

A note on exchange rate pass-through and its asymmetry in CIS countries^{*}

Iikka Korhonen, Bank of Finland

Paul Wachtel, Stern School of Business, New York University

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Abstract

We assess the extent and speed of exchange rate pass-through in the countries of Commonwealth of Independent States (CIS). We do this in the framework of vector autoregressive regressions, utilising impulse functions and variance decompositions with monthly data that starts in 1999 in order to avoid the periods of very high inflation and the Russian crisis. We find that exchange rate movements have a clear impact on price developments in the CIS countries. Speed of pass-through is also fairly high, in most cases the full effect is transmitted into domestic prices in less than 12 months. Unlike in many other emerging market countries, an additional effect from US prices on to domestic prices is not significant. The extent of exchange rate pass-through is usually much higher than in our benchmark group of emerging market countries. Variance decomposition shows that the relative share of exchange rates in explaining changes in domestic prices is higher in the CIS countries than in the benchmark group. In addition, we examine whether there are any asymmetries in the exchange rate pass-through, i.e. whether depreciations have a different effect on inflation than appreciations. It turns out that in some countries there seems to be some asymmetry in the pass-through, but the results across countries are far from robust.

Key words: exchange rate pass-through, inflation, exchange rate regime, transition countries

JEL: E31, E42, F31, F42

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1. Introduction

The 12 CIS countries (the former Soviet Union less the Baltics) are a widely disparate group of transition countries. The CIS includes both some very large economies (e.g. Russia and the Ukraine) and some very small countries (e.g. Moldova); some countries are very closely tied to the developed world through the energy industry (e.g. Kazakhstan) and some are very isolated (e.g. Armenia). All of the CIS countries experienced several years of very high inflation in the early 1990s although the median annual inflation rate fell to 44% in 1996 and has been below that since. The median has been below 10% since 2002 and annual inflation rates in excess of 20% are rare exceptions (Wachtel and Korhonen, 2004). Our intent in this paper is to examine one of the important influences on this remarkable disinflation, the behaviour of exchange rate pass-through. We will examine the extent and speed of exchange rate pass-through on the domestic price level in the CIS countries which will provide some indication of their integration with the world economy. The issue could not be examined before because many of these countries were highly unstable through most of the 1990s and reliable monthly inflation data were often unavailable. Moreover, even the larger more developed CIS countries were buffeted by the Russian financial crisis in 1998. However, there are now approximately six years of post crisis data, which warrant a closer examination of economic integration of the CIS countries with the world economy.

We will examine the relationships among domestic inflation, foreign inflation and the exchange rate movements for a number of CIS countries and compare the results with those for a benchmark group of emerging market economies.¹ In our empirical work we emphasise comparability across specifications. Therefore we do not try to model individual country experiences in great detail, but hope to find some general trends among these countries that we will compare to a benchmark group of emerging market countries. First, we examine the stationarity of the individual series. Not surprisingly, they all seem to be non-stationary, a result that would be observed for most developed economies as well. Second, we test for the existence of a cointegrating relationship among the three variables in each country. The presence of a cointegrating relationship would indicate that the stationarity of the real exchange rate which would be observed among most developed economies. The results for the CIS countries are mixed; there is little indication of the existence of stationarity in the

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real exchange rate. Since there are no cointegrating relationships, we estimate vector autoregressive (VAR) models without error correction terms. VAR systems are estimated for each country with the log differences of the variables and the estimates are used to examine the pass-through relationships using impulse response functions and variance decompositions.

We find that the adjustment of domestic price levels to exchange rate shocks tends to be quite fast, although far from complete. However, extent of pass-through seems to be clearly higher in the CIS countries than in our comparison group of other emerging market countries.

In addition, we perform a simple test on the asymmetry of exchange rate pass-through. Results are far from conclusive, although asymmetry seems to be present in some countries. Usually exchange rate appreciations have had larger absolute effect on inflation than depreciations.

The paper is structured as follows. In the next section we provide a brief literature survey on exchange rate pass-through, concentrating on contributions relating to transition and emerging market countries. In section three we discuss the data and note its time series properties. In section four we estimate the VAR models, which form the basis for our pass-through calculations. These calculations are performed and discussed in section five. In section six we assess the potential asymmetry of exchange rate pass-through. Section seven offers our conclusions.

2. Brief literature survey

The literature on exchange rate pass-through and the law of one price reflects considerable surprise that economies appeared to be less fully integrated than could be anticipated. The law of one price is violated by large margins and exchange rate pass-through is far from complete in developed as well as developing countries. In the 1980s explanations focused on microeconomics, pricing behaviour (e.g. the currency used for invoicing, the role of mark-up pricing and competitive strategy). In the 1990s research interest included macroeconomic influences such as the role of macro stability, exchange rate regimes, stabilization policies and financial crises on the pass-through. The empirical literature originally focused on the major developed economies but more recent work has examined developing economies, including the transition economies but not the CIS countries.

¹ Due to lack of data we had to omit several smaller CIS countries.

Goldberg and Knetter (1997) summarize the extensive literature on pass-through and the law of one price and show why incomplete pass-through persists even as trade and economic integration increase. More recent developments which include macroeconomic explanations are summarized by Frankel, Parsley and Wei (2005). They note that smaller countries, countries with a higher presence of foreign firms and less developed countries generally tend to have higher pass-through of exchange rates on to prices. Moreover there has been a downward trend in the extent of pass-through which is partly due to the global decline in inflation. Careful analysis with disaggregated price data by Frankel, et. al. and Campa and Goldberg (2004) provide some explanations for the pass-through results. In addition to technical issues like the composition of imports, both strategic pricing in segmented markets and the stability of the macro environment play explanatory roles. However, much of the typically less than full pass-through and the trend remain unexplained.

The size of the pass-through is important for less developed economies because it has implications for the effectiveness of independent monetary policy. In transition economies where price liberalization led to substantial inflation in the 1990s and where real exchange rate appreciation occurred with disinflation, the size of the pass-through is important to policy makers

A few papers have examined the interrelationships among exchange rates and inflation in the transition economies with time series methodologies that are similar to ours. Dibooglu and Kutan (2001) use cointegration tests and VAR models to analyze the relationship between real exchange rates and inflation in Poland and Hungary with monthly data for the 1990s. They find that nominal shocks (pass-through) had a greater impact on the real exchange rate in Poland than in Hungary. Coricelli, Jazbec and Maston (2003) estimate exchange rate pass-through for four advanced transition economies and find that the pass-through is larger when there is less exchange rate management. Ganey, Molnar, et. al. (2002) report similar results in ten transition economies.

To our knowledge, no one has studied these issues with data from the CIS countries. The pass-through relationships in these countries will indicate the extent of their integration in the world economy and also shed light on the efficacy of different approaches to monetary policy management.

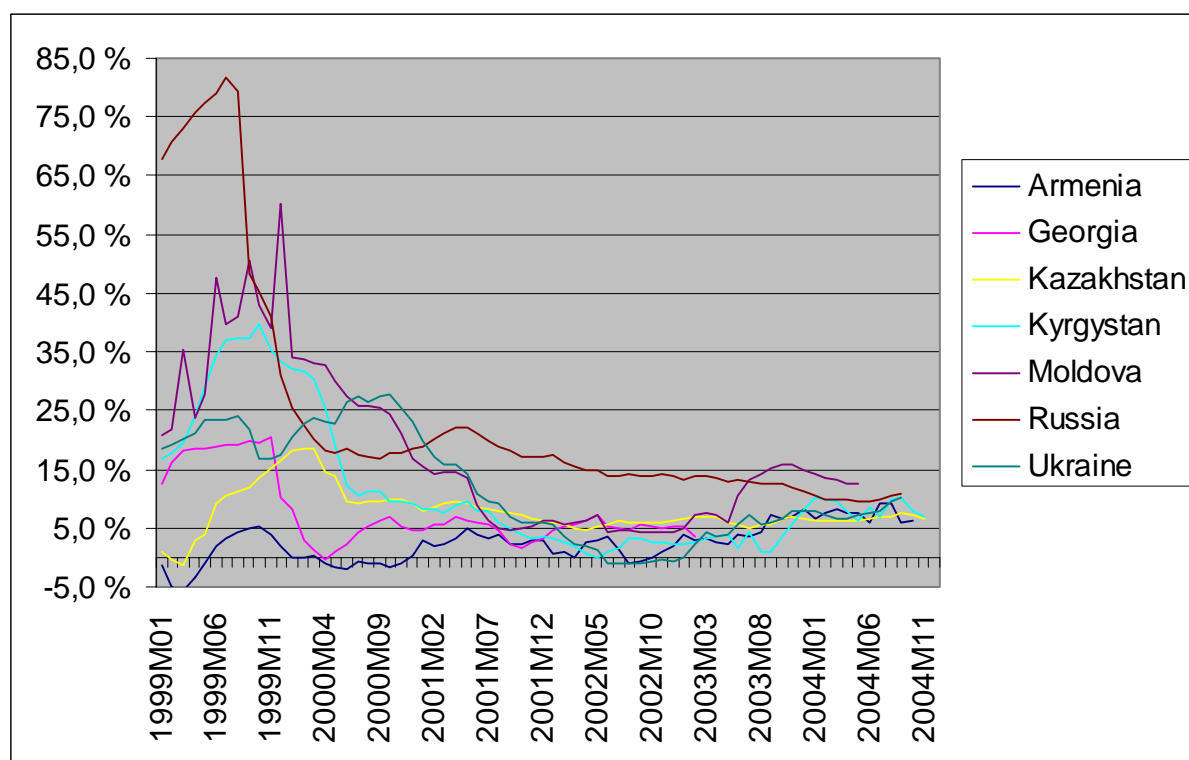
3. Data

We use monthly data from the beginning of 1999 until November or December 2004 in our estimations. Even though this is a fairly short sample (six years), we prefer to concentrate on this shorter sample than to include the period prior to the Russian crisis of August 1998. The crisis marked such a dramatic change in the exchange rate regime of Russia and several other CIS countries that it would most likely be futile to include data from the previous period in our estimations. Furthermore, by concentrating on more recent data, the analysis is hopefully more relevant for future policy discussion as well. The obvious downside of limiting the data sample in this way is that we have to settle for fairly parsimonious model specifications.

All the data are taken from the IMF's International Financial Statistics database. To study exchange rate pass-through in the CIS countries, we use consumer price indices. While it would be preferable to examine import prices and consumer prices, separate import price indexes are not available for all of the CIS countries. The exchange rate is the monthly average exchange rate against the US dollar. This choice is motivated by the fact that many, if not most, CIS countries have continued to orientate their exchange rate management towards the US dollar. Also, their economies are still heavily dollarized, making the dollar exchange rate one of the most important relative prices in the economy.

In addition, we will use inflation data from the US and oil prices (Brent in US dollars) in our VARs. Inflation in the US is used to represent price pressures emanating from the rest of the world. For the European emerging markets, we will also estimate the models with euro exchange rates and euro area inflation. Finally, oil prices are included as a source specific of price (and exchange rate) fluctuations. This may be especially relevant for some CIS countries. All the variables are used in their log form. Figure 1 plots 12-month inflation rates in our sample of CIS countries.

Figure 1 Annual inflation in seven CIS countries



We check the stationarity of the time series with unit root tests. Our a priori expectation is that consumer price indices and exchange rates in the CIS countries are non-stationary. Inflation has been relatively high until recently and, while nominal exchange rates have often been heavily managed, they have tended to reflect the large inflation differential with the US. Also, the price of oil in this period shows a clear upward trend, implying non-stationarity.

Table 1 shows the results from unit root tests for seven CIS countries.² The data has been seasonally adjusted (X-12 procedure in EViews 5.0) prior to the unit root testing. The first column shows the ADF unit root test where a significant result indicates that non-stationarity can be rejected. The null hypothesis for the KPSS test is stationarity. Most of the tests imply non-stationary of the levels. In some cases structural breaks (such as the exchange rate crisis in Argentina at the beginning of 2002) seem to affect the validity of the tests. Taking into account also our theoretical priors, we conclude that the variables are indeed non-stationary. Therefore, we estimate the VARs in log-differences.³

² Unit root tests for our benchmark emerging market countries also confirm non-stationarity of the series in levels. There results are not reported here, but are available from the authors upon request.

³ In addition, we tested for co-integration between domestic and foreign prices as well as the exchange rate in the CIS countries. In the majority of cases no co-integrating relationship could be found. In some cases a relationship may have been present, but their statistical significance was marginal at best. Also, in these cases the estimated long-run coefficients

Table 1 Unit root tests for the levels of variables

		ADF (constant as exogenous variable)	KPSS (constant as exogenous variable)
Armenia	CPI	3.428	0.848***
	Exchange rate	-1.439	0.367*
Georgia	CPI	-1.350	0.922***
	Exchange rate	-2.042	0.189
Kazakhstan	CPI	-2.841*	1.104***
	Exchange rate	-4.543***	0.499**
Kyrgystan	CPI	-3.353**	0.987***
	Exchange rate	-4.512***	0.245
Moldova	CPI	-7.322***	0.953***
	Exchange rate	-2.002	0.614**
Russia	CPI	-2.641*	1.087***
	Exchange rate	-3.120**	0.712*
Ukraine	CPI	-4.124***	0.494**
	Exchange rate	0.019	0.828
Oil		-2.869*	0.679**

*, ** and *** denote rejection of the null hypothesis at 10%, 5% and 1% significance levels, respectively. In the ADF test null hypothesis is that time series is non-stationary, while in the KPSS test the null is that of stationarity.

4. VAR estimation results

To maintain comparability across different countries, we start our estimation always with a similar set-up. All the data are in logs, and consumer prices have been seasonally adjusted. We start with a four-variable VAR, where the variables are first difference of oil price, first difference of the US con-

did not have any clear economic meaning. This may because the time span is simply too short. Therefore, we proceed from the assumption that there are no long-run relationships in the data, and simple VAR is the best modelling strategy.

sumer prices (to reflect international price movements), first difference of exchange rate (local currency per one US dollar) and first difference of local consumer prices. The initial lag length is arbitrarily set at six (mainly in order to preserve degrees of freedom). Thereafter, we allow the data to decide on the appropriate lag length and whether foreign prices are to be included in the final specification.

First, we look at the residuals. Obvious outliers (more than three standard deviations from the predicted value) are handled with dummies. Usually we can always find a clear rationale for the timing of dummies. For example, sometimes even seasonally adjusted consumer prices exhibit spikes at the beginning of the year, if administratively set prices are adjusted more (or less) than is usually the case. Then we check whether foreign prices (i.e. US consumer prices) have a statistically significant effect (at 10% significance level) either on domestic prices or on the exchange rate. If this is not the case, US prices are dropped. (We believe that CIS or emerging market countries' variables do not affect US prices.) After this, the optimal lag length is determined by Wald tests of lag exclusion. The resulting VAR specifications are once more checked for large outliers in the same manner as before. Details of resulting VAR specifications can be found in the Table 2. Almost by construction we have ensured that there are no large outliers. However, it should be noted that almost all VARs have only one or two dummies, which indicates that the basic specifications work reasonably well. In most cases lag length is quite short, only two or three.

Table 2 Preferred VAR specifications

	Lag length	US prices included	Number of dummies
Armenia	2	no	2
Georgia	2	no	1
Kazakhstan	4	no	3
Kyrgystan	4	yes	1
Moldova	1	no	1
Russia	2	no	2
Ukraine	2	no	6
Brazil	1	no	3

Bolivia	3	no	1
Chile	3	no	0
Colombia	2	no	2
Croatia	3	yes	0
Czech Rep.	3	no	1
Hungary	2	yes	2
Indonesia	3	yes	3
Mexico	4	yes	0
Paraguay	4	yes	1
Peru	2	yes	1
Philippines	2	yes	0
Poland	2	yes	0
Romania	3	no	2
South Af- rica	3	yes	2
Slovenia	5	yes	0
Slovakia	6	yes	2
Thailand	4	yes	2
Turkey	3	no	3
Uruguay	6	yes	1

5. Pass-through calculations and discussion

Next, we use impulse response functions from the estimated VARs to assess the degree of pass-through in the CIS countries. In each of the VARs a one-unit shock is used to examine both the speed and extent of pass-through. Because the series are in logs, this corresponds to 1% shock to the original variables. We can then calculate how large a fraction of the 1% innovation in the exchange rate is transmitted to the domestic prices.

We are interested in both the speed and extent of pass-through. If the pass-through is very fast, domestic monetary policy can do little to affect the real exchange rate even in the short-run. This is even more true if changes in the nominal exchange rate are reflected one-to-one in the consumer prices. To

assess these issues, we calculate a) how much of the one-unit exchange rate shock has been transmitted to the consumer prices at 12 and 24-month horizons, and b) how much of the final pass-through (at 24-month horizon) has taken place at 6 and 12-month horizons. In other words, first we try to calculate the extent of pass-through and then its speed. We can then compare the speed and extent of pass-through in the CIS countries to those of other emerging markets, as VARs have been estimated with the same specification.

Table 3 summarizes the results based on the VAR specifications in Table 2 from our first stab at impulse responses. Some general conclusions seem to emerge. First, in the CIS countries the extent of pass-through seems to be higher than in most countries in our comparison country group. Of course, this comparison group is not some randomly drawn sample of countries, but rather a handful of fairly advanced emerging market countries, both in terms of per capita GDP and at least somewhat functioning of financial markets. In the majority of the emerging market cases the extent of pass-through is almost negligible.

There are a handful of countries where the extent of pass-through is roughly comparable with that of the CIS countries: Peru, Slovenia, South Africa, Turkey and Uruguay. It may be hard to find a common denominator for these countries, but some observations on their exchange rate policies may be offered. Slovenia has pursued a crawling peg regime against the euro, and the objective of the central bank appears to have been to keep the real exchange rate constant. Shocks to the exchange rate have, therefore, been accommodated by the central bank. In South Africa the exchange rate depreciated markedly during the latter half of 2001, although it quickly reversed its trend. Such a large depreciation may lead to faster and more complete pass-through. Turkey experienced exchange rate crisis in the beginning of 2001, and the Turkish lira depreciated more than 20% in one month. Although the level of exchange rate stabilised fairly quickly, the exchange rate has been much more volatile following the crisis. High volatility may lead to fuller pass-through. Also Uruguay experienced an exchange rate crisis in early 2002. Sharp depreciation of the exchange rate was followed higher volatility. Therefore it appears that in our benchmark group high level of exchange rate pass-through is mostly associated with large depreciations and their aftermaths. In the CIS countries no such obvious link can be detected.

High pass-through observed in Romania appears not to be caused by any large depreciation of the Romanian leu. During 1999-2001 the Romanian currency depreciated quite steadily against the US dollar, while after 2001 the leu has been quite stable. Therefore, the observed pass-through may be caused by two factors. In the first period Romanian exchange rate policy targeted the real exchange rate, i.e. the policy was very similar to the one in Slovenia. This may explain the observed pass-through. Also, high pass-through may be caused by Romania's relatively high degree of dollarisation.

In the CIS countries the extent of exchange rate pass-through is reasonably high, with the exception of Georgia. Even in a relatively large country like Ukraine 1% increase (i.e. depreciation) in the exchange rate is associated with an increase of 0.64 percentage points in the inflation rate. However, one should note that in Armenia and Moldova the extent of exchange rate pass-through is lower, in Armenia clearly so.

However, results from our very basic pass-through exercise are not very intuitive for a small number of countries. In the uniform set-up that we use, depreciation of the exchange rate is associated with *lower* inflation in Kazakhstan, Russia, Bolivia, Mexico and Indonesia. Moreover, the absolute size of the impulses is implausibly large in the case of Indonesia and Kazakhstan. Merely noting the five countries affected by this problem, one could guess that prices of raw materials, and especially energy, may have something to do with the result. In the recent years (practically throughout our sample period), oil prices have increased quite rapidly. In our VARs the price of oil may be interacting with the nominal exchange rate and domestic consumer price in surprising ways. Higher oil revenues put pressure on the real exchange rate to appreciate. However, central banks in many CIS countries (including Russia) have tried to limit the nominal appreciation of their currencies, leading ultimately to higher inflation. Therefore part of the real appreciation comes from nominal exchange rate, part from domestic prices. In the data it may seem that currency appreciation is correlated with higher inflation, which is somewhat counter-intuitive, unless one takes into account the effects of oil prices.

For these five countries we also experimented with alternative specifications. When we leave out also oil prices from the VAR specifications, impulse responses in Russian and Mexican VARs are more in line with the results from other countries, i.e. depreciation of the exchange rate increases inflation. In Russia 1% increase in exchange rate increases inflation by 0.2 percentage points during the next 24 months. This effect is fully realised already after 12 months. Therefore, including oil prices in a ma-

major oil-producing country may bias the results somewhat. In Mexico the extent of pass-through after 24 months is very similar to other countries, 0.03. However, same adjustment does not change the situation in Bolivia, Indonesia or Kazakhstan.

Another potential source of errors in our calculations is the choice of exchange rate. For reasons of comparability, the US dollar was used for all the countries. Many emerging market countries around the globe have used the US dollar as a reference currency in their exchange rate policy, and dollarisation remains widespread. However, it may very well be that the euro is more relevant at least for European emerging markets.⁴ Many of these countries had by 1999 started to anchor their exchange rates on the euro (and earlier the D-mark). Also, in many Eastern European countries cash euros (and earlier D-marks) are widely used. Therefore, we replicate the VAR estimations and pass-through calculations for European countries with the euro area inflation and exchange rates against the euro. Results are reported in the Appendix.

First, Table A1 reports the preferred specifications as in the Table 2. Then, Table A2 gives the corresponding calculations for the extent and speed of exchange rate pass-through. For our benchmark group, we can see that pass-through from the euro exchange rate to consumer prices is clearly higher in the countries which have generally oriented their economic policies towards the EU and the euro area: Croatia, the Czech Republic, Hungary, Slovenia and Slovakia. However, speed of pass-through appears to be slower. Exception is Poland, where the extent of pass-through actually declines. In Romania and Turkey it is also clearly lower, as these countries have pegged at least informally mainly to the US dollar. These results show that the choice of the relevant exchange rate can have a large influence on the estimated pass-through. Nevertheless, European CIS countries seem to be quite clearly within the dollar's zone of influence. Pass-through from euro exchange rates is lower in Moldova and Ukraine. In Russia the negative pass-through observed already with the rouble/dollar rate is somewhat smaller in absolute size. It appears that if pass-through is important in the CIS countries, it relates to the US dollar, not to the euro.

Table 3 Extent and speed of exchange rate pass-through

Extent of pass-through	Speed of pass-through
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⁴ Of course, for many smaller CIS countries also pass-through from the rouble exchange rate into prices might be relevant. However, given the observed exchange rate policy of Russia during the period under study, it might be difficult to disentangle the effects of the US dollar and the rouble rates. Therefore, we do not pursue this issue further.

	12 months	24 months	6 months	12 months
Armenia	0.25	0.25	1.03	1.00
Georgia	0.14	0.14	1.05	0.99
Kazakhstan	-2.01	-4.00	0.19	0.50
Kyrgyzstan	1.35	1.62	0.61	0.83
Moldova	0.49	0.49	1.02	1.00
Russia	-0.42	-0.42	0.80	1.01
Ukraine	0.63	0.64	0.79	0.98
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Brazil	0.02	0.02	1.00	1.00
Bolivia	-1.49	-1.71	0.50	0.87
Chile	0.07	0.07	1.00	1.00
Colombia	0.05	0.05	0.98	1.00
Croatia	0.06	0.06	1.04	0.99
Czech Rep.	0.03	0.03	1.04	1.00
Hungary	0.06	0.06	0.69	0.94
Indonesia	-0.97	-1.51	0.27	0.64
Mexico	-0.09	-0.10	0.72	0.88
Paraguay	0.01	0.01	1.03	0.96
Peru	0.20	0.20	1.05	0.98
Philippines	0.03	0.03	1.00	1.00
Poland	0.09	0.09	0.81	1.00
Romania	0.88	1.13	0.44	0.77
South Africa	0.17	0.19	0.66	0.92
Slovenia	0.16	0.18	0.65	0.87
Slovakia	0.05	0.05	-0.06	0.93
Thailand	0.01	0.01	1.55	0.94
Turkey	0.31	0.38	0.56	0.83
Uruguay	0.30	0.31	0.40	0.96

We also used variance decomposition from the VARs to assess the relative importance of different variables in affecting the domestic inflation. Variance decompositions tell us how large a share of

variation in any endogenous variable can be explained by stochastic innovations of that and the other variables of the VAR. In variance decompositions the variables are ordered so that oil comes first, US prices (if present) second, then bilateral exchange rates and finally domestic prices. This means e.g. that concomitant shocks to US prices, bilateral exchange rate and domestic prices do not affect oil prices, while oil affects all the other variables also contemporaneously. In the same vein, shocks to US prices affect exchange rates and domestic prices, but in the same period the causality does not run the other way.

Table 4 offers results of variance decompositions. We can see that the largest effect from exchange rate on domestic prices can be found in two very small CIS economies, Kyrgystan and Moldova, as well as Uruguay, where the exchange rate depreciated markedly during the sample period. Otherwise, shocks to the exchange rate tend have only a modest effect on inflation, sometimes smaller than oil prices.

Table 4 Results of variance decomposition, relative effect on domestic prices after 24 months

	Oil	US prices	Exchange rate	Domestic prices
Armenia	0.50		4.57	94.93
Georgia	11.08		7.76	81.16
Kazakhstan	1.86		0.20	97.94
Kyrgystan	6.19	13.62	29.14	51.04
Moldova	5.86		59.94	34.19
Russia	6.45		3.96	89.59
Ukraine	6.73		2.70	90.56
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Brazil	9.33		4.89	85.79
Bolivia	13.39		6.27	80.34
Chile	8.73		17.91	73.37
Colombia	0.19		6.80	93.01
Croatia	11.50	12.19	9.09	67.22
Czech Rep.	2.98		7.32	89.70
Hungary	7.72	3.78	14.85	73.65
Indonesia	13.53	0.47	14.37	71.64

Mexico	21.19	12.92	10.03	55.86
Paraguay	17.66	8.87	10.69	62.78
Peru	20.82	15.86	4.23	59.08
Philippines	5.12	0.47	9.98	84.44
Poland	4.82	3.27	9.22	82.69
Romania	3.90		32.57	63.53
South Africa	3.26	7.18	20.43	69.12
Slovenia	13.12	8.59	20.42	57.87
Slovakia	15.99	14.06	13.26	56.69
Thailand	32.85	9.68	1.61	55.86
Turkey	11.11		18.16	70.73
Uruguay	12.79	3.49	43.04	40.68

6. Asymmetry of pass-through

In this subsection we check whether there are significant asymmetries in the exchange rate pass-through in the CIS countries. If, for example, companies operating in the retail sector have market power, exchange pass-through can be asymmetric, i.e. exchange rate depreciation has larger (absolute) effect on inflation than exchange rate appreciation. Effects of weaker currency are transmitted to retail prices faster than effects of stronger currency. Companies can enjoy economic rents for a while, if the exchange rate is stronger, but retail prices of foreign goods remain at their previous level. Over time, these extra rents should attract more competition, and the rents should disappear.

We investigate the potential asymmetry in a very simple manner. We estimate OLS regressions for the seasonally adjusted monthly changes in the consumer price indices, where the main exogenous variables are the change in the nominal exchange rate and its lags. However, we treat separately those observations where the exchange rate has appreciated and those where it has depreciated. More formally, changes in consumer price index (π) are explained by changes in the exchange rate, Δe^+ and Δe^- . We define these variables as follows:

$$\Delta e^+ = \begin{cases} \Delta e, & \text{if } \Delta e > 0 \\ 0, & \text{if } \Delta e < 0 \end{cases}, \text{ and } \Delta e^- = \begin{cases} 0, & \text{if } \Delta e > 0 \\ \Delta e, & \text{if } \Delta e < 0 \end{cases}.$$

Then the equation to be estimated is:

$$\pi_t = \alpha + \sum_{i=0}^k \beta_i \Delta e_{t-i}^+ + \sum_{i=0}^l \delta_i \Delta e_{t-i}^- + \sum_{i=0}^m \gamma_i \Delta x_{t-1},$$

where x_t is a vector of control variables, in this case oil price changes and US inflation, if their inclusion is warranted. Then one can test whether $\beta_i=0$ ($i=0,\dots,k$) and $\delta_i=0$ ($i=0,\dots,l$). If coefficients of (say) negative exchange rate changes (appreciation in our case) are not significantly different from zero, it would appear that exchange rate appreciation has no effect on inflation. Also, one can assess whether $\sum_{i=0}^k \beta_{i,t-i} = \sum_{i=0}^l \delta_i$. If this restriction is rejected, asymmetry is definitely present in the exchange rate pass-through.

As in previous sections, we aim to keep the analysis fairly simple and uniform across the countries. We start each estimation with six lags of positive and negative exchange rate changes as well as six lags of oil price and US consumer price index changes (US CPI changes are seasonally adjusted). For each variable lags are taken out one by one, unless the longest remaining lag is statistically significant. Trimming start always from US inflation, followed by oil prices.

In Table 5 we report results from our asymmetry regressions for the CIS countries. It appears that the absolute sizes of the coefficient sums are different in each country (although not always statistically significantly), which would indicate the presence of some asymmetry in the exchange rate pass-through. However, in the case of Kazakhstan and Ukraine, the sum of coefficients on negative exchange rate movements has a "wrong" sign, implying that exchange rate appreciation accelerates inflation. This problem is obviously similar to the one we encountered in the previous section with impulse responses. There seems to be some evidence of asymmetry in Georgia, Kyrgyzstan and Moldova. In all of these countries exchange rate appreciation has affected inflation more strongly than depreciation. In Armenia⁵ and Russia we find very little evidence for asymmetry. These results

⁵ Standard deviations for Armenias are fairly large.

seem to be in contrast to some previous results in the literature, where exchange rate depreciation has larger absolute effect on inflation. However, in many cases this effect seems to be driven by large exchange rate movements. By construction, our sample avoids the period of large devaluations in the CIS countries. On the contrary, in many CIS countries there has been tendency towards real exchange rate appreciation, which has manifested itself partly as stronger nominal exchange rate and partly as higher inflation.

All in all, results concerning pass-through asymmetry are far from uniform. This may reflect the fact that the CIS countries still manage their exchange rates with different degrees of flexibility. Also, in some countries internal liberalisation and structural reforms have progressed more than in others. If e.g. lack of competition contributes to asymmetry, structural reforms (or lack of them) contribute to asymmetric response of consumer prices to exchange rate movements. Finally, changing inflation expectations can play a role. If authorities are successful in lowering inflationary expectations, economic agents may view exchange rate depreciations as temporary disturbances, which do not have an effect on inflation. As inflation has been on downward path in most CIS countries since the Russian crisis in 1998, expectations concerning inflation may very well have been changing as well.

Table 5 Asymmetry of exchange rate pass-through in the CIS countries

	Sum of β_i	Sum of δ_i	Test of $\sum_{i=0}^k \beta_{it-i} = \sum_{i=0}^l \delta_i$	Oil prices included	US inflation included	Number lags, k,l
Armenia	0.329	-0.405		yes	no	5,5
Georgia	0.073	0.188*		no	no	4,4
Kazakhstan	0.903	-9.569***	†††	yes	no	3,3
Kyrgystan	0.683***	-0.035	††	yes	yes	6,3
Moldova	0.675***	-0.408	†††	no	no	6,6
Russia	0.298***	0.547***		yes	yes	6,5
Ukraine	0.372***	-3.878**	†††	yes	yes	2,5

*, **, *** indicate that the sum is different from zero at 10%, 5% and 1% significance level, respectively

†, ††, ††† indicate that the null hypothesis is rejected at 10%, 5% and 1% significance level, respectively

7. Concluding remarks

In this note we have assessed exchange rate pass-through in the CIS countries. As a benchmark we have used a fairly large number of emerging market countries. Exchange rate pass-through was examined in a framework of simple VAR models. A common parsimonious modelling strategy was chosen because of limited data availability and in order to maintain comparability across the countries.

We find that changes in exchange rates have a clear effect on consumer prices in the CIS countries. Moreover, this effect was larger than in the benchmark group. Changes in exchange rates are reflected in domestic prices fairly rapidly, usually in less than 12 months. This may reflect the high degree of dollarisation in many CIS countries. Also, several CIS countries are very small and dependent on foreign goods. However, in our sample of countries there appears to be no correlation between openness and the extent of pass-through⁶ (see Figure 2). However, if one looks only at countries where the extent of pass-through is over 0.1, a positive correlation does emerge. This implies that other factors explain most of the pass-through, but if it is present, it may be stronger in more open economies.

It may also be that the extent of pass-through is influenced by the level of inflation. Many previous studies have found inflation rate to be negatively correlated with the extent of pass-through. Figure 3 looks at the average inflation between 1999-2002 and the extent of pass-through. Now some positive correlation seems to emerge, although it is far from perfect. This would imply that a regime of high (and possibly volatile) inflation encourages economic agents to follow more closely exchange rate changes in their pricing decisions.

We also find that prices in the CIS countries are largely driven by their own dynamics which is not surprising given that the liberalization of prices took place during our sample period. Since inflation has fallen dramatically in most of these countries, domestic policy must have been successful in changing expectations. Changing inflationary expectations may also have had other effects: in our

⁶ Estimates for the extent of pass-through in the Figures 2 and 3 are 24-month values taken from table 3.

sample exchange rate pass-through has been asymmetric in a number of countries, and exchange rate appreciation has had a larger absolute effect on inflation than depreciation.

Our results have also some clear policy implications. Policy-makers in the CIS countries need to pay attention to their exchange rates, as they have an effect on the inflation developments. Even though the degree of exchange rate pass-through is perhaps lower than expected, it is still higher than in many other emerging market countries.

Figure 2 Relationship between openness and pass-through

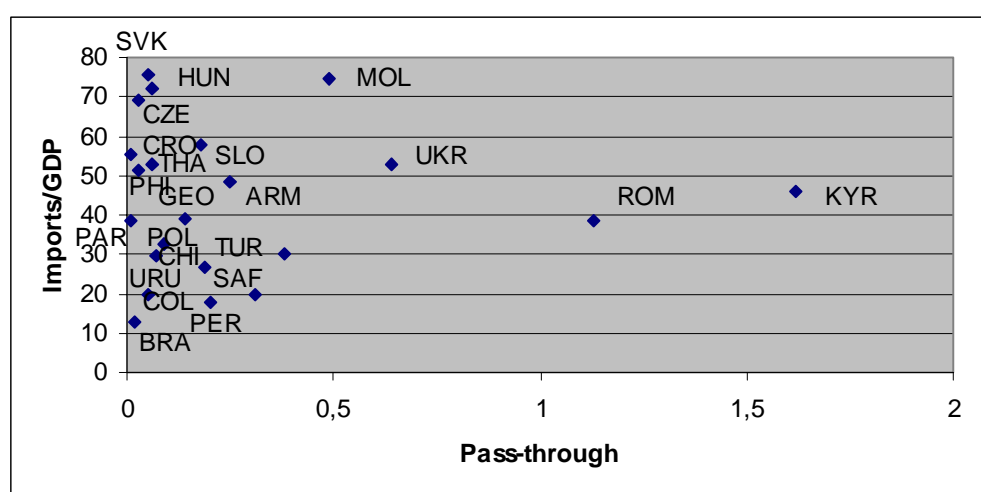
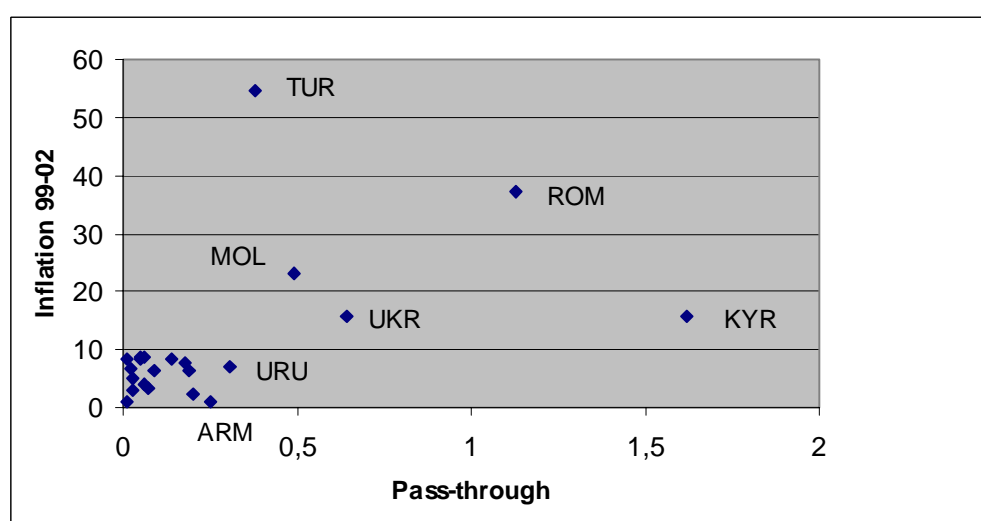


Figure 3 Relationship between average inflation and pass-through



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Appendix

Table A1 Preferred VAR specifications

	Lag length	Euro prices included	Number of dummies
Moldova	2	yes	2
Russia	6	no	0
Ukraine	4	no	1
Croatia	5	no	0
Czech Rep.	6	yes	0
Hungary	3	yes	5
Poland	2	yes	0
Romania	5	no	3
Slovenia	5	no	1
Slovakia	5	no	3
Turkey	5	no	3

Table A2 Extent and speed of exchange rate pass-through with the euro rates

	Extent of pass-through		Speed of pass-through	
	12 months	24 months	6 months	12 months
Moldova	0.43	0.45	0.82	0.97
Russia	-0.24	-0.21	0.56	1.13
Ukraine	0.24	0.28	0.56	0.86
Croatia	0.09	0.14	0.33	0.68
Czech Rep.	0.09	0.07	0.59	1.31
Hungary	0.22	0.31	0.42	0.73
Poland	-0.03	-0.03	0.78	1.00
Romania	0.08	0.11	n/a	0.79
Slovenia	0.67	1.08	0.62	0.72

Slovakia	0.17	0.15	1.14	0.92
Turkey	0.13	0.12	1.09	1.06