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Exchange Rate Policy and Inflation in Acceding Countries: The Role of Pass-through[†]

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Abstract

This paper analyzes the link between the choice of exchange rate regime and inflationary performance in four acceding countries to the EU: the Czech Republic, Hungary, Poland and Slovenia. The results allow a clear ranking of countries according to the size of the pass-through effect and the importance of exchange rate shocks to overall inflationary performance. In particular, perfect pass-through effect can be associated with accommodative exchange rate policy, which can moreover become the most important source of inflationary pressures. The analysis suggests that for CEEC-4 an early adoption of the Euro can provide the most efficient framework for reducing inflation.

JEL codes: E42, E52, E58, C32

Keywords: EMU accession, pass-through effect, I(2) cointegration analysis, policy accommodation

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1. Introduction

Following accession to the European Union, candidate countries (CEECs) will eventually have to adopt the euro, as no opt-out clause is allowed for new entrants. Therefore, the main open question about exchange rate policy for new members is the speed of entry into the eurozone. Official positions of the European Commission (EC) and the European Central Bank (ECB) indicate that CEECs should go through the ERM2 mechanism before adoption of the euro. This would imply two years in the ERM2 system with an agreed central parity and a ±15 % band, with a review of Maastricht indicators at the end of the first year. As a result, the minimum time lag for adoption of the euro is two years after joining the EU. For acceding countries it will be most challenging to fulfill the inflation criterion. Moreover, due to potential problems with speculative capital flows in face of unsound macroeconomic situation, it is highly desirable to bring inflation to the levels required by Maastricht criteria even prior to the entry into ERM2. In this respect the aim of this paper is to empirically analyze the role of exchange rate regimes in overall inflationary performance of a subset of acceding countries: Hungary, the Czech Republic, Poland and Slovenia. In the following these are referred to as CEEC-4.

The interplay between the exchange rate regime and the speed of convergence of inflation rates between CEECs and the eurozone is studied by estimating the pass-through from exchange rate changes to domestic inflation in CEEC-4. The exchange rate was the main nominal anchor in most transition economies at the beginning of transition. To curb inflation and maintain macroeconomic stability, the Czech Republic, Hungary and Poland introduced exchange rate-based stabilization programs in the early 90's, while Slovenia followed a combination of targets on M3 and tightly managed exchange rate. Over time several CEECs have moved towards a more flexible regime (i.e. the Czech Republic, Poland, Hungary and the Slovak Republic), Slovenia instead continued to maintain managed float, while others, the Baltic states and Bulgaria, opted for currency boards. There is a question of whether a move to more flexible exchange rate regimes have helped transition economies to carry on independent monetary policy and to more effectively respond to shocks. To answer this question it is important to distinguish between cases where higher exchange rate flexibility reflects an exchange rate policy geared at achieving a certain inflation target, and cases where exchange rate policy is accommodative, i.e. tries to neutralize the effects of adverse shocks on the real exchange rate. In the latter case, when taking the form of a reaction function to perceived disequilibria in the real exchange rate, a systematic component is induced into the dynamics of nominal exchange rate. Such a policy is likely to be incorporated into the pricing decisions of economic agents and hence, exchange rate pass-through becomes and endogenous phenomenon. For this reason, a strong correlation between exchange rate movements and inflation rates can be observed in managed float regimes. Following this line of reasoning, we estimate the extent of exchange rate pass-

through in CEEC-4 and find that regimes with a more accommodative stance of exchange rate policy generate higher pass-through. Although accommodative exchange rate rules could stabilize the real exchange rate, it is questionable whether such a policy is welfare improving as it generates costs associated with higher average inflation. As shown by Uribe (2003), real exchange rate targeting results in indeterminacy of equilibria for a whole range of assumptions about nominal price rigidity. Consequently, prolonged periods of stubbornly high inflation should not be a surprising outcome.

With exchange rate pass-through we understand a change in the selected price index caused by the change in the nominal exchange rate. Its empirical importance has been analyzed in a number of papers in recent years. Campa and Goldberg (2001) estimate pass-through to import prices for 25 OECD countries over the period 1975 to 1999. Goldfajn and Werlang (2000) study the relationship between exchange rate depreciations and inflation for 71 countries in the period 1980 to 1998. Choudhri and Hakura (2001) extend the study of Goldfajn and Werlang (2000) and try to establish the role of the exchange rate regime in determining the extent of pass-through in 71 countries in the period 1979 to 2000. Darvas (2001) provides evidence on pass-through for the same set of countries as here for the period 1993 to 2000. Our study differs substantially in the estimation methodology employed. Using a cointegrated vector autoregressive model we identify the pass-through from exchange rates to prices and estimate the importance of shocks to the nominal exchange rate in the movements of domestic inflation for the CEEC-4. In addition, we invoke theoretical results from Johansen (2002) to address the issue of identification of pass-through effect, which has not been achieved in previous studies using cointegration analysis (e.g. Kim, 1998). Thus, we are not the first to use cointegration analysis to estimate exchange rate pass-through, but the first to solve the identification problem within this framework.

The empirical analysis indicates that pass-through is highly significant in the four candidate countries examined, although important differences emerge. Those can be associated with differences in exchange rate regimes. While Slovenia and Hungary have engaged in relatively tightly managed exchange rates, the Czech Republic and Poland have let their exchange rate float more freely, at least recently. Additionally, the Czech Republic and Poland introduced inflation targets, which helped monetary authorities to maintain inflation at lower levels than in Slovenia and Hungary. In this respect it was not surprising to find a perfect pass-through from exchange rate growth to domestic inflation for Slovenia and Hungary. A much smaller impact is found for Poland and especially the Czech Republic. Similarly, in Slovenia shocks to the exchange rate play a dominant role in determining inflationary pressures. By contrast, in Poland autonomous shocks arising from monopolistic behavior in goods markets and wage pressures dominate the inflation pressures, with smaller effects from exchange rate shocks. Note that Slovenia and Poland have followed rather different exchange rate policies. Even though

it has never been officially declared, Slovenia apparently targeted the real exchange rate throughout the period, trying to maintain external competitiveness. Poland, after the initial use of the exchange rate as a nominal anchor, has progressively moved toward a more flexible exchange rate, culminating in the floating regime that started in April 2000. Therefore, one can conjecture that such different exchange rate regimes have had a fundamental impact on domestic inflation. The real exchange rate rule in Slovenia was probably internalized by price setters, thus becoming a persistent source of inflation. In fact, although Slovenia apparently had the best fundamentals of CEEC-4, it has been unable to reduce inflation below 6-8% in the last five years. By contrast, Poland did not follow an accommodative exchange rate policy. Considering as well that Slovenia is a much more open and smaller economy than Poland, one would expect a smaller pass-through in Poland and a smaller role of exchange rate shocks driving the domestic inflationary process. Hungary and the Czech Republic lie between the two extreme cases, with Hungary more similar to Slovenia and Poland more to the Czech Republic. In general it would seem that more predictable exchange rate policies, like those followed in Slovenia and Hungary (and Poland until 2000) tend to be associated with larger pass-through coefficients. The size and openness of the countries are also important factors.

The analysis has a number of clear policy implications, all based on empirical fact that exchange rate changes importantly affect domestic inflation and hence in any disinflation experiment the central role should be given to the path of the nominal exchange rate. The large pass-through from exchange rates to domestic inflation reduces the scope for flexibility in exchange rates. Even abstracting from the issue of propagation of exogenous shocks originating in international financial markets (see Habib (2002) on this issue), flexible exchange rates are not an effective instrument for absorbing asymmetric real shocks (Masten, 2002). Large pass-through facilitates the expenditure switching effect and gives incentives to policy-makers to attempt ex-post to drive the exchange rate in a way that maintains external competitiveness. As can be seen in the case of Slovenia, such a policy of real exchange rate targeting creates persistent inflationary pressures that can be broken down by credibly adopting a non-accommodating exchange rate policy. For a small open economy this may imply the adoption of fixed exchange rates. Luckily, candidate countries have the point of arrival, the euro, already set. Their main policy decision is how fast to enter the euro. Results in this paper suggest that there are no significant advantages to delaying entry.

The paper proceeds as follows. Section 2 presents stylized facts on inflation and exchange rate behavior in CEEC-4. After briefly discussing the long-run trend appreciation of the exchange rate and its connections with the Balassa-Samuelson effect, the section emphasizes the relationship between exchange

rate regime and inflation dynamics. Section 3 discusses the empirical analysis of pass-through effect in relation to the choice of exchange rate regimes. Section 4 concludes.

2. Stylized Facts on Inflation and Exchange Rate Dynamics

Following the initial jump in price levels associated with price liberalization, inflation has declined gradually in CEEC-4. Reduction to single-digit inflation was much faster in Slovenia and the Czech Republic, countries less affected by large stocks of debt and the attendant need to finance large debt service payments. However, inflation rates seem to be more stubborn in Slovenia and Hungary than in the Czech Republic and Poland. In the last 3-4 years, inflation hovered around 6-8 % in Slovenia and Hungary, with some sign of small fall after the second half of 2002 in a period of economic slowdown. The sharp decline in the Czech Republic and Poland reflects two different realities. The Czech Republic has been successful in reducing inflation through an effective and credible policy of inflation targeting. In Poland the fall in inflation, which declined to around 1% annual rate in 2002, reflects perhaps an overshooting of the desired decline. This was the result of an excessively tight monetary policy that negatively affected the economy during a period of general economic slowdown in Europe. Output performance in Poland during 2002 has been among the worst in candidate countries. A sharp fall in demand and output and persistent unemployment rate at around 18% have contributed to the fall in inflation.

The gradual decline in inflation has been accompanied by a sizable appreciation of the real exchange rate in all CEEC-4, and indeed in all transition economies. A component of this trend appreciation can be considered an equilibrium phenomenon, in line with the Balassa-Samuelson effect, that affects inflation and the real exchange rate in a catching-up phase. However, there is, in addition, a dynamic process connecting exchange rates and inflation. Figure 1 illustrates the dynamics of inflation, and the growth of nominal and real exchange rates in CEEC-4 since 1995. The figure also contains an indicator of the state of the economy, proxied by the growth of industrial production.

Figure 1 indicates the presence of at least two different patterns in CEEC-4. On one hand, there is the case of Slovenia and Hungary. Nominal exchange rate growth and inflation exhibit a comparatively more aligned co-movement. Both countries have kept the positive depreciation rates on average. While Hungary broke up with this practice in second half of 2001, Slovenia continues with sterilized foreign exchange market interventions that support a positive depreciation rate. On the other hand, the Czech Republic and Poland display a high correlation in the movements of nominal and real exchange rates. Moreover, it is especially notable for the Czech Republic that the exchange rate growth never deviated

permanently from zero, which considerably contributed to its most favorable inflationary performance in the CEEC-4 group.

In addition to the above considerations, different patterns of inflation dynamics in CEEC-4 seem to be associated with different exchange rate regimes. Table 1 presents the exchange rate regimes in selected transition economies with shifts in regimes from less flexible - or fixed - to more flexible as they occurred during transition. Dates presented in bold stand for current exchange rate regime. It is important to keep in mind that classification as in Table 1 gives only the first characterization of an exchange rate regime. The second dimension along which exchange rate regimes and monetary policy in general are characterized in this paper is the degree of accommodation, as discussed in the text. For this one needs to look closely at actual path of the exchange rate and results of empirical analysis. For Slovenia it is clear that tight management was oriented towards sustaining positive depreciation rate, which can be understood as a sign of accommodative monetary policy. In the Czech Republic this has not been the case even after the move to a more flexible arrangement. Thus, although two exchange rate regimes can be officially characterized as very similar, managed float, say, it is important to take into account also whether exchange rate management is used as one of key tools for achieving a preset inflation target, or to accommodate shocks to the real exchange rate. In the case of inflation targeting regime exchange rate flexibility can be seen desirable as it enables faster adjustment of relative prices and thus does not add to inflationary pressures. With real exchange rate targeting just the opposite is the case. This policy suffers from determinacy problems (Uribe, 2003) and thus can result in permanent deviations of inflation from the target.

Figure 1: Growth of Industrial Production, Growth of Nominal and Real Exchange Rates and Inflation in CEEC-4 (3-month moving average)

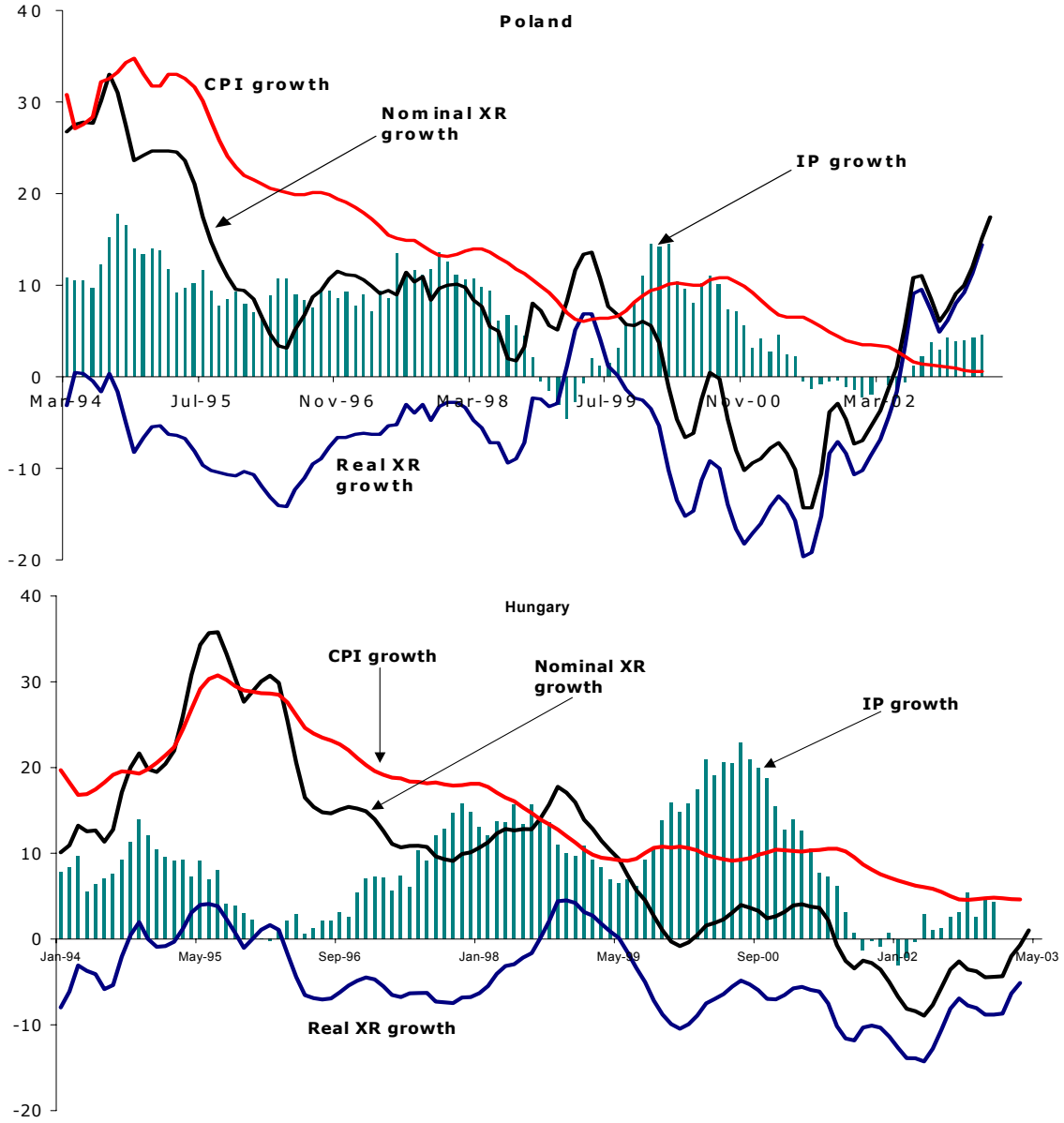
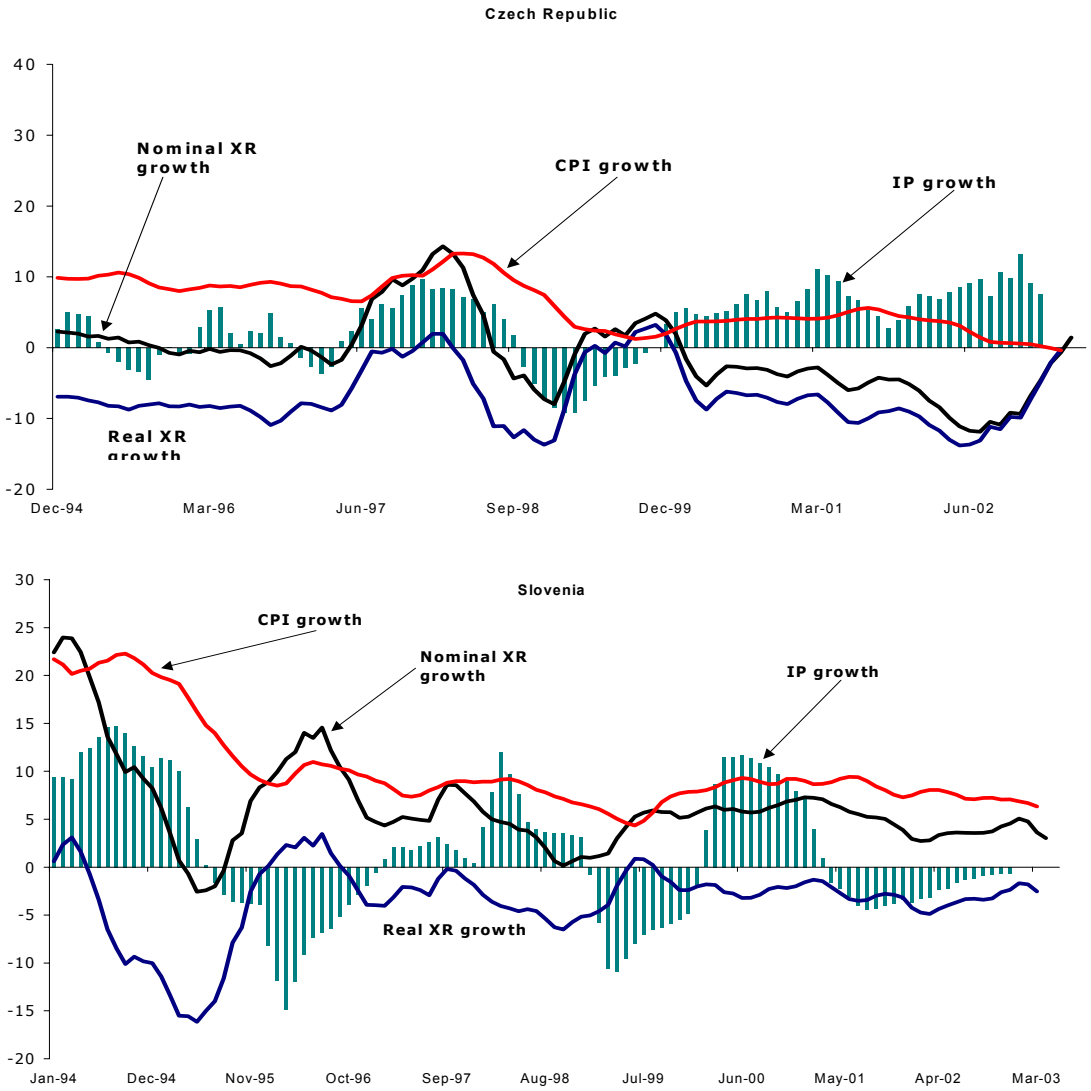


Figure 1: continued



Source: Datastream.

With respect to the exchange rate regimes, all CEEC-4 moved from fixed to more flexible exchange rate regimes during transition, perhaps also to be able to curb inflation rates toward required levels, although the main reason for the move was believed to be the pressure caused by a surge in capital inflows (Corker et al., 2000). In so doing, CEEC-4 added a potential new source to higher inflation rates and its stubbornness in addition to the working of the Balassa-Samuelson effect and relative price convergence. There has been substantial heterogeneity in overall monetary policy setting in CEEC-4, not only with respect to the choice of exchange rate regime. While the Czech Republic and Poland set inflation targets, Hungary and Slovenia stuck to the exchange rate (crawling peg) and M3 targets,

respectively.[1] As shown in Coricelli and Jazbec (2001), the switch of the exchange rate regimes from a less to a more flexible framework with respect to the regimes employed at the beginning of 90's, broadly corresponds to a diminishing effect of structural reforms on the real exchange rate determination in transition economies. In the mid-90's, CEEC-4 were on average in the fifth or sixth year of the transition process when productivity and demand factors began to affect the real exchange rate more than structural reforms. Additionally, the shift in exchange rate regimes in the Czech Republic and Hungary broadly corresponds to the liberalization of trade and current account convertibility, while in Poland a shift toward free floating happened only in 2001. Although Slovenia officially targeted M3 throughout the last decade, the tightly managed exchange rate regime was substantially supported by capital controls on short-term capital flows together with extensive sterilization policy. Despite the variety of approaches to the exchange rate policy, the CEEC-4 have all made substantial progress in reducing inflation, which has, on average, been below 10 percent since 1998.

Table 1: Exchange Rate Regimes in CEEC-4

	Conventional Peg	**Narrow Band**	**Tightly Managed**	**Broad Band**	**Managed Float**	**Relatively Free Float**
Czech Republic	January 1991			February 1996	**May 1997**	
Hungary		March 1995	→	**October 2001**		
Poland		May 1991	→			**April 2000**
Slovenia			**February 1992**			

Source: Arratibel, Rodriguez-Palenzuela, and Thimann, 2002.

The anti-inflationary programs in CEEC-4 have been successful in bringing down inflation from almost hyperinflationary levels at the beginning of transition; however, the inflation rates are still above the rates required for entry to EMU. As already mentioned, part of the reasons for higher inflation rates could be found in the working of Balassa-Samuelson effect and the remaining convergence of relative prices (on the latter see Čihak and Holub (2002)). However, it is suspected that the combination of an exchange rate regime and monetary policy could substantially contribute to the differences in inflation rates in CEEC-4 as the Czech Republic and Poland have on average produced lower inflation rates than Hungary and Slovenia in the last three years. As the Czech Republic and Poland maintain relatively less managed exchange rate regimes than Hungary and Slovenia, and additionally employ inflation targets, it is believed that the combination of a relatively flexible exchange rate regime subordinated to a given explicit inflation target produces lower inflation.

[1] It was only in October 2001 when Hungary switched to an inflation-targeting regime.

3. Exchange Rate Pass-Through

This reviews and discusses the empirical analysis of exchange rate pass-through in view of the implications the empirical analysis can have for the choice of exchange rate regime. After a brief review of different approaches to the study of pass-through in the literature, we focus on the empirical estimates of pass-through effect of exchange rate growth to CPI inflation presented in Coricelli, Jazbec and Masten (2003). This paper complements the analysis by showing that the reported estimates of equilibrium pass-though effect are actually identified and can thus be interpreted as elasticities in structural sense. The issue of identification of pass-through effect has not yet been addressed in the existing literature. For the purposes of the analysis that follows it also usefull to give the following technical definition of equilibrium pass-through:

Definition 1: *Equilibrium pass-through effect* is measured by the coefficient of nominal exchange rate growth on the difference between domestic and foreign CPI inflation in a cointegrating relationship that contains no other variables.

3.1. Methodological Issues and Limitations of Existing Empirical Studies

The measure of pass-through estimated in the paper is the effect of changes in nominal exchange rate growth on CPI inflation, a common final target variable of monetary authorities. In particular, the main focus of the paper is the equilibrium effect of exchange rate changes on inflation, real interest rates and output, and short-run adjustment to deviations from equilibrium. In the literature there is no uniform approach to the analysis of pass-through. Some authors attempt to measure the pass-through directly; others use empirical results not to measure it directly, but to investigate the underlying economic mechanisms.

In terms of methodology structural VAR methods is most common in the literature, of which McCarthy (2000) is a very notable study. Pass-through there is measured by means of impulse responses of different price series to an identified structural exchange rate shock. The problem with this approach is that it is not entirely consistent with the simplest notion of pass-through: the co-movement between the exchange rate and prices can be caused by any type of shock. In principle this would imply that we could observe as many measures of pass-through as there are identified structural shocks. Campa and Goldberg (2002) for this reason estimate a simple single-equation model for OECD countries and measure the pass-through effect (to import prices in their case) with the coefficient on the nominal exchange rate. A single equation approach is used also by Darvas (2002) for the group of Acceding Countries. A different use of

SVAR analysis is found in Choudhri, Faruqee, and Hakura (2002). Their empirically observed impulse responses of various price indexes to an exchange rate shock (UIP shock) are used not to measure pass-through effect directly but as a benchmark for simulated responses obtained from calibrated theoretical model under different assumption about nominal rigidities in the economy.

A common drawback of all SVAR-based studies is that they do not account explicitly for the possibility of cointegration. Price series are commonly integrated at least of order one, which calls for an explicit test for cointegration. From an economic point of view, neglecting cointegration is very surprising since theoretically long-run co-movement of prices and exchange rate seems very plausible. Neglecting cointegration when it is genuinely present leads to neglecting the intrinsic meaning of equilibrium long-run relationship between the nominal exchange rate and prices. Identifying long-run equilibrium relations and analyzing the adjustment to disequilibria allows us to evaluate some important theoretical aspects of New Keynesian models.

The analysis of Coricelli, Jazbec, and Masten (2003) improves over existing studies of pass-through in three ways. First, the analysis is conducted within the framework of cointegrated vector autoregression model (CVAR). The study is not the first in this respect, since it can be found before in Kim (1998); and Billmeier and Bonato (2002). However, the estimates presented in these two studies do not comply with Definition 1, which means that in their case the pass-through is not identified.

Second, the pass-through effect is estimated without relying on the identification of structural shocks. These can be identified using non-testable restrictions, which are very often imposed arbitrarily and in high-dimensional systems even with weak theoretical justification. Moreover, the procedure used in the paper directly distinguishes between permanent and transitory shocks. For the analysis of pass-through this is a very important distinction, since only permanent exchange rate shocks can have a non-zero equilibrium pass-through effect and hence cause a different change in pricing behavior of economic agents. In particular, it is unlikely that transitory exchange rate shocks induce significant short-run changes in pricing behavior if firms face costs associated with frequent price changes. If the analysis is to be used for policy implications about disinflation policies and the choice of exchange rate regime tracing the effects of permanent shocks only becomes even more important.

The third potential deficiency of existing studies is that in general they do not address the possibility of prices, the nominal exchange rate and nominal wages being integrated of order 2, which is an increasingly common finding in the literature (see Banerjee, Cockerell, and Russel (2001), Juselius (1999, 2001), Coenen and Vega (2001) and Ericsson, Hendry, and Prestwich (1998)). Also Kongsted (1998), for example, analyzes pricing-to-market behavior explicitly within an I(2) cointegration framework. I(2)-ness of prices effectively means that inflation rate is not stationary, i.e. it is driven by a

stochastic trend. Nominal shocks in this respect have a fully persistent effect on the level of inflation. Treating inflation as stationary results in invalid statistical inference. Thus, all results obtained without testing for I(2)-ness in the price level before treating inflation as stationary should be interpreted with caution. Coricelli, Jazbec, and Masten (2003) find that prices (as well as nominal wages and the nominal exchange rate) can be better described as variables integrated of order two and take this finding into account in the estimation of pass-through.

Econometric analysis in Coricelli, Jazbec, and Masten (2003) is conducted on monthly data, whereas a vast majority of other studies uses quarterly data. It is believed that use of monthly data is more informative, because it does not average out the price dynamics occurring at the frequency at which the data is collected. In addition, econometric investigation of the pass-through effect on quarterly data in accession countries is seriously hindered by short time series. Namely, the inclusion of a number of control variables that are important for exchange rate determination quickly leads to a dimension of the system that does not allow for a fully-fledged cointegration analysis. The data intensive technique employed here requires the use of monthly data.

3.2 Identifying the Pass-Through Effect in I(1) Framework

In this section we show how pass-through effect from the nominal exchange rate to domestic CPI inflation can be identified within an I(1) cointegration framework. From the statistical analysis presented in Coricelli, Jazbec, and Masten (2003) for CEEC-4 we derive the crucial results that are needed for the discussion of the identification of pass-through effect and of policy issues. The system of variables that we look at is the following:

$$X_t = \left(\pi_t - \pi_t^*, \Delta e_t, i_t - i_t^*, y_t\right)',$$

where $\pi_t - \pi_t^*$ the inflation differential with respect to Germany, Δe_t the growth of nominal exchange rate, $i_t - i_t^*$ the nominal interest rate differential with respect to Fibor/Euribor (3 month) and y_t, as before, the index of total industrial production. Industrial production index enters the system in levels as it does not exhibit signs of I(2)-ness. The nominal exchange rate has to be differenced, however, in order to rule out I(2)-ness with certainty. Domestic and foreign inflation rate enter as a homogeneous relation because the relation between nominal exchange rate growth and inflation differential is what we are primarily interested in as the coefficient to the inflation rate differential can be directly related to the pass-

through effect of nominal exchange rate changes to domestic inflation.[2] By analogy the nominal interest rates enter the system also as a spread. The estimation period is from 1993 to 2002. It is important to emphasize that formal test of structural parameter stability do not reject the hypothesis of parameter stability for all countries under analysis. Thus, even though some countries formally changed the exchange regimes during this period this does not show as deterministic breaks in behavior of economic series we analyze.

Coricelli, Jazbec, and Masten (2003) estimate three cointegrating vectors for each country under analysis. With suitable normalization we can write them in regression format as

$$\pi_t - \pi_t^* = \lambda_1 \Delta e_t; \quad i_t - i_t^* = \lambda_2(\pi_t - \pi_t^*); \quad y_t = \lambda_3 i_t - i_t^*,$$

or in algebraic format as

$$\beta_1 = (1, -\lambda_1, 0, 0)', \beta_2 = (-\lambda_2, 0, 1, 0)' \text{ and } \beta_3 = (0, 0, -\lambda_3, 1)'.$$

Consider also an I(1) system written as

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + \varepsilon_t$$

with a corresponding reduced rank condition $\Pi = \alpha\beta'$ (see Johansen, 1995 for a detailed presentation). The matrix β contains the cointegrating relations and α contains the corresponding loading coefficients. In that model matrices C and Γ are defined as

$$C = \beta_\perp \left(\alpha_\perp' \Gamma \beta_\perp\right)^{-1} \alpha_\perp' \text{ and } \Gamma = I - \sum_{i=1}^{k-1} \Gamma_i$$

where $\alpha_\perp$ and $\beta_\perp$ are the orthogonal complements to α and β respectively. In the following we invoke results in Johansen (2002). It is shown there that it follows from the solution of the error-correction model that the long run value $X_{\infty/t}$ as a function of current values $(X_t, X_{t-1}, ..., X_{t-k+1})$ is given by

$$X_{\infty/t} = \lim_{h\to\infty} E\left(X_{t+h} \mid X_t, ..., X_{t-k+1}\right) = C\left(X_t - \sum_{i=1}^{k-1} \Gamma_i X_{t-i}\right).$$

(1)

Expression (1) says that the long-run changes in endogenous variables are proportional to $\beta_\perp$, the orthogonal complement to β. A given long-run change $k \in sp(\beta_\perp)$ can be achieved by either adding k to all current values or by adding Γk to X_t. Since we are looking at cointegrating vectors identified

[2] The pass-through of foreign (import) prices into domestic inflation is not analyzed in this paper.

using zero restrictions, Proposition 2 in Johansen (2002) can be used in the interpretations below. The admissible long-run changes in variables are summarized by the orthogonal complement to cointegrating vectors

$$\beta_{\perp} = (\lambda_1, 1, \lambda_1\lambda_2, \lambda_1\lambda_2\lambda_3)',$$

which is normalized on the second element, which for simplicity corresponds to a unit change in the nominal exchange rate growth. The pass-through effect is identified and directly measured by λ_1.[3] Note that Definition 1 is directly satisfied in the present case with rank three in a four-dimensional system, but it can be obtained also for rank two by a simple solution of the system of variables (see also Masten (2003)).

A given equilibrium change in the depreciation rate is also matched by a corresponding change in the interest rate differential i.e. by $\lambda_1\lambda_2$, which is economically meaningful. It is matched disproportionally, which implies that real interest rates and/or UIP shock process have been non-stationary in all countries under study. Note that rank three implies also that the long-run relation between exchange rate changes and inflation is supported by a non-zero effect on real output ($\lambda_1\lambda_2\lambda_3$), whereas this is not necessarily the case for lower rank orders.

The left panel of Table 4 presents the estimates of just-identified cointegrating coefficients using the same notation as above. Signs of all coefficients are consistent with economic theory. As explained above, λ_1 can be interpreted as long-run or equilibrium pass-through effect. We can observe that it is the largest in Slovenia and practically identical to 1. For Hungary it is only marginally different. For Poland the point estimate of this coefficient is smaller than 1, 0.86 to be precise; however, we still cannot say that it is statistically significantly different from 1 (see Coricelli, Jazbec, and Masten (2003)). The smallest is the point estimate of the coefficient for the Czech Republic, roughly 0.5, but the estimate is more dispersed relative to other countries. It is worth mentioning that all these estimates of equilibrium pass-through are high, especially because this is the pass-though effect on the price index that contains also not-tradable good prices. This implies that the prevalent form of firm pricing behavior in these economies is producer-currency pricing. The result is not surprising because all these economies are relatively small and very open.

[3] For a complete and detailed discussion of identification of pass-through effect in cointegration framework see Masten (2003). He demonstrates that in the present case the pass-through effect could be identified also for rank 2, but not for rank 1.

Table 2: Cointegration coefficient and orthogonal complements to cointegrating space - $\beta_{\perp}'$

	Cointegration coefficients			$\beta_{\perp}'$			
	λ_1	λ_2	λ_3	$\pi - \pi^*$	Δe	i-i^*	y
Czech Republic	0.46 (0.06)	1.28 (0.19)	-0.03 (0.001)	0.5	1	0.625	-0.018
Hungary	0.97 (0.10)	1.49 (0.11)	-0.03 (0.004)	1	1	1.5	-0.045
Poland	0.86 (0.10)	0.84 (0.08)	-0.03 (0.006)	0.8	1	0.67	-0.020
Slovenia	1.01 (0.10)	2.32 (0.20)	-0.01 (0.001)	1	1	2.5	-0.025

* standard errors in brackets

For each country the orthogonal complement to β is a *4x1* vector and reported in right panel of Table 4. Admissible long-run co-movements of the variables analyzed are thus summarized by a one-dimensional space. Since the estimates of cointegrating vectors are quite similar for all countries, it also holds that orthogonal complements to cointegrating space show qualitatively the same structure. For the case of Slovenia $\beta_{\perp}$ is *(1,1,2.5,-0.025)'*. This means that an equilibrium or permanent change in exchange rate growth, sustained by a corresponding increase in the interest rate spread, is accompanied by an equivalent increase in inflation differential and also a lower level of output. That the effect is on the level of output and not on the growth rate was determined in the I(2) analysis, where we observe that real output is not affected by I(2) stochastic trends. Also, the effect on the level of output is significant for all countries as neither of cointegrating spaces supports a unit vector (with one on the position of output). Because the rise in interest rate spread is more than proportional, ex-post real interest rate spread also increases, which is most likely the cause of lower output.[4] A disproportionate effect on the interest rate differential is a consequence of non-stationarity of the risk premium and the real interest rate spread. This non-stationarity is observed for all countries and is not surprising as these countries had gone through the process of transition to market economies.

It is important to note that any other vector linearly independent of *(1,1,2.5,-0.025)'* will violate the orthogonality with respect to β and hence cannot span the equilibrium long-run changes in variables of interest. It is important to note that when the central bank uses sterilized intervention on the foreign exchange market (hence counteracting market forces, which is the case of Slovenia, for example) to maintain a positive depreciation rate this causes an equal change in the difference in CPI inflation rates. In

[4] To see this, note that we can rewrite the third cointegrating relation generically denoted as $i - i^* = \lambda_2(\pi - \pi^*)$ as $r - r^* = (\lambda_2 - 1)(\pi - \pi^*)$, where *r* denotes the ex-post real interest rate.

such a case we can talk about the causal relation going from policy determined changes in the depreciation rate to domestic inflation. In other words, when interpreting the λ_1 coefficient as pass-through effect we must note that $(\lambda,1,2.5,-0.025) \notin sp(\beta_\perp)$ for any $\lambda \neq 1$. This means that we can indeed interpret this coefficient as a measure of equilibrium pass-through into CPI inflation.

Hungary again shows very similar properties to Slovenia, the only difference being that a policy of further exchange rate stabilization while yielding the same gain in inflation reduction yields a somewhat smaller, but still more than proportional, reduction in interest rate spread, and a larger positive effect on output. Poland and the Czech Republic share many similarities and appear slightly distinct from Hungary and Slovenia. Their point estimate of pass-through is smaller than one, and consequently, there is also a smaller negative effect on output and a smaller required increase in interest rate spread to support a potential policy of accelerated exchange rate depreciation.[5] Again this fits with our priors about the nature of exchange rate policy in these two countries.

Empirical results can be summarized as follows. A higher growth rate of nominal exchange rate results in equally higher difference between domestic and foreign inflation in Slovenia and Hungary, two countries with most accommodative exchange rate policy. Moreover, from I(2) analysis for Slovenia it follows that innovations to the exchange rate are transferred most strongly to domestic inflation. In Hungary, on the other hand, exchange rate innovations have comparatively smaller effect. The point estimate for Poland shows a coefficient between exchange rate growth and inflation differential that is smaller than one, but not significantly different. Nevertheless, we tentatively conclude that the effect of the exchange rate growth on inflation is smaller than in Slovenia and Hungary. The country with the lowest effect of exchange rate on prices is the Czech Republic. This is also in line with the I(2) analysis presented in Coricelli, Masten and Jazbec (2003), where it is found that inflationary pressures in these countries are dominated by the shocks to the nominal exchange rate, CPI and PPI. The share of nominal exchange rate in the nominal stochastic trend is the highest in Slovenia, approximately twice as large as the corresponding shares of the CPI and PPI, which are roughly equal. This implies that in Slovenia shocks to the nominal exchange rate have the highest effect on inflation, the autonomous pricing behavior of imperfectly competitive firms, on the other hand, has a much smaller effect. Exactly the opposite is the case of Poland, where the share of the nominal exchange rate is almost negligible, whereas inflationary pressures can be mostly attributed to shocks to the CPI and PPI in roughly equal proportions. For the Czech Republic all three variables seem have important effect on inflationary movements in the economy;

[5] Note that for Poland even though the point estimate of λ_2 is larger than 1, it is not significantly different from 1. This means that Polish risk premium and real interest rate differential have been stationary in the period under analysis. A change in the rate of depreciation of zloty thus does not yield lower equilibrium real interest rates.

however, the effect of a shock to the nominal exchange rate of equal size has a considerably smaller effect than the shocks to two price indexes. From the two, the share of PPI is higher. For Hungary the situation is different in the sense that shocks to the PPI have no inflationary effect. Inflationary pressures are mostly affected by shocks to the exchange rate, and more importantly, from shocks to the CPI. As one of the major differences from the PPI and the CPI is that the latter also reflect prices of non-tradable goods, we could infer that in Hungary an important share of inflationary pressures comes from the non-tradable sector. This could arise from a combination of monopolistic pricing, wage pressure and administrative price changes in non-tradable sectors.

A central question of this paper is how different exchange rate regimes influence the overall inflationary performance of an economy. Our priors were that a regime that systematically depreciates the domestic currency leads to firms strongly incorporating expected depreciations into their pricing behavior. As a result, exchange rate policy becomes an important source of inflationary pressures and leads to an average inflation rate considerably above the one corresponding to structural dynamics of the economy. In this respect the inflationary impact of exchange rate policy is the highest in Slovenia, followed by Hungary, the Czech Republic and Poland.

4. Concluding Discussion

Despite the variety of approaches to the exchange rate policy, CEEC-4 have all made substantial progress in reducing inflation, which has been on average below 10 percent since 1998. Part of the explanation for inflation rates that are still higher than in the EU could be found in the working of the Balassa-Samuelson effect and the process of overall relative price convergence in CEEC-4 on average. However, it is argued in this paper that the combination of exchange rate regime and monetary policy contribute to the differences in inflation rates among CEEC-4. The paper finds a strong pass-through from nominal exchange rates to domestic inflation. In such a context, the dichotomy between inflation targeting and exchange rate targeting is more apparent than real. Moreover, in many instances, flexibility of exchange rates turns out to be a policy of accommodation of inefficiencies and monopoly power in non-tradable sectors.

As real appreciation in transition economies has resulted in higher inflationary pressure rather than nominal appreciation, part of the inflationary pressure could derive from goods and labor market rigidities. This brings up the issue of the relationship between exchange rate policy and disinflation in an economy with price-wage and inflation inertia, which has been in our case confirmed in the I(2) cointegration analysis. A useful reference framework for discussing the costs and benefits of different speeds of disinflation is a two-sector model with monopolistic power in the non-tradable sector. In the

context of perfect capital mobility, interest rates in candidate countries are determined by foreign interest rates and expected depreciation of the exchange rate. In the staggered price model of Calvo (1983) with price level inertia in the non-tradable sector, it is easy to show that by reducing the rate of depreciation of the exchange rate, a country can reduce the overall rate of inflation with little if any fall in output in the non-tradable sector. However, empirical analysis of this paper shows that inflation rates in CEEC-4 are non-stationary, which implies that these economies exhibit full inflation inertia and not only price inertia. Calvo, Celasun, and Kumhof (2002) have recently proposed a theoretical framework that incorporates inflation inertia into the framework of staggered price setting of firms in a monopolistically competitive market. The intuition of this model is that firms choose a price rule that includes a revision of price schedule depending on the rate of inflation in the economy. This implies that firms internalise the effects of policies such as that of a persistent rate of depreciation of a central bank that wants to target the real exchange rate. As a result, the model contains inflation inertia in addition to price-level inertia. A simulation of a disinflation policy implemented through a reduction of the rate of depreciation of the exchange rate shows that output in the non-tradable sector temporarily declines. Under the assumption of monopolistic competition also in the tradable sector the output decline, even though smaller, would have occurred also in the tradable sector. Nevertheless, disinflation brings welfare gains as it reduces the welfare losses associated with monopolistic power in the non-tradable sector. A disinflation policy can thus be seen as a way of reducing the welfare losses of monopolistic price setting. This line of reasoning seems very relevant for exchange rate policy in candidate countries, because it shows that in presence of high and fast pass-through effect, which has been found for two countries with most accommodative exchange rate policies: Hungary and Slovenia, disinflation can be achieved by a different choice of exchange rate policy at low costs in terms of output decline and with potential gains in welfare.

What are the policy implications that can be drawn from presented empirical results? The most important conclusion is that in any policy design the important effect of the nominal exchange rate on prices should not be underestimated. The path of nominal exchange rate within a more general exchange rate regime arrangement during disinflation should be given a priority role. In the last three years, inflation rates have been lower in the Czech Republic and Poland than in Hungary and Slovenia. As the Czech Republic and Poland maintain relatively less managed exchange rate regimes than Hungary and Slovenia, and additionally employ inflation targets, it is believed that such a combination produces lower inflation. However, in the case of Poland the costs in terms of output and unemployment appear very large. In the case of the Czech Republic it appears that the exchange rate features as a main intermediate target to achieve the final target on inflation, as is natural in a small open economy. Before adopting the euro, all candidate countries will have to enter the ERM2 system with an agreed central parity and a ±15

% band. It is argued in the paper that the pre-adoption period may generate persistent inflationary pressure, as candidate countries will probably try to maintain external competitiveness and use exchange rate as a shock abosorber. The case of Greece in this process, which has been forced twice to revalue its parity to cope with inflationary pressures in the ERM mechanism, is a notable example. One can thus expect rising interest rates and output volatility in ERM2 prior to actual adoption of the euro. Such volatility will be affected by the regime of full capital mobility that the countries have to adopt upon entry in the European Union. Results in the paper suggest that the best policy would be the adoption of the euro as early as possible.

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