - \underset{(-1.78)}{0.233}K_{t-2} \quad /10/$$

R^2 =0.713 F-statistic = 12.4 Log-likelihood = -27.5

The inclusion of the equilibrium variables, however, resulted in changes. On the one hand, the quality of estimate is amended, however the majority of deficiencies mentioned before remained. Convergence to the long term equilibrium could not be realised, moreover, neither direction of the movement is suitable, since the convergence parameter is positive and inflation remained insignificant. The signs of parameters of foreign and domestic equilibria are in accordance with theoretical considerations but the level of significance of these variables is not convincing. So estimate /10/ can be accepted as an empirical verification of models /1/-/2/ and equation /7/ only with some reservations.

3. Conclusions

On the basis of the model described in this paper and its empirical verification it can be stated without fail that the governments in the transition period were not unequivocally committed to fight against inflation. Their economic policies considered inflation control often as one of the instrumental variables of improving the equilibrium position and not as a target variable. The econometric analyses did not result in the explanation on the temporal changes in regard of the dominance of target or instrument character. (Due to the characteristics of the applied model these aspects could not be investigated.) Thus in this respect one could resort to the assumption of accelerating inflation in the periods of hard problems of domestic and foreign equilibria (i.e. the periods of intensive strive for equilibrium). Therefore in the period of equilibrium problems inflation served as an instrument, while, on the other hand, in more equilibrated periods inflation was a target and, as a consequence, had much lower rates.

The hypothesis of the cyclical character of the Hungarian inflationary process has not been convincingly confirmed by the autoregressive model based on quarterly data. The four year periodicity that matches that of general elections cannot be proven. The length of periodicity is uncertain, it depends highly on the selected length of the time series used for estimation. Based upon the estimates the existence of governments working according to the philosophy of the political business cycle is probable, but regarding the short time series and further missing information, this statement can not be proven at a convincing level of confidence.

It has been indicated by the analysis of inflationary expectations derived from real rates of interest that the assumptions of adaptive expectations were not valid for Hungary. In the transition period the inflationary expectations could be better attributed to some rational characteristics. This assumption is supported by that fact that the inflation rates of a previous period could not explain the rates of expected inflation, but the inclusion of the

indicators of macro-economic equilibrium of the preceding period provide more or less acceptable estimates.

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