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DETERMINANTS OF REAL-EXCHANGE RATE FLUCTUATIONS IN HUNGARY[1]

[1] The views expressed in this paper are those of the authors and do not necessarily reflect the official view of the National Bank of Hungary. The authors are grateful for comments by Gyula Barabás, Fabio Canova, Carlo Favero, Tamás Glanz, Gábor Körösi, Judit Neményi, György Szapáry, István Székely, János Vincze and Axel Weber. All remaining mistakes are entirely our own.

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Abstract

This paper investigates the different sources of real exchange rate fluctuations in Hungary. We consider the effect of tradable pricing behavior and nominal rigidities in tradable real-exchange rate movements, and investigate the importance of relative productivity changes between the tradable and nontradable sector in relative price (nontradable/tradable) adjustments. We formulate a policy reaction function to separate the effect of tradable pricing shocks from policy shocks. The framework we use is a two sector open economy real exchange rate model. Its contemporaneous structure is used for the identification of structural shocks. Since the effect of policy shocks on tradable real exchange rate was not significant, our results suggest that nominal rigidities did not play an important role during the period under consideration. The evolution of nontradable prices and relative (nontradable/tradable) prices were well explained by nontradable output shocks. Thus, the Balassa-Samuelson-effect seems to have been at work in Hungary during the first eight years of transition.

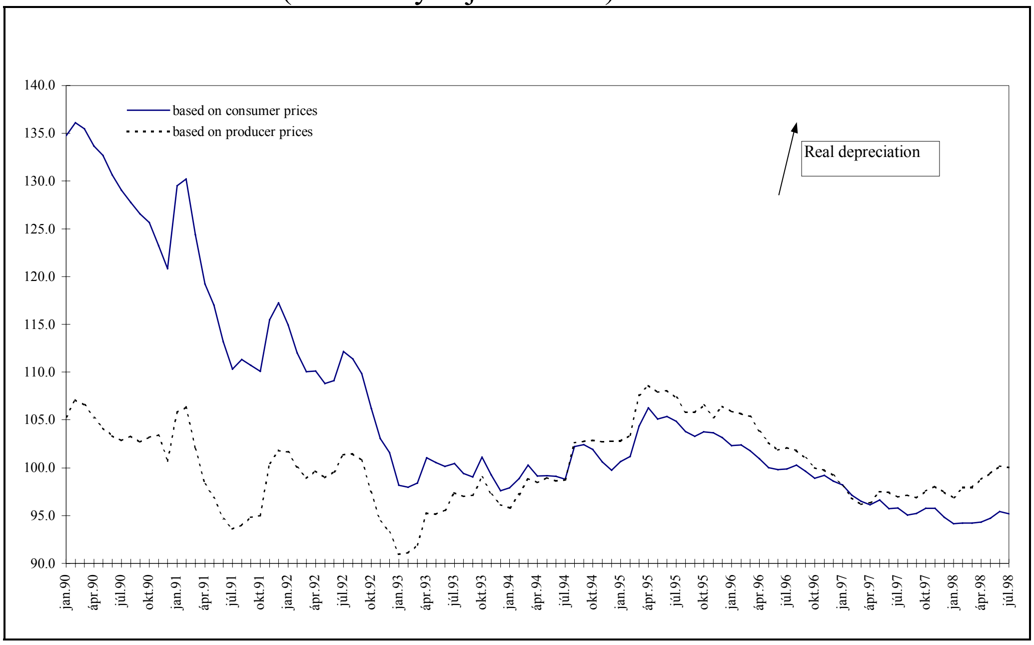
Contents

I. Introduction

Since 1989, the beginning of the transition process towards a market economy, Hungary has gone through dramatic economic changes. In ten years, the formerly centrally directed, state owned economy took on the characteristics of a developed economy, where the bulk of GDP is produced by the private sector. Economic policy, and more specifically exchange rate policy played a key role in the process. It had to serve two conflicting objectives simultaneously: maintaining competitiveness and being a nominal anchor in disinflation. In the early stages of transition (until March 1995) an adjustable peg regime was in place, which, as a result of continuous real appreciation combined with loose fiscal policies, led to a loss of competitiveness, deteriorating external balance and increasing indebtedness. The stabilization package of March 1995 brought about fiscal adjustment and introduced a new exchange rate regime, the crawling peg (with a +-2.25%- intervention band). Macroeconomic conditions have improved substantially since then. (On a detailed description of the Hungarian exchange rate policy see Szapáry and Jakab(1998) pp. 691-717). After a one year period of overshooting, real appreciation (measured on the basis of different price indices) continued after 1995, despite the new exchange rate regime. Unit labor cost indices showed remarkable improvement however, keeping competitiveness intact and supporting rapidly growing exports.

In the period under consideration the CPI based real exchange rate appreciated by over 40% by the first half of 1998, whereas the PPI based real exchange by a mere 7%. There seem to be substantial differences in real exchange rates depending on the extent to which the underlying indices contain nontradable products. This leads us to conclude, that considerable relative (nontradable/tradable) price adjustments took place in Hungary.

FIGURE 1:
Real effective exchange rates of the forint based on consumer prices and wholesales prices in manufacturing
(Seasonally adjusted data) 1994=100



In this paper we present a two sector open economy real exchange rate model of the Hungarian economy. (The methodology is very similar to Clarida and Gali (1995) pp.1-56, Weber(1997) and Weber(1998) as we use Strucural Vector Autoregression (SVAR) to identify the different sources of real exchange rate fluctuations. However, as we are interested to a large extent in relative price effect we use a tradable nontradable, rather than a one sector model.) We address two main issues regarding the behavior and fluctuations of the real exchange rate in Hungary. First, we discuss to what extent purchasing power parity (PPP) could be valid for a transition economy. In assessing PPP we deal with tradable prices, as for nontradables even theory does not predict PPP to be a necessarily valid assumption. Rather than testing PPP (whether in absolute or relative form), we are interested in pricing behavior in the tradable sector, and use PPP as a departure for explanation. We are also interested in determining the extent to which policy or tradable pricing shocks are responsible for fluctuations in the tradable real exchange rate and in evaluating the importance of nominal rigidities. The results suggest that pricing to the market and nominal rigidities cannot be responsible for the discrepancy between domestic tradable prices and the nominal exchange rate, although its importance could have increased after the credibility of the crawling peg regime strengthened. According to the historical decompositions nominal rigidities did not play a substantial role in tradable real exchange rate movements during the period under consideration.

Our second question concerned the determinants of nontradable and relative (nontradable/tradable) prices. This point is crucial from with regard to disinflation. While the prices of tradable goods are well explained by foreign prices multiplied by nominal exchange rate in the medium-long term, nontradable inflation is a result of relative price adjustments and domestic nontradable market conditions, which foreign exchange policy cannot directly influence. As a result, policymakers cannot use the nominal exchange rate as a simple nominal anchor for prices, and have to determine a rate of devaluation that will not stifle competitiveness, yet will contribute to disinflation. Our results suggest that the evolution of nontradable and relative prices can be well explained by nontradable output shocks, that is, the so called Balassa (Balassa (1964) pp. 584-596) and Samuelson (Samuelson(1964) pp. 145-154) effect seems to have been at work in Hungary. On the other hand, the effects of nontradable demand shocks can be detected since the second part of 1996 as well. The sharp devaluation in the first part of 1995 also contributed to the increase in tradable prices.

To separate market pricing behavior from policy effects on the tradable real exchange rate we endogenized the effect of economic policy by explicitly including the reaction function of the authorities in our model. This feature of the model is the one most open for criticism, as in March 1995 Hungary's exchange rate policy was thoroughly revised. The system of adjustable pegging was abandoned and a new crawling band system adopted. Data availability made it impossible to estimate the model for the pre- and post-crawl period separately[2], hence we estimated the reaction function for the whole sample. Imperfections notwithstanding, we believe that it is a reasonable approximation of the true reactions, as it is supported by the data. Despite the small sample and the shortcomings of our approach, the results we obtained appear to be plausible. These are the following:

a. The authorities attempted to stabilize the tradable real exchange rate throughout the period.

b. The authorities also reacted to fluctuations in tradable output.

Our results suggest that for a negative tradable output shock the authorities decreased the rate of devaluation and vice versa. This may seem a bit shocking at first, but becomes more sensible when one looks at the data. In the early phase of the transition the recession in industry deepened, yet the rate of devaluation was decreased as the authorities were more concerned about accelerating inflation. When the external balance of the Hungarian economy started to deteriorate in mid 1993, the authorities set the average rate of devaluation at ever increasing levels. Simultaneously, tradable output started picking up. This suggest that from a theoretical point of view exchange rate policy was, *ceteris paribus*, destabilizing for the external sector. This statement is naturally overly

[2] We had overall 28 observations.

simplified, as there have been other important indicators that the authorities reacted to (nontradable prices and overall inflation, external debt situation, credibility issues etc.) and several of them are not incorporated in our model.

II. Stylized facts

Before presenting the model that is geared towards detecting different structural shocks, we will consider some theoretical and empirical aspects regarding tradable pricing behavior and relative price adjustments.

1. Tradable pricing behavior

For a small open economy the benchmark for tradable prices is the nominal exchange rate (after correcting for foreign price changes). Even in theory, the PPP hypothesis is valid for tradable prices only. Empirically, regressions on international data examining the convergence of prices and the exchange rate yielded results that did not appear to be robust.[3] In analyzing the relationship between tradable prices and the exchange rate, one should take several different effects into consideration.[4]

Even if one rejects the unit-root in tradable real exchange rates or finds cointegration between prices and the nominal exchange rate, an identification problem emerges. The authorities of small open economies are keen to preserve price competitiveness, that is, to maintain a favorable real exchange rate *vis-a-vis* the country's competitors. As a result, the real exchange rate becomes a policy indicator and stabilizing its behavior a macroeconomic policy goal. At the same time, international arbitrage also exerts a leveling influence on the prices of small open economies. For larger and more closed economies PPP is not pivotal for the authorities, nor is the role of international arbitrage of such prominence. Consequently, we will usually find PPP to be valid in relation to small competing economies, but even in their case, it will not obvious whether this is a result of policy or of international arbitrage.

In assessing PPP, one should find two consumer baskets consisting of identical products. Most of the price indices considered in empirical studies do not fulfill this condition (Goldberg-Knetter(1997) pp. 1243-1272).

Tradable prices can deviate from PPP as a result of nominal rigidities as well. Economic theory suggests these effects to cancel each other out in the long run. Nominal rigidities are usually deemed to cause only short term fluctuations. The relation between the average duration of rigidities and inflation is presumably inverse. The higher inflation is, the shorter nominal contracts are, and hence the less significant their role.

If the costs of arbitrage are relatively high, the reaction of exporters and importers to changes in relative prices are nonlinear (Taylor and Peel (1998)). The role of transaction costs and trade barriers in exports can weaken the forces for international arbitrage, and cast doubt on the validity of PPP. When contemplating transaction costs, differences in legal and cultural environment should also be taken into account. The results of Engel and Rogers (Engel and Rogers (1996) pp. 1112-1125) suggest, that the variability of relative prices are much higher across countries than within, even after controlling for distance.

Usually all tradable products contain some form of nontradable components (service, network, marketing). As there is no one international market for nontradables, the price and quality of these

[3] We have to mention, that most of the studies deal with real exchange rate relative to the USD. In Europe the results for PPP are much more robust.

[4] We do not intend to discuss accurately the problems with testing PPP, the following list is just a basis for discussion without the requirement of generality and completeness.

can be quite different internationally, leading to the segmentation of markets for tradable products as well.

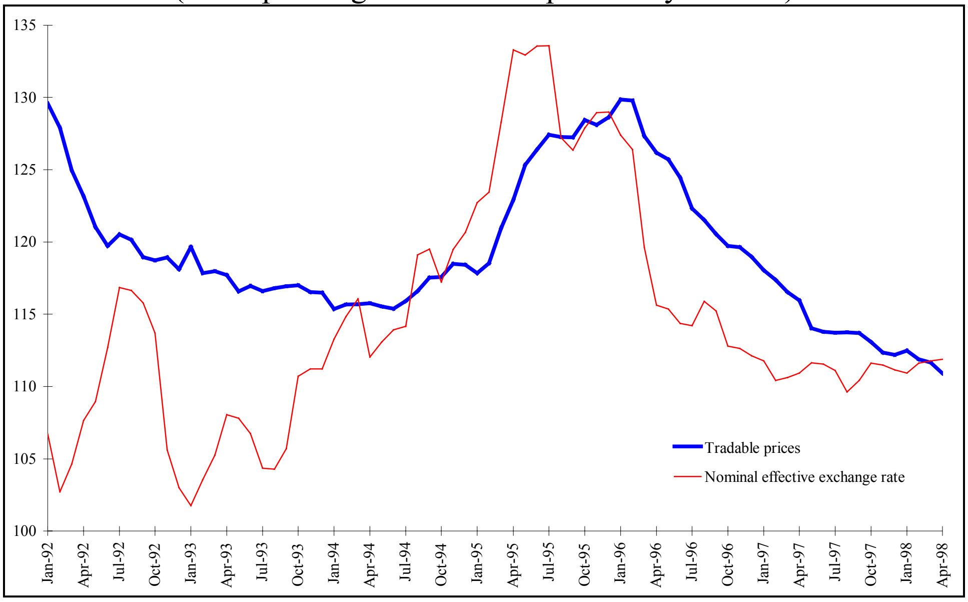
Given different preferences in two countries, PPP need not be valid for their price levels, even if the law of one price for the products hold. In this case we use different consumer baskets for purposes of aggregation.

As discussed earlier, tradable markets could easily become segmented because of transaction costs and nontradable inputs. If individual firms have the market power for price discrimination they can apply monopolistic pricing, setting different prices for different markets depending on the structure of regional demand (Goldberg and Knetter (1997)). If pricing to market is relevant, the foreign price of a given product will be much more stable than its domestic price expressed in foreign currency using the nominal exchange rate, as producers use their profit margins to accommodate exchange rate fluctuations. In this case, the domestic and foreign price of the same product can behave differently even in the medium term

These effects may be of relevance when testing PPP for Hungary as well. Assessing their extent would, however, require highly disaggregated data. We do not attempt to analyze these effects in a very detailed manner, rather we try to capture the aggregate effect of policy and tradable pricing causing deviations from PPP. FIGURE 2. displays annual changes in tradable prices derived from CPI and the nominal effective exchange rate.[5]

[5] The results above seem to be robust to the definition of the nominal exchange rate no matter whether we use the nominal effective exchange rate, the currency basket or the DEM for discussion we get almost exactly the same.

FIGURE 2.
Evolution of tradable prices and the nominal effective exchange rate
(corresponding month of the previous year=100)



One can observe that the difference between the two series was significantly higher in the 1991-1994 period than later. From 1991 to 1994 tradable prices increased more than the nominal exchange rate. In the first half of 1995 - as an effect of the sharp devaluation which was part of the 1995 stabilization package - tradable prices increased much less than the nominal exchange rate leading to a depreciation of the tradable real exchange rate. Since the first quarter of 1996, the annual growth rate of tradable prices has been higher again than that of the nominal exchange rate. In the last three periods the two series almost perfectly coincided.[6] Since 1995 the co-movement of tradable prices and the nominal exchange rate has been much clearer than before. Clearly, the change in the exchange rate regime has played an important role in this. The crawling peg regime is more forward looking than its predecessor, the adjustable peg. As changes in the exchange rate became more foreseeable, pricing behavior took on a more forward looking character: in the absence of unexpected changes in the exchange rate, tradable inflation and exchange rate dynamics have grown similar. Earlier, when changes in the exchange rate were more uncertain, prices might have contained a "devaluation premium". This hypothesis is supported by the fact that not only the variance, but also the average size of the discrepancy was higher before 1995. Another important factor at work could have been the change in the efficiency of arbitrage. With the Hungarian economy becoming increasingly liberalized during the sample period, transaction costs for arbitrage decreased. Trade barriers and customs were lowered[7], the efficiency of the financial infrastructure enhanced. The information of domestic producers concerning the structure of foreign markets also improved. The change in the gap in price and exchange rate dynamics in the two periods could also reflect the effect of changes in the quality of products and in preferences, i.e. the composition of baskets considered have become more similar.

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[6] For assessing real exchange rate obviously we should take into consideration the evolution of foreign tradable prices as well. As we do not have disaggregated foreign data matching the Hungarian category, we cannot use them. As foreign tradable price inflation is very small in magnitude in comparison with the Hungarian price dynamics, considering it as exogenous we do not impose serious restriction on the data.
[7] One obvious exception is the import surcharge for durables since 1995 until 1997 which was part of the stabilization package.

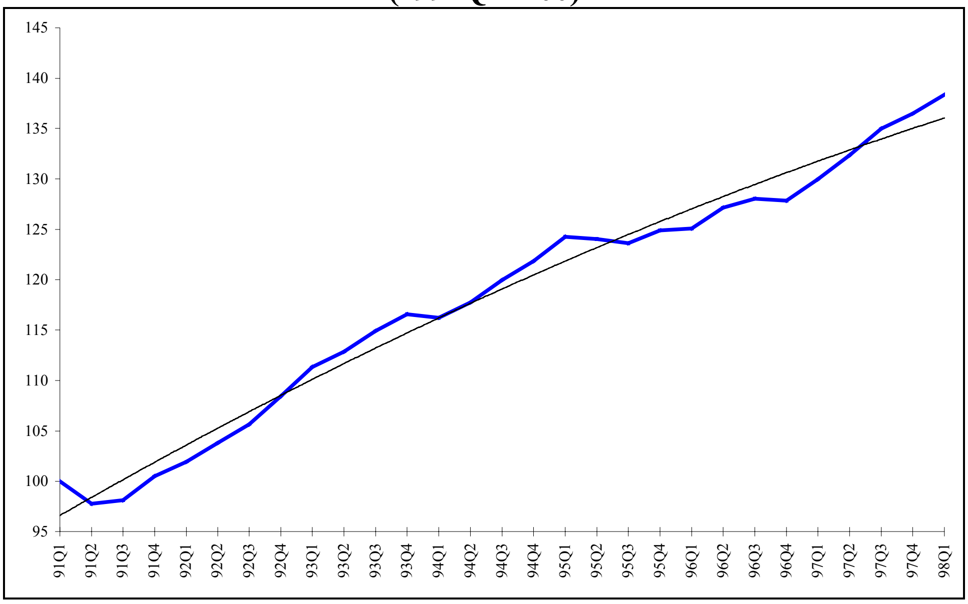
Some intuition about the presence of nominal rigidities may also be gained from FIGURE 2. The variance of tradable prices is much smaller than that of the exchange rate, which indicates that nominal rigidities were present.

As we discussed earlier, detecting the influence of pricing behavior requires highly disaggregated data. This is the case with pricing to the market (PTM) as well. In Hungary the importance of this is presumably asymmetric for exporters and importers. It is dubious that Hungarian firms have the market power for PTM. What we can assume, is that they set their export prices to foreign prices, rather then deriving their export prices from the price discriminating solution. Even in this case, nominal exchange rate fluctuations can cause changes in the profit margin of exporters, but this is because of nominal rigidities, not PTM. The assumption is more plausible in the case of large multinationals that export to Hungary. They do have the market power and the strong enough balance sheets to implement third degree price discrimination and absorb exchange rate fluctuations in their profit margin.

2. Demand and supply shocks and relative prices

Relative prices have increased by 40% since the first quarter of 1991 (see FIGURE 3.). One can observe that exchange rate policy could influence relative price behavior only to a very limited extent. The effect of the 1995 stabilization package - when the forint was devalued by over 29% - lasted for only about half a year.

FIGURE 3.
The evolution of relative (nontradable/tradable) prices
(1991Q1=100)



This observation leads us to conclude that there are fundamental determinants of the evolution of relative prices which exchange rate policy can only influence to a very limited extent. There are two groups of explanations of relative price adjustment. The first group contains general explanations, the second transition economy specific ones.

As the exchange rate affects tradable prices directly, but nontradable prices only indirectly, it affects relative prices at least temporarily, as we mentioned earlier. Changes in tradable pricing behavior can also generate relative prices adjustments in a general equilibrium framework. If productivity gains in the traded sector exceed those in the nontradable sector while wages and profits are equalized between the two, a relative price increase is necessary to decrease relative real wages[8]. This is the well-known Balassa-Samuelson effect.

Due to fiscal policy or changes in consumer preferences one can observe temporary or more permanent changes in nontradable demand that change nontradable prices.[9]

The second group of explanations deals with factors specific to transition economies (Halpern (1996), Halpern and Wyplosz (1997) pp. 430-461, Krajnyák and Zettelmeyer (1998) pp. 309-362, Kovács (1998)).

As the prices of services - usually referred to as typical non-tradable products - were artificially low before the transition, the increase in their prices in comparison with other products can be seen as an equilibrium process. It is a result of these prices moving to their market clearing level, or reflect faster gains in quality.

Wages in the nontradable sector could increase faster than in the traded sector. If the rate of return on capital is equalized between the two sectors, a higher wage increase must be associated, ceteris paribus, with relative price adjustment[10].

Inefficiencies in wage formation mechanisms disappear quicker in the nontradable sector than in the tradable. This could result in relative price increases if nominal wages are equalized between the two sectors. Then the necessary relative real wage decrease could only be attained at higher nontradable/tradable price-ratios.

The adverse Balassa-Samuelson effect developed by Grafe and Wyplosz (1997) – as its name implies – works in the opposite direction as the original one. Their model contains three sectors: a "new tradable", a "new nontradable" and an "old tradable" one. Unless nontradable wages increase, the "new nontradable" sector could not emerge. This wage-pressure gradually passes through to tradable wages, which reinforces the pressure on the unproductive "old tradable sector" to close down and increases the share of the more productive "new tradable" sector.

In summary, in explaining the behavior of relative prices the following effects need to be considered: exchange rate, tradable pricing, tradable productivity, nontradable productivity, nontradable demand and labor market shocks.

Our purpose is to decompose relative price movements into these components, and asses their relative importance. We have to stress, that this decomposition is not exclusively of theoretical interest. The more important demand shocks are in relative price adjustment, the bigger role active fiscal or monetary policy can play in disinflation. Naturally, the authorities have to take changes in consumer preferences - in Hungary's case the increased relative demand for nontradable consumption - as given. Economic policy can, nevertheless, play a role in disciplining excessive nontradable demand, that is due to excess money supply.[11] The more important supply shocks are found in explaining relative price behavior, the more ineffective demand policy is in stabilizing inflation.[12] In this case, exchange rate policy and nontradable supply oriented policy are important. In the case of labor market shocks (differences in wage increases, skills or labor market behavior), the flexibility of labor market could be the most desirable goal.

In analyzing relative productivity and relative price movements we exclude labor market effects, as empirical studies suggest that the role of asymmetric labor market shocks were not

[8] One additional condition is that the share of labor in nontradable production should exceed that in the tradable one.

[9] Changes in consumer preferences could equally be a phenomena associated with transition factors.

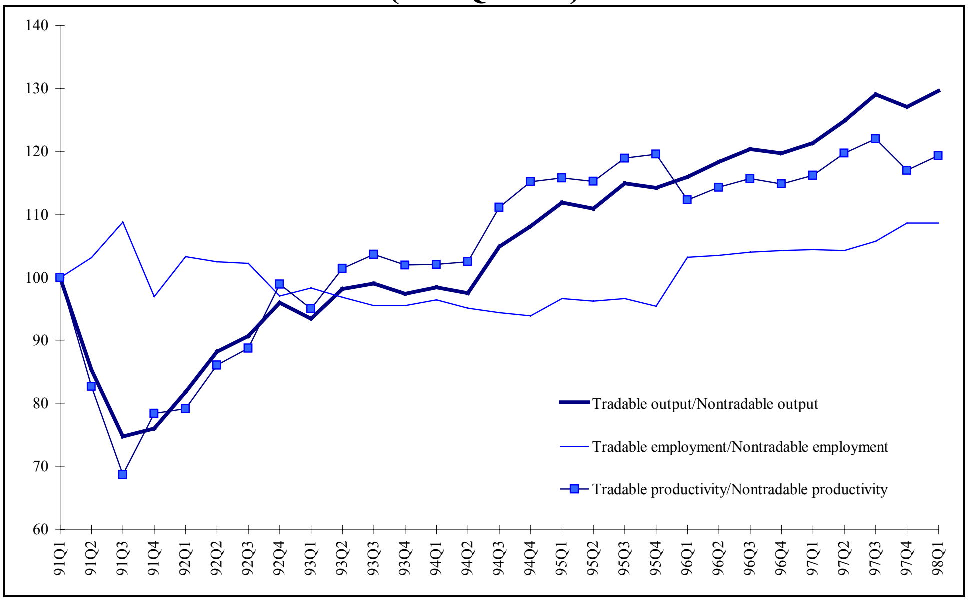
[10] The relative wage increase does not necessary imply relative price adjustment if this reflect the differences in the marginal productivity of labor. That is why we use the ceteris paribus assumption.

[11] Note that a large part of fiscal expenditures are devoted to tradable goods (durables and investment goods) as well, so fiscal policy can be equally important in stabilizing tradable demand.

[12] Monetary and fiscal policy even in this case are important in stabilizing tradable demand which effects the external balance.

significant in size compared with the other, above mentioned effects: neither the evolution of employment, nor of wages substantially differed in the two sectors during the transition. (The only outlier is the 1995 period, when, as a consequence of fiscal adjustment, nontradable wages increased less than tradable wages. (For a detailed discussion of the problem see Kovács (1998).) If asymmetric labor market shocks are not important, the evolution of relative output should be quite similar to the evolution of relative productivity in the two sectors. One can verify in FIGURE 4. that this was exactly the case for Hungary during the period under consideration.

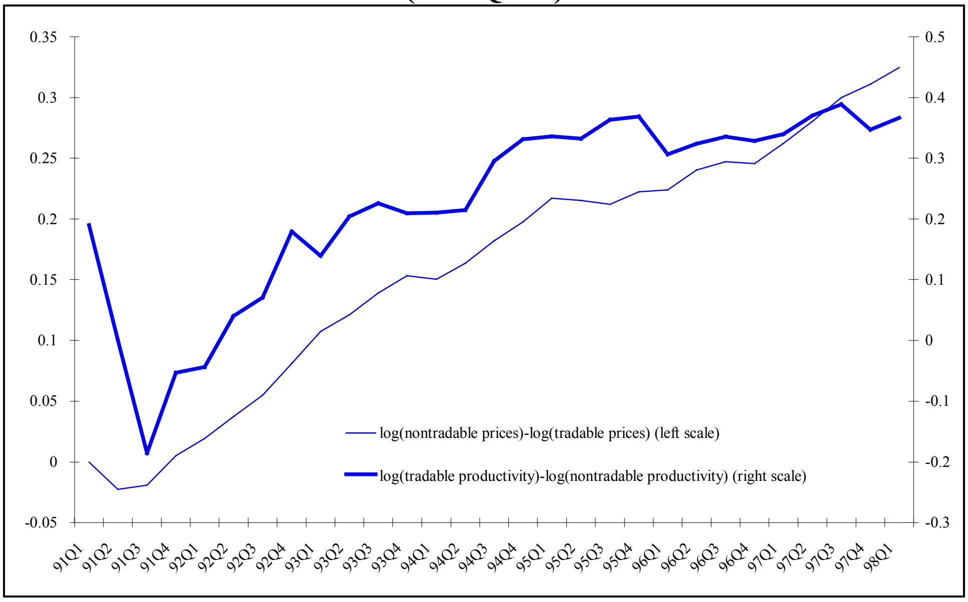
FIGURE 4.
Tradable/nontradable output, employment and productivity (1991Q1=100)



One can argue that relative price adjustment is dictated by demand or supply shocks as discussed above. Kovács and Simon (1998) and Kovács (1998) argue that supply shocks dominated the process.

On FIGURE 5 one can observe the evolution of relative prices and productivity. It can be visually verified that the trend increase in relative prices since 1991 can be associated with the trend increase in relative productivity. Although the period under consideration was subject to serious structural breaks, six year’s time is probably long enough to draw some conclusions of longer run relationships. The rest of the paper attempts to verify our previous statements about relative prices and tradable pricing behavior in the framework of a simultaneous model.

FIGURE 5.
Relative (nontradable/tradable) prices and relative (tradable/nontradable) productivity (1991Q1=0)



II. A two sector small-open economy model

Consider a small open economy with a tradable sector and a nontradable sector, each of which produces one product. Taking our discussion on tradable pricing behavior into account and assuming that foreign prices are constant, tradable prices depend on the expected nominal exchange rate, past price developments and a tradable pricing disturbance term ε_t^{pt} , which is driven by an autoregressive process[13].

$$p_t^T = (1-\pi)E_{t-1}(s_t) + \pi p_{t-1}^T + \varepsilon_t^{pt} \qquad (1)$$

and $\varepsilon_t^{pt} = \alpha_1 \varepsilon_{t-1}^{pt} + \zeta_t^{pt}$

p_t^T denotes the price of tradable output at time *t*

s_t refers to the nominal exchange rate at time *t*

ζ_t^{pt} is a tradable pricing shock

$E_{t-1}()$ is the mathematical expectation operator

π is the rigidity parameter in tradable pricing.

The pricing shock captures deviations from the pricing behavior that exchange rate developments dictate. Depending on the magnitude of the α_1 parameter pricing shocks can be more or less persistent.

As we mentioned earlier, it is of crucial importance to endogenize the effect of economic policy reactions, to facilitate the identification of factors moving the real exchange rate. We assume that the nominal exchange rate is determined by the authorities, that is, it is a fixed exchange rate

[13] All the equations presented in this section are assumed to be valid in logarithmic form, so the presented linear parameters are in fact elasticities, thus small case letters indicate variables in logarithm.

regime. The authorities use the exchange rate to stabilize macro variables they consider to be relevant, namely, inflation, output and external balance.[14]

$$s_t = -a_1\left[\gamma p_t^T + (1-\gamma)p_t^N\right] - a_2\left[\lambda y_t^T + (1-\lambda)y_t^N\right] + (1-a_1-a_2)\left[c_t^T - y_t^T\right] + \varepsilon_t^s \qquad (2)$$

where the disturbance term is given by $\varepsilon_t^s = \alpha_2 \varepsilon_{t-1}^s + \zeta_t^s$, and

p_t^N refers to the price of nontradable output

y_t^T denotes tradable output

y_t^N is nontradable output

c_t^T is the consumption of tradables

λ is the share of tradable output in GDP

γ refers to the preference parameter of tradable goods in the instantaneous Cobb-Douglas utility function of consumers

ζ_t^s is a policy shock

a_1 is the inflation preference and a_2 is the output preference parameter of the authorities

As may be seen from (2), the authorities devalue the exchange rate for a negative inflation or output shock or when the external balance deteriorates. The reaction function attempts to capture the dilemma the authorities in an open economy face, namely, how much weight to give to domestic and external conditions. Depending on α_2, the deviations from the above rule can be more or less persistent. Observe, that the formulation above assumes, that the nominal exchange rate is set contemporaneously with the inflation rate, output, and external balance. For a forward looking regime, like the crawling peg in Hungary, the assumption may be disputable, as the authorities do not observe the relevant macro variables at the time of setting the rate of the crawl. Therefore, from a theoretical point of view, it might have been better to specify a separate reaction function for the crawling peg and the pre-crawl period. Because of the extreme scarcity of observations (we only had 28 quarterly observations) this could not be accomplished. That is the main reason why, in spite of its theoretical shortcomings, we assumed that the contemporaneous reaction function is valid for the entire period. However, there are several arguments to support this assumption[15]:

If policy reacts only to lagged macro variables, we impose zero restriction on the contemporaneous matrix of our model. The validity of these restriction can be tested statistically. According to our results (see later), the zero restrictions are rejected for the whole period.

Even if the rate of the crawl is preannounced, policy makers have some leeway in contemporaneously reacting to deteriorating fundamentals. And even if the path of the central

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[14] The reaction function in (2) can be derived from a minimization of a quadratic loss function, for the variables of interests around their target level. $\gamma p_t^T + (1-\gamma)p_t^N$ is the CPI, $\lambda y_t^T + (1-\lambda)y_t^N$ denotes overall GDP, where γ and λ are share parameters. $c_t^T - y_t^T$ equals to the trade deficit by definition.

[15] We analyzed the statistical properties of the reaction function. The results are ambivalent, as differents tests for detecting structural breaks produced varying results. The F-tests were unable to reject the null hypothesis of no break, while the likelihood ratio tests indicated structural change for all of the breakpoints examined between 1994-1996, except for 1995Q3 and Q4. As the stability of the reaction function was unclear, we examined an alternative model specification, where instead of the nominal exchange rate, tradable real exchange rate was on the left hand side of the reaction function. One can argue that the reaction of the real rather than the nominal exchange rate was much more similar in the two exchange rate regimes. The results of this specification were quite similar to the former one, except that in some cases the standard errors increased.

parity is unchanged, interest rate policy has some room in changing the path of the nominal exchange rate within the band[16,17].

According to the “price puzzle”, introduced by Sims (Sims (1980) pp. 1-48), imposing zero restrictions on the authorities’ contemporaneous reaction function could lead to inconsistent relationships if there is an omitted leading indicator or some contemporaneous information that policy reacts to, which is correlated with both observed variables. In this case, even if there is a time lag in observing the variable of interest, it is safer to assume contemporaneous reaction as a proxy for the relationship induced by leading indicators[18].

The policy equation can be simplified if we assume a representative agent optimizing its expected lifetime utility over a logarithmic intertemporal consumption function, who considers the intratemporal consumption of tradable and nontradable products in a Cobb-Douglas index form. Assuming for simplicity, that aggregate real consumption is constant over time, one can establish (See Obstfeld - Rogoff (1996) pp. 199-267.) the following relationships for tradable and nontradable consumption:[19]

$$c_t^T = (1-\gamma)(p_t^N - p_t^T) \qquad (3)$$

and

$$c_t^N = -\gamma(p_t^N - p_t^T) \qquad (4)$$

Where c_t^T refers to tradable consumption and c_t^N denotes nontradable consumption at time t. Substituting (3) and (4) into (2), after a bit of algebra one gets the following result:

$$s_t = -\left[a_1\gamma + (1-\gamma)(1-a_1-a_2)\right]p_t^T + \left[(1-a_1-a_2) - a_1\right](1-\gamma)p_t^N - \left[a_2\lambda + (1-a_1-a_2)\right]y_t^T - (1-\lambda)a_2 y_t^N \qquad (5)$$

According to (5) the behavior of economic policy is the following:

For an increase in tradable prices the authorities revalue the nominal exchange rate, as an increase in tradable prices, *ceteris paribus*, reduces tradable consumption, and consequently improves the external balance. On the other hand, this increase in tradable prices passes through to overall inflation. That is contrary to the goals of economic policy, therefore it induces them to take stabilization action.

A nontradable price increase presents a dilemma for the authorities. Higher nontradable prices stimulate tradable consumption and thus lead to deteriorating external balance ((1-a_1-a_2) parameter). Devaluation would appear to be the appropriate move. However, the increase in nontradable prices also leads to higher inflation, which would prompt the authorities to do just the opposite: revalue (-a_1 parameter). The eventual outcome will depend on the relative magnitude of the policy preference parameters.

The reaction of the authorities to a positive tradable output shock is unequivocally revaluation, as both the output and the external balance goal dictate the same move. The same applies to nontradable output shocks.

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16 Note that through the uncovered interest rate parity condition exchange rate policy stochastically can correspond to interest rate policy. If the risk premium is not constant over the period, shocks to the risk premium appear in the policy reaction function as a policy shock.

17 There is still one measurement problem with this reasoning. As changes in the rate of the crawl were always implemented in advance, and the exchange rate in most of the crawling peg period was stucked to the stronger edge of the band, there is no variance in the data to be able to capture these effects.

18 In this case the error captures both the policy shock and a measurement error for contemporaneous variables. This case is clearly better as there is some contemporaneous information in the information set of the authorities, even if the official numbers are unobserved.

19 Recall, that if aggregate real consumption is constant, we can normalize it to 1, which means, that in logarithmic form it is zero. In this case the share of tradable and nontradable consumption in overall consumption depend only on relative prices.

In describing production we do not consider the role of intermediate inputs and assume that value added is produced according to a Cobb-Douglas production function in both sectors:

$$y_t^T = \alpha k_t^T + (1-\alpha) l_t^T + tfp_t^T \qquad (6)$$

$$y_t^N = \beta k_t^N + (1-\beta) l_t^N + tfp_t^N \qquad (7)$$

where

l_t^T, l_t^N are the employment in the two sectors

k_t^T, k_t^N are the capital stock in the two sectors

tfp_t^T, tfp_t^N are total factor productivities or efficiency factors.

We derive the labor demand function from the production functions of the two sectors. By equalizing wage with the marginal value product of labor in the two sectors the following labor demand function obtains:

$$l_t^T = \frac{1}{\alpha}\left[(1-\omega)p_t^T + \omega s_t\right] + k_t^T + \frac{1}{\alpha} tfp_t^T - \frac{1}{\alpha} w_t \qquad (8)$$

$$l_t^N = \frac{1}{\beta} p_t^N + k_t^N + \frac{1}{\beta} tfp_t^N - \frac{1}{\beta} w_t \qquad (9)$$

where ω is the share of export sales in production[20]

We assume, that the labor market is entirely demand determined in both sectors, so (8) and (9) also set the level of employment. We also assume that wages are equal in the two sectors, though it is clear that this was not always exactly the case during the period under consideration. Nevertheless, we believe that it is a reasonable approximation of reality, as wages behaved similarly in the two sectors for most of the period. It was only the 1995 stabilization package that drove a wedge between them. This assumption is of crucial importance for the model, as without it the Balassa-Samuelson effect could not be reproduced. We incorporated wage rigidities in the model, as labor market participants set their wage one period ahead so as to equal the expected marginal value product of labor in the tradable sector:

$$w_t = E_{t-1}\left[(1-\omega)p_t^T + \omega s_t + \alpha(k_t^T - l_t^T) + tfp_t^T\right] \qquad (10)$$

Substituting (10) into (8) and (9) we get:

$$l_t^T = E_{t-1}(l_t^T) + \frac{1}{\alpha}(1-\omega)\left[p_t^T - E_{t-1}(p_t^T)\right] + \frac{\omega}{\alpha}\left[s_t - E_{t-1}(s_t)\right] + k_t^T - E_{t-1}(k_t^T) + \frac{1}{\alpha}\left[tfp_t^T - E_{t-1}(tfp_t^T)\right] \quad (11)$$

and

$$l_t^N = \frac{\alpha}{\beta}E_{t-1}(l_t^T) + \frac{1}{\beta}\left[p_t^N - (1-\omega)E_{t-1}(p_t^T)\right] - \frac{\omega}{\beta}E_{t-1}(s_t) + k_t^N - \frac{\alpha}{\beta}E_{t-1}(k_t^T) + \frac{1}{\beta}\left[tfp_t^N - E_{t-1}(tfp_t^T)\right] \quad (12)$$

Equation (11) shows the determinants of tradable employment. Tradable employment is higher than expected if there is an unanticipated increase in tradable prices, the exchange rate, the capital stock or the efficiency of the tradable sector.

We make two additional simplifying assumptions:

- It can be seen from (1), that tradable producers are responsible for the tradable pricing shock. As a consequence, it is not realistic to assume that an unexpected tradable price shock increases tradable employment, as in this case tradable consumption decreases (see (3)), while foreign tradable prices remain unchanged. Therefore there is no reason for tradable output to expand.

[20] We assume the share of exports and domestic sales to be constant, although it is clear that in a fully specified model these are determined endogenously. (It depends mainly on the real exchange rate.) This assumes that the magnitude of changes in the share of export sales are small compared to the effect of other variables considered. One can think of this as an approximation of the model in a small environment.

- As we neglected labor supply (assumed that it is infinitely elastic), the expected value of labor employed at time t-1 is indeterminate. Instead of explicitly modeling the long run equilibrium level of employment, we assumed for simplicity, that it is constant over time (and we denote with l^*). The fact that in structural vector autoregressions the number of endogenous variables must equal the number of structural shocks also necessitated this step. If we had endogenized labor market behavior, the dimension of the model would have increased to seven, which is too high given the extreme brevity of the time series used.

With the latter assumption we ran the risk of identifying structural shocks that are linear combinations of the true and the labor market shocks. We believe that the potential of making a grave mistake here is limited, as the size of asymmetric labor market shocks were negligible in comparison with other shock. (See the discussion earlier.)

Taking the above considerations into account we find:

$$l_t^T = l^* + \frac{\omega}{\alpha}\left[s_t - E_{t-1}(s_t)\right] + k_t^T - E_{t-1}(k_t^T) + \frac{1}{\alpha}\left[tfp_t^T - E_{t-1}(tfp_t^T)\right] \qquad (13)$$

Substituting this into the nontradable employment equation we get:

$$l_t^N = \frac{\alpha}{\beta}l^* + \frac{1}{\beta}\left[p_t^N - (1-\omega)E_{t-1}(p_t^T)\right] - \frac{\omega}{\beta}E_{t-1}(s_t) + k_t^N - \frac{\alpha}{\beta}E_{t-1}(k_t^T) + \frac{1}{\beta}\left[tfp_t^N - E_{t-1}(tfp_t^T)\right] \qquad (14)$$

From (14) it can be seen that the deviation of nontradable employment from its long run value is bigger the higher nontradable prices, the stock of nontradable capital or nontradable efficiency are. On the other hand, lagged variables from the tradable employment equation affect nontradable employment in the opposite direction. Higher tradable prices, exchange rate, stock of tradable capital and tradable efficiency in the previous period exert downward pressure on nontradable employment. This is a Balassa-Samuelson type interdependence between the two sector, generated by the wage setting behavior.

Substituting (13) and (14) into (6) and (7) we get (15) and (16)

$$y_t^T = (1-\alpha)l^* + \alpha E_{t-1}(k_t^T + \frac{1}{\alpha}tfp_t^T) + \frac{(1-\alpha)\omega}{\alpha}(s_t - E_{t-1}(s_t)) + k_t^T + \frac{1}{\alpha}tfp_t^T - E_{t-1}(k_t^T + \frac{1}{\alpha}tfp_t^T) \qquad (15)$$

$$y_t^N = \frac{\alpha}{\beta}(1-\beta)\left[l^* - E_{t-1}(k_t^T + \frac{1}{\alpha}tfp_t^T)\right] - \frac{(1-\beta)}{\beta}\left[(1-\omega)E_{t-1}(p_t^T) + \omega E_{t-1}(s_t)\right] + \frac{(1-\beta)}{\beta}p_t^N + k_t^N + \frac{1}{\beta}tfp_t^N \qquad (16)$$

From (15), one can see that tradable output is made up of three main components. The first component is the expected output based on information available at (t-1) ($(1-\alpha)l^* + \alpha E_{t-1}(k_t^T + \frac{1}{\alpha}tfp_t^T)$). The second one is the change in output due to an unexpected exchange rate shock ($\frac{(1-\alpha)\omega}{\alpha}(s_t - E_{t-1}(s_t))$), and the third is the change in output due to an unexpected capital or TFP shock ($k_t^T + \frac{1}{\alpha}tfp_t^T - E_{t-1}(k_t^T + \frac{1}{\alpha}tfp_t^T)$).

From (16) one can derive the components of nontradable output. The first is a component determined by the state of the tradable sector ($\frac{\alpha}{\beta}(1-\beta)\left[l^* - E_{t-1}(k_t^T + \frac{1}{\alpha}tfp_t^T)\right] - \frac{(1-\beta)}{\beta}\left[(1-\omega)E_{t-1}(p_t^T) + \omega E_{t-1}(s_t)\right]$).

The second one is determined by the state of the nontradable sector ($\frac{(1-\beta)}{\beta}p_t^N + k_t^N + \frac{1}{\beta}tfp_t^N$).

The first component comes from the fact that wages are determined by the tradable sector. The higher the marginal value product in the tradable sector, the higher wages are in the next period, which leads to reduced employment and output in the nontradable sector. The first large term of the second component increases output through an increase in nontradable employment (the rise in nontradable prices decreases real wages). The second term (an increase in nontradable capital and efficiency) increases nontradable output directly.

As we do not have reliable data on the capital stock and we did not want to increase the dimension of the problem by modeling investment, we treated capital and total factor productivity as a joint latent variable. We made the following substitutions in (15) and (16):

$$\varepsilon_t^{YT} = k_t^T + \frac{1}{\alpha} tfp_t^T$$

$$\varepsilon_t^{YN} = k_t^N + \frac{1}{\beta} tfp_t^N$$

These processes are assumed to by described by the following dynamics:

$$\varepsilon_t^{YT} = \varepsilon_{t-1}^{YT} + \zeta_t^{YT}$$

$$\varepsilon_t^{YN} = \varepsilon_{t-1}^{YN} + \zeta_t^{YN}$$

This way we capture the evolution of capital and TFP in both sector with integrated latent variables of order one. Substituting these into (15) and (16) we obtain:

$$y_t^T = (1-\alpha)l^* + \frac{(1-\alpha)\omega}{\alpha}\left[s_t - E_{t-1}(s_t)\right] + \varepsilon_t^{YT} - (1-\alpha)\varepsilon_{t-1}^{YT} \tag{17}$$

$$y_t^N = \frac{\alpha}{\beta}(1-\beta)l^* - \frac{(1-\beta)\alpha}{\beta}\varepsilon_{t-1}^{YT} - \frac{(1-\beta)\omega}{\beta}E_{t-1}(s_t) + \frac{1-\beta}{\beta}\left[p_t^N - (1-\omega)E_{t-1}(p_t^T)\right] + \varepsilon_t^{YN} \tag{18}$$

To close the model, the equilibrium of the nontradable market needed to be specified. Setting nontradable supply equal to nontradable consumption[21] we obtain:

$$y_t^N = -\gamma\left(p_t^N + \varepsilon_t^{PN} - p_t^T\right) \tag{19}$$

and $\varepsilon_t^{PN} = \alpha_{PN}\varepsilon_{t-1}^{PN} + \zeta_t^{PN}$

As can be seen from (19) nontradable prices evolve in a way so as to clear the nontradable market. The variable ζ_t^{PN}, the nontradable demand shock parameter, captures shifts in demand for nontradable products. Depending on α_{PN} demand shocks can be more or less persistent: changes in consumer preferences during the transition could be permanent, whereas shifts in fiscal policy usually produce transitory shocks. In a transition economy nontradable demand shocks are likely to contain persistent components, thus we assumed these kind of shocks to be permanent.

Equation (1), (5), (17), (18) and (19) constitute a dynamic system. The logic of the model is the following. At t-1 actors set wages for time t. At time t, after observing the three shocks (tradable and nontradable supply and nontradable demand shock), economic policy simultaneously alters exchange rate while tradable producers change tradable prices.

The five dimensional model can be represented in the following structural form:

$$A_0 Y_t = B(L)Y_{t-1} + \varepsilon_t$$

where

A_0 the five dimensional matrix of contemporaneous relationships among endogenous variables

B(L) is a 5*5 lag polynomial

ε_t is a five dimensional vector of structural disturbances

From the system of equations defined above one can obtain the following A_0 matrix of contemporaneous relationships[22]:

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[21] While nontradable consumption equals to nontradable demand by definition.

[22] Where $\psi_{21}=a_1\gamma+(1-\gamma)(1-a_1-a_2)$, $\psi_{23}=a_2\lambda+(1-a_1-a_2)$, $\psi_{24}=(1-\lambda)a_2$, $\psi_{25}=-(1-2a_1-a_2)(1-\gamma)$, $\psi_{32}=\frac{-(1-\alpha)\omega}{\alpha}$, $\psi_{45}=\frac{-(1-\beta)}{\beta}$, $\psi_{51}=-1$ and $\psi_{54}=\frac{1}{\gamma}$.

$$A_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \psi_{21} & 1 & \psi_{23} & \psi_{24} & \psi_{25} \\ 0 & \psi_{32} & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & \psi_{45} \\ \psi_{51} & 0 & 0 & \psi_{54} & 1 \end{bmatrix}$$

I. Data

The scope for econometric analysis was constrained by limited data availability. We proxied tradable output with manufacturing output and determined nontradable output on a residual basis. Output data was gained from volume indices in the national accounts and industry statistic figures published by the Central Statistical Office (CSO). We used quarterly data, as this was the highest frequency for which output variables could be constructed. Considering the nature of the processes examined here the use of monthly data would not necessarily yield higher quality information anyway. Our sample includes the period between 91Q1 and 98Q1, that is, we had 29 observations of the variables in levels. As quarterly sectoral output data are not available for the period, we constructed those series from annual manufacturing value added data, manufacturing production and quarterly aggregate GDP figures using a nonlinear optimization method[23].

We derived tradable and nontradable prices from the CPI figures of the CSO using the methodology of Vincze and Zsoldos (1996) which deems consumer durables, clothing, and other manufactured goods tradable and services nontradable. As nominal exchange rate we used the official nominal effective exchange rate index of the NBH.

II. Methodology

We used the Structural Vector Autoregression (SVAR) methodology to estimate our model. (For a detailed description see Canova (1995a) pp. 59-77 Canova (1995b) pp. 53-138 and Hamilton (1994) pp.291-350) We made restriction on the contemporaneous matrix to identify structural shocks. In this section we will briefly summarize the SVAR methodology.

Let's assume that the structure of the economy can be characterized in the following way:.

$$\boldsymbol{A}_0 \boldsymbol{y}_t = \boldsymbol{B}(\boldsymbol{L})\boldsymbol{y}_{t-1} + \varepsilon_t \qquad (20)$$

$$\boldsymbol{E}(\varepsilon_t \varepsilon_t') = \boldsymbol{D}, \qquad (21)$$

where D is the variance-covariance matrix of orthogonal structural shocks with zero off-diagonal elements.

The reduced system takes the following form:

$$\boldsymbol{y}_t = \boldsymbol{C}(\boldsymbol{L})\boldsymbol{y}_{t-1} + \boldsymbol{u}_t \qquad (22)$$

$$\boldsymbol{E}(\boldsymbol{u}_t \boldsymbol{u}_t') = \Omega \qquad (23)$$

where Ω is the variance-covariance matrix of the reduced form residuals.

By matching the coefficients of (20) and (22) , and (21) and (23) one can obtain:

$$\boldsymbol{u}_t = \boldsymbol{A}_0^{-1} \varepsilon_t \qquad (24)$$

$$\boldsymbol{C}(\boldsymbol{L}) = \boldsymbol{A}_0^{-1} \boldsymbol{B}(\boldsymbol{L}) \qquad (25)$$

and

$$\Omega = \boldsymbol{A}_0^{-1} \boldsymbol{E}(\varepsilon_t \varepsilon_t')(\boldsymbol{A}_0^{-1})' = \boldsymbol{A}_0^{-1} \boldsymbol{D}(\boldsymbol{A}_0^{-1})' \qquad (26)$$

[23] The methodology is available from the authors upon request.

The relevant A_0 and D matrix can be found by maximum likelihood estimation.

III. Results

Our original model is valid for the level of the variables, and – as mentioned earlier - contains long run restrictions as well as restrictions on the contemporaneous matrix. Rather than using all this information we estimated the model for first differences[24, 25].

In estimating the reduced form VAR we determined the optimal lag length by likelihood ratio test. The optimal lag number was one, and in this case, according to the a Breusch-Godfrey statistics, none of the residuals appeared to be autocorrelated[26]. The overall fit of the reduced form equations were acceptable, except for the nominal exchange rate equation. This reinforces our previous statement that the most unstable part of the analysis is the exchange rate equation. However, when we estimated the equation in its structural form (with contemporaneous and lagged endogenous variables included) the overall fit improved (R^2=0.517, Adj. $R^{2=}$0.26) which lends support to our identification scheme that postulates an exchange rate policy that reacts not only to lagged, but also contemporaneous information. According to the Ramsey-RESET tests all the functional forms were correct but that of the tradable output equation. The normality of the residuals could not be rejected, except in the case of the tradable price equation. Significant ARCH effects could only be detected in the nontradable output equation. According to the White-tests the null hypothesis of homoskedasticity held for all equations.

[24] More precisely, we have a dynamic system that contains endogenous variables, three permanent and two transitory shocks. This implies that there are three common stochastic trends, (following Stock and Watson (1988) pp. 1097-1107) and two cointegrating vectors in this economy. Due to the extreme brevity of the time series we did not experiment with cointegration analysis, as in a sample of 28 observations it is impossible to detect long run relationships. As all of the series seemed to be I(1) according to the unit-root tests, we differenced the data and used the A_0 matrix to identify the structural shocks. The problem with this approach is obvious. If there are any cointegrating relationships among the series a finite order VAR representation for the differenced data does not exist.

[25] All estimations and simulations were prepared on Rats for Windows 4.31.

[26] In assessing significance we evaluated all tests at 5 percent significance levels.

TABLE 1.
Estimation results for the reduced form equations

	Equation				
	Δp^T	Δs	Δy^T	Δy^N	Δp^N
R^2	0.851	0.139	0.507	0.408	0.518
Adj. R^2	0.815	-0.067	0.389	0.267	0.404
DW[a]	2.169	2.027	2.112	2.033	1.972
F-statistic	23.970	0.676	4.312	2.893	4.519
p(F-stat)	0.000	0.647	0.007	0.039	0.006
Ramsey-RESET[b]	0.196	0.316	12.798	1.450	0.046
p(Ramsey-RESET)	0.658	0.574	0.000	0.229	0.830
Normality[c]	39.321	0.005	0.229	0.533	0.816
p(Normality)	0.000	0.998	0.892	0.766	0.665
Serial Correlation[d]	1.346	0.306	0.668	0.758	1.386
p(Serial Correlation)	0.510	0.858	0.716	0.685	0.500
ARCH[e]	0.250	2.859	1.990	6.724	1.384
p(ARCH)	0.883	0.239	0.370	0.035	0.500
Heteroskedasticity[f]	26.372	23.714	22.968	11.571	21.327
p(Heteroskedasticity)	0.154	0.255	0.290	0.930	0.378

[a] Durbin-Watson statistics
[b] Ramsey RESET test statistics with squared residuals, Likelihood-ratio value
[c] Value of Jarque-Bera normality test
[d] Value of Breusch-Godfrey serial correlation test with 2-quarterly lags included (=number of observation multiplied by R^2)
[e] ARCH LM test with 2-quarterly lags included (=number of observation multiplied by R^2)
[f] White heteroskedasticity test with cross terms, (=number of observation multiplied by R^2)

Subsequent to estimating the reduced form we estimated the contemporaneous A_0 and D matrices. As the diagonal elements were normalized to one in the contemporaneous matrix, we had eight parameters to estimate in A_0 and five in D from the model. In the variance-covariance matrix of the reduced form shocks, there were n*(n+1)/2 free parameters, thus just identification required n*(n-1)/2 restrictions (zero elements) in the contemporaneous matrix[27]. It can be easily verified that our structural model is overidentified with two zeros[28]. By restricting the policy reaction function to only include lagged variables we can impose four additional zero restrictions. We tested the validity of overidentifying restrictions with likelihood ratio tests. The test strongly rejected the possibility that policy only looked at past events.

Monte Carlo simulations with 5000 realizations were performed to obtain 95% confidence intervals for the impulse response functions. It can be seen, that the nominal exchange rate reacts positively to a tradable pricing shock. This indicates that the authorities were targeting the tradable real exchange rate. As expected, nontradable prices rise in response to a tradable pricing shock, which is required for the nontradable market to stabilize nontradable demand. (See (19) in the model.) The effect of tradable pricing shocks on tradable output is the opposite. This result is again quite intuitive: higher domestic producer prices imply lower competitiveness, which reduces domestic tradable output. There is a similar, although not obviously significant effect of tradable pricing shocks on nontradable output.

One can observe that for an unexpected policy (exchange rate) shock tradable prices increase and the effect spills over to nontradable prices. These two effects are entirely consistent with the

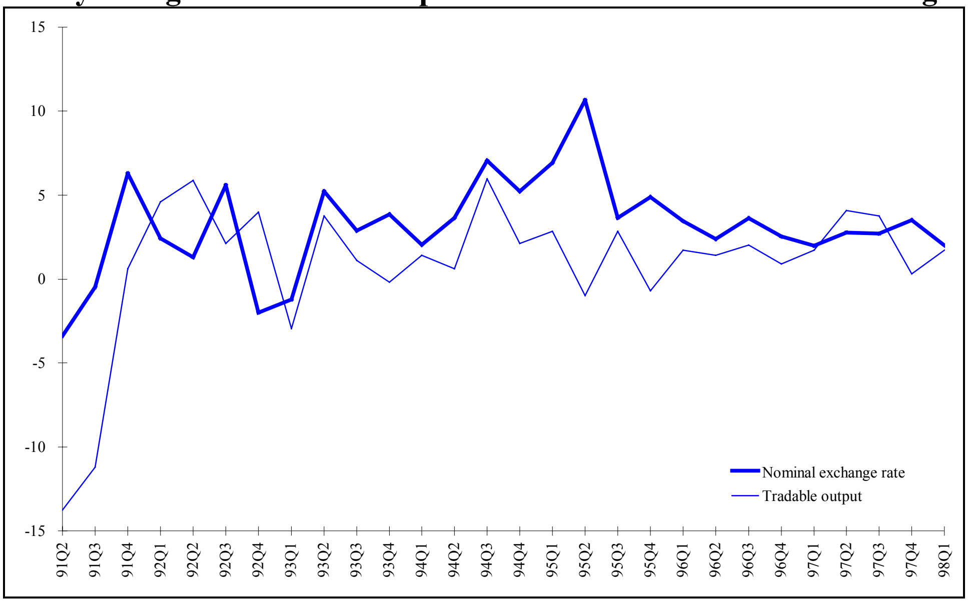
[27] Where n denotes the number of endogenous variables.
[28] The number of restrictions required for just identification is 4*5/2=10, in our case we imposed 12 zeros on the A_0 matrix.

model. We found the response of tradable output to be non-significant. This could imply that the average duration of nominal rigidities is quite low and prices respond relatively quickly to exchange rate shocks. In contrast, nontradable output significantly declines. This may indicate that there is some substitution of resources between the two sectors. The effect on nontradable output is, however, short-lived, which renders this supply side explanation implausible. Substitution effects may work through the demand side[29].

We found the surprising result that a tradable supply shock led to the devaluation (depreciation) of the nominal exchange rate. This may be a sensible result for a large economy with a flexible exchange rate, but not for a small open economy with a relatively fixed exchange rate.

As the nominal exchange rate depreciates tradable prices increase significantly as well. This result can be well explained by the positive correlation between the nominal effective exchange rate and tradable output in most of the sample considered. (See FIGURE 6.)

FIGURE 6.
Quarterly changes in tradable output and the nominal effective exchange rate



Note however, that:

1. The authorities targeted almost in the whole period a currency basket whose composition did not exactly correspond to the nominal effective exchange rate. In times of marked cross rate movements there could be significant discrepancies between the two. In this case, there could be times when the authorities did not react to the proper variable.
2. Until 1993, after the 35% peek in inflation in 1991, economic policy cared much more about inflation than external balance. As a result the output effects of the exchange rate policy pursued were not in the front line of the agenda.
3. External balance dramatically deteriorated by the end of 1993, and continued to do so later despite increasing rates of devaluation, and growing tradable output, leading to growing indebtedness. As our model is cast in real terms, it cannot capture financial effects. Therefore one must be very careful in drawing conclusions about the role of the economic policy, as the gamut of effects is beyond what our framework can handle.

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[29] If the intertemporal elasticity of substitution for consumers is high, and the intratemporal elasticity between tradables and nontradables is low it can easily be the case.

A nontradable supply shock decreases nontradable prices, which verifies that we did indeed identify a nontradable supply shock. We have a positive effect on nontradable prices as a result of nontradable demand shocks. This effect is consistent with theory and proves that what we call nontradable demand shock is really a demand shock. Tradable prices respond positively as well, which indicates the symmetric nature of pricing behavior. An increase in tradable prices passes through to nontradable prices and vice versa.

As far as historical decompositions are concerned one can verify, that fluctuations in tradable prices could mainly be explained by tradable pricing shocks. This shows that deviations from the tradable pricing equation (defined in (1)) were significant. The importance of tradable pricing shocks seems to be decreasing since mid 1996, which indicates that (1) describes pricing behavior increasingly accurately. The jump in tradable prices in 1995 (with the stabilization package) can be clearly attributed to a tradable pricing shock, more specifically to an unexpected the exchange rate realignment, to which tradable producers quickly adjusted their prices. This indicates that the importance of nominal rigidities is not so significant. This statement - as we will see later - is confirmed by the fact that tradable pricing shocks do not seem to drive tradable real exchange rate movements. Movements in the nominal exchange rate are mainly the products of tradable output shocks. This is consistent with our previous statement, that the authorities gave much attention to tradable output and external balance in their reactions. There is a slight tradable pricing effect in 1995, which may reflect expectations of changes in the exchange rate . All shocks played an approximately equal role in size in the fluctuations of tradable output,. One can observe, that in 1992-1993, during the recession, tradable output shocks dominated, while in 1995 we can again detect the effects of the stabilization efforts.

Nontradable output is mainly explained by nontradable supply shocks, and since mid-1996 by nontradable demand shocks as well. We have again the stabilization effect in 1995 in the form of a tradable pricing shock. Fluctuations in nontradable prices are, it seems, mainly driven by nontradable supply shocks in most of the sample. The effect of the 1995 stabilization is discernible for more than a year and, since mid-1996, so are the effects of fluctuations in nontradable demand.

The tradable real exchange rate is constructed as the difference between tradable prices and the nominal exchange rate. The main driving force of this variable were tradable supply shocks as the nominal exchange rate (e.g. the authorities) reacted to tradable supply shocks, but tradable prices did not react at all. Policy shocks did not play any role in the variable's movement. This result again indicates that the role of nominal rigidities was small, that is, the average length of nominal contracts in the tradable sector are quite short. One of the most interesting result is that during the period investigated relative nontradable/tradable prices were mainly driven by nontradable supply shocks, which reinforces the positive findings of an earlier paper (Kovács and Simon (1998)), concerning the relevance of the Balassa-Samuelson effect in Hungary. It is worth mentioning that since mid-1996 the role of nontradable demand shocks is also significant.

Forecast error variance decompositions display similar patterns. One can see that around two third of the variance of tradable prices is explained by tradable pricing shocks. The variance of the nominal exchange rate is mainly explained by tradable output shocks (72%). Shocks from different sources played a more even role are in the determination of tradable output. Tradable pricing and tradable supply shocks wielded the most influence (34-34%) The variance of nontradable output is mainly explained by nontradable supply shocks. (72%) Half the variance of nontradable prices is explained by nontradable supply shocks, 27% by tradable pricing and 20% by nontradable demand shocks. The relative importance of the latter two changes in an interesting way, when different time horizons are considered. In the short run nontradable demand shocks dominate, while in the longer run pricing shocks assume more significance.

VII. Concluding Remarks

Since the beginning of the transition Hungary has experienced substantial real exchange rate appreciation when measured on the basis of the CPI. At the same time, real appreciation was subdued when measured on the basis of indices containing exclusively tradable products (manufacturing - PPI). This observation poses the following questions:

1. To what extent could PPP be valid for real exchange rates based on tradable prices in a transition economy? What are the main causes of deviations from it in Hungary? Did policy shifts or changes in tradable pricing behavior play a dominant role in the process?
2. What are the main determinants of relative price movements and why did nontradable prices grow more rapidly than tradable prices? What is the relevance of supply side and demand side explanations for Hungary?

To identify the main sources of real exchange rate fluctuations we formulated a two-sector two factor small open economy model, which we used to build a SVAR model. We used its structure to decompose the time series into supply, demand, pricing behavior and economic policy induced shocks. Three main results emerged from our analysis. First, nominal rigidities did not play a substantial role in tradable real exchange rate fluctuations. Second, exchange rate policy shocks were not the main sources of real exchange rate fluctuations. Third, the increasing ratio of nontradable prices to tradable prices can be well explained by productivity differentials between the two sector. Thus, supply shocks were the main determinants of relative price adjustments. The small explanatory power of nominal rigidities can be attributed to the inflationary environment. The higher inflation is, the shorter is the average duration of nominal contracts and the higher the opportunity cost of not adjusting prices. Naturally, as the disinflation process proceeds the role of nominal rigidities should increase. In contrast, the role of the third effect should diminish as transition moves on. In the first phase of transition relative productivity increased faster in the tradable sector due to extensive lay-offs. The second phase was characterized by investments (both foreign direct investments and domestic investments) flowing mainly into the tradable sector, which further improved efficiency relative to the nontradable sector. In 1998, however, we argue that Hungary entered a third phase, when the nontradable sector began attracting new investments (mainly in the retail and banking sector). With this process relative productivity differences on the supply-side could abate, and thus the pressure on relative prices may diminish.

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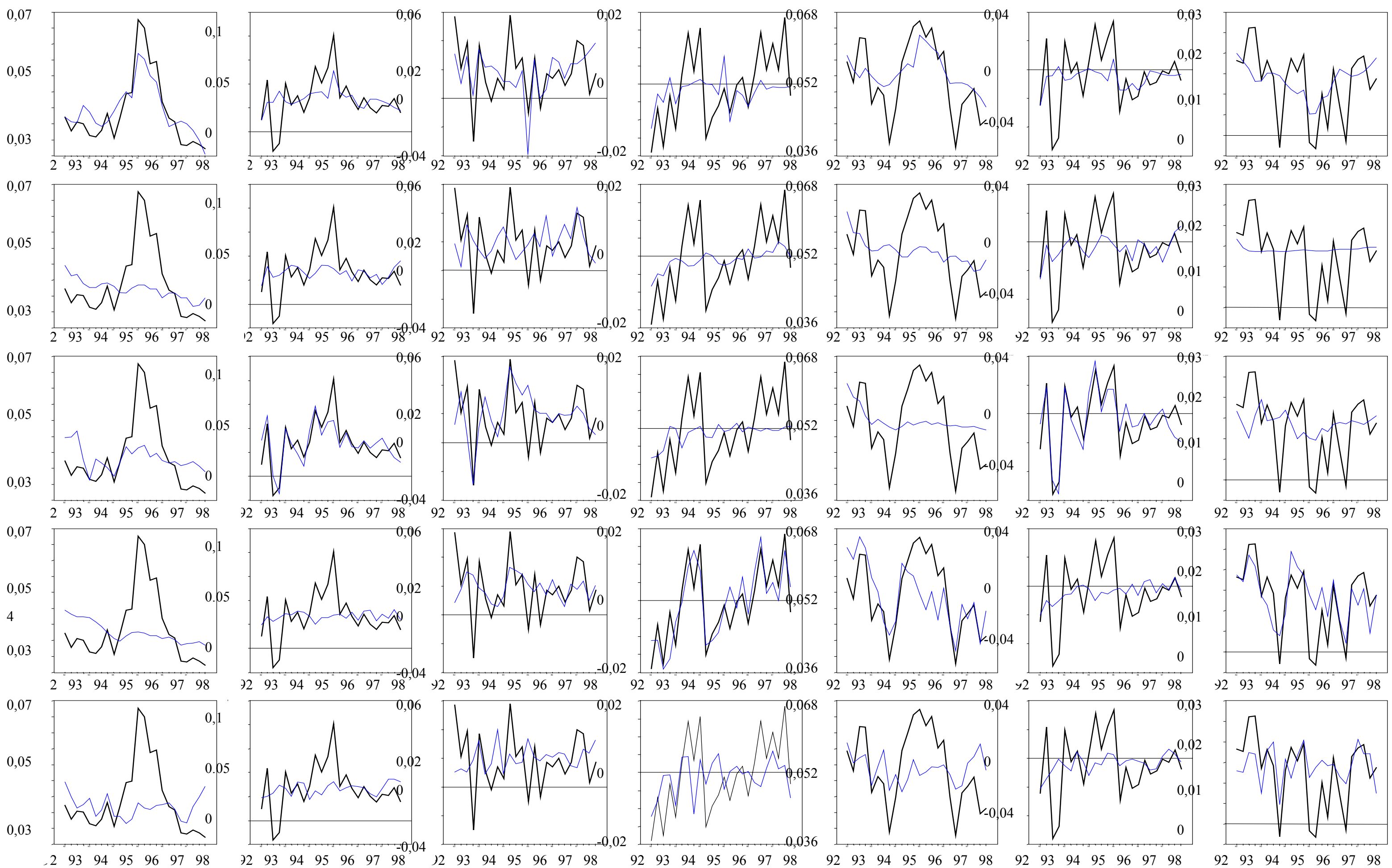
HISTORICAL DECOMPOSITIONS

(solid lines indicate original series, dashed lines indicate shock components)

Tradable prices | Nominal exchange rate | Tradable output | Nontradable output | Nontradable prices | Tradable real exchange rate | Relative prices



Tradable pricing shock

Policy shock

Tradable supply shock

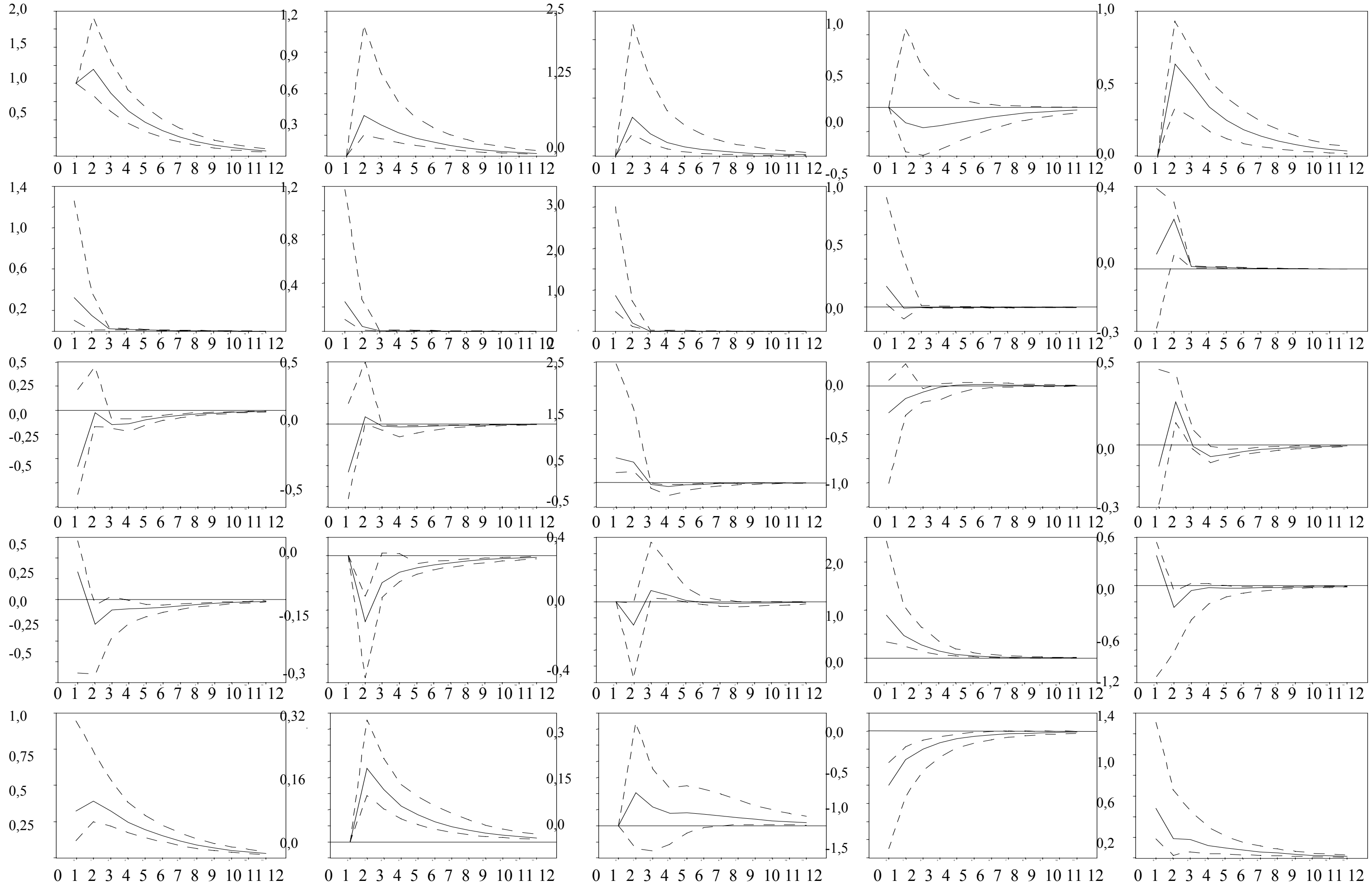
Nontradable supply shock

Nontradable demand shock

IMPULSE RESPONSE FUNCTIONS

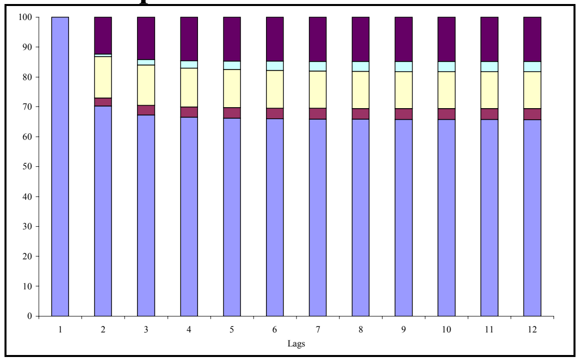
(± 2,25% critical values are based on Monte-Carlo simulations with 5000 draws)

	Tradable pricing shock	Policy shock	Tradable supply shock	Nontradable supply shock	Nontradable demand shock
Tradable prices					
Nominal exchange rate					
Tradable output					
Nontradable output					
Nontradable prices					

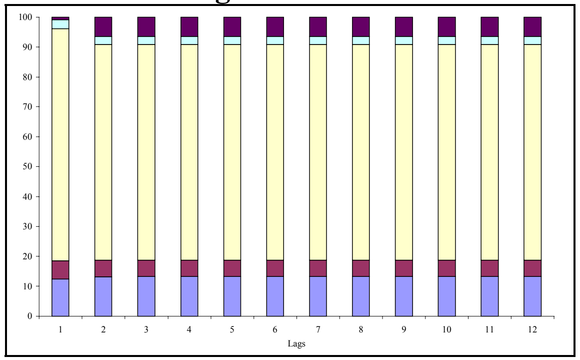


FORECAST ERROR VARIANCE DECOMPOSITIONS

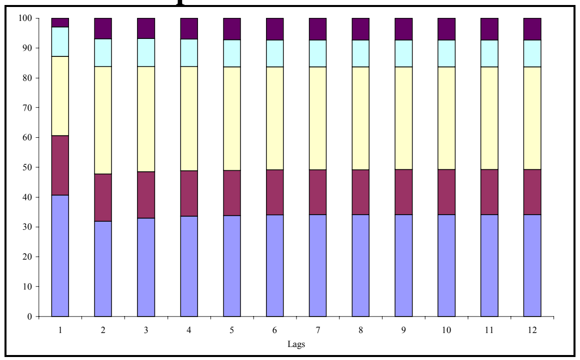
Tradable prices



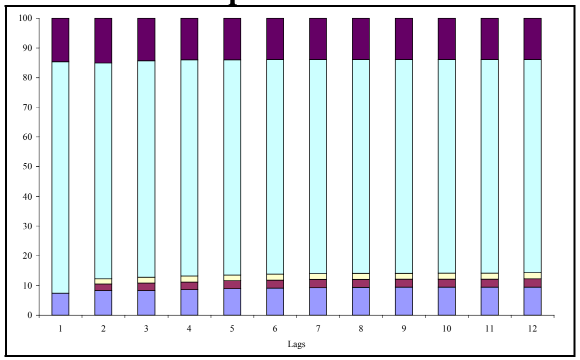
Nominal exchange rate



Tradable output



Nontradable output



Nontradable prices