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Highlights in this issue:

- **Review of theoretical determinants of the pass-through elasticity between the exchange rate and inflation**
- **Estimates of the exchange rate pass-through for Slovakia**
- **The impact of the recent exchange rate appreciation on inflation could be spread over a longer period**

Exchange rate pass-through to inflation in Slovakia

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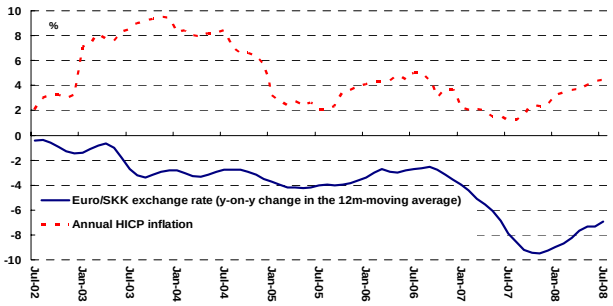
Summary

The extent to which exchange rate movements affect consumer prices in a given country depends on a number of micro and macro elements. This Country Focus discusses the relevance of theoretical determinants of the exchange rate pass-through to inflation in the case of Slovakia. Subsequently, empirical estimates of the pass-through elasticity for Slovakia, based on several methods, are presented. While econometric estimates suggest that the sensitivity of consumer prices in Slovakia to exchange rate developments is relatively high, a close analysis of inflation data concludes that the disinflationary impact of the recent exchange rate appreciation might have been smaller than implied by model-estimated elasticities. The impact could thus be spread over a longer time period and could, as a result, continue to favourably affect inflation even after Slovakia's entry into the euro-area on 1 January 2009.

Exchange rate developments and domestic price changes

In recent years, Slovakia has experienced substantial trend exchange-rate appreciation: against the euro, the Slovak koruna has appreciated by almost 30% from around 44.5 in July 2002 to around 31.5 in May 2008. In nominal effective terms, the appreciation over the same period was 45%. At the same time, annual HICP inflation fluctuated considerably, swinging between 1 and 10%, mainly reflecting the impact of external factors and adjustments in administered prices. When adjusted for these factors, inflation has followed a declining trend, with headline HICP inflation reaching an historical low of 1.2% in summer 2007.

Chart 1: Exchange rate appreciation and annual HICP inflation



Source: Eurostat

*** Directorate for the Economies of the Member States, Directorate for Macroeconomy of the euro area and the EU.**

Given Slovakia's aim of adopting the euro in 2009, in the run-up to the publication of the Convergence Report 2008, there has been much interest in assessing the extent to which Slovak consumer prices have been affected by exchange rate developments. Pass-through elasticities are defined as the percentage change of domestic prices (import, producer or consumer prices) resulting from a one percent change of the exchange rate. If the response of import prices to exchange rate movements is one to one, the pass-through is said to be complete or full. If this condition is not met, then the pass-through is said to be incomplete, or partial.

The empirical literature reports strong evidence of generally incomplete pass-through. Menon (1995) and Goldberg and Knetter (1997), for example, survey several studies and conclude that there is a well-supported consensus for incomplete pass-through. Besides, the literature also reports large cross-country differences. Goldfajn and Werlang (2000) for instance study a sample of 71 countries and, like other authors, find that the pass-through tends to be lower in developed countries and upper-income emerging economies, and higher in developing economies. Moreover, the pass-through is found to be effective only with a certain time lag (from 3 to 24 months) as prices along the supply chain are not adjusted instantaneously.

There are a number of factors affecting the pass-through elasticity.

As a consequence, several models have been developed that attempt to uncover the underlying determinants of pass-through – either micro or macro – and to account for incompleteness.

Micro and macro determinants of the exchange rate pass-through

Following the classification of An (2006), the main **micro** factors affecting pass-through are: 1) pricing-to-market and mark-up adjustments; 2) market segmentation features such as transportation and distribution costs, non-tariff barriers and the role of multinational corporations; 3) the degree of returns to scale; and, 4) the elasticity of demand for imported goods.

1) Krugman (1987) analyses the pricing-to-market phenomenon according to which foreign suppliers, wishing to keep constant market shares, accept smaller profit margins when the importing country's currency depreciates. Pricing-to-market thus implies a lower pass-through.

2) Burstein et al. (2001) calculate that local distribution costs (such as wholesaling and retailing) represent up to 40% of the final retail price of any commodity. As these costs are less dependent on exchange rate developments, they may consequently lower the pass-through even for internationally tradable goods.

3) Yang (1997) and Olivei (2002) study the degree of returns to scale, concluding that the rate of exchange rate pass-through is inversely related to the elasticity of the marginal cost with respect to output. Hence, if marginal costs decrease with output, higher demand stimulated by price decreases resulting from exchange rate appreciation should lead to further cost and thus price reductions, implying a higher rate of pass-through.

4) Foreign suppliers are likely to adjust their prices according to the perceived demand elasticity in the import country. The higher the elasticity of demand to price changes, the less likely are firms to pass through the whole exchange rate shock (Yang (1997)).

Macro factors frequently presented as important determinants of pass-through include: 1) the level of inflation and the perceived persistence of exchange rate swings; 2) the monetary policy environment; and 3) the size and openness of a country.

1) Taylor (2000) formulates the argument that the inflationary environment and the perceived persistence of shocks are decisive determinants of pass-through rates. More precisely, firms are less likely to adjust their prices if the exchange rate changes or inflation are expected to be volatile and temporary (a point already stressed by Mann (1986) and empirically supported by McCarthy (2000)).

2) The connection between inflation and pass-through levels implies that monetary policies should also affect the transmission of exchange rate movements

to domestic prices. Gagnon and Ihrig (2004) find that countries with credible and anti-inflationary monetary policies generally exhibit lower pass-through levels.

3) Country openness, proxied by the import share in total production, also affects pass-through rates. Intuitively, the more open the country is to international trade, the greater the exchange rate pass-through to consumer prices should be. Moreover, according to McCarthy (2000), a small country should experience higher pass-through levels than a large country. This is because the fall in demand in a large country in reaction to domestic price increases resulting from exchange rate depreciation reduces world demand and hence depresses world prices.

It is difficult to disentangle their impact on the overall elasticity.

However, since numerous factors influencing the exchange rate pass-through have been identified, their combined and sometimes opposing effects often make it difficult to pin down the main causes underlying domestic price responses to exchange rate movements. In the case of Slovakia, the small size and high degree of openness of the economy should lead to a relatively strong pass-through. On the other hand, the oligopolistic nature of some sectors, resulting from small market size combined with low number of suppliers, indicates the possibility of pricing-to-market, which is likely to cause the degree of pass-through to vary across sectors. At the same time, the relatively high exchange rate volatility should decrease the level of pass-through in Slovakia since a significant part of exchange-rate movements might be considered to be temporary. However, as the koruna has been on an appreciating trend for several consecutive years, agents should have concluded that most of the gains were not temporary in nature.

Estimates of the exchange rate pass-through for Slovakia

Available recent empirical estimates of the exchange rate pass-through to consumer price inflation in Slovakia fall in a relatively wide range between 10 and 44%. Recent studies on the exchange rate pass-through include papers by authors from the National Bank of Slovakia (see Vyskrabka (2007) and Doliak and Karmazin (2007)), the Institute of International Finance (2007), ING (see Toth and Hagara (2007)) and Merrill Lynch (see Bodys and Eterovic (2008)). The broad range of results stems from variation in the models applied, the consumer price index used, input variables, the length of available time series and in the assumed lag in the pass-through.

In the remainder of this section, we present estimates of the exchange rate pass-through in Slovakia undertaken by DG ECFIN using a variety of approaches. The use of multiple methods increases the robustness of the results and the plausibility of the pass-through range. The pass-through is estimated at the aggregate level (for core HICP, PPI and import prices). While there are several different econometric methods for estimating exchange rate pass-through in the literature, we concentrated on the two most commonly used methods: the single equation model and the VAR model.

First, in the single equation model, as in Campa and Goldberg (2002), the pass-through is measured by a regression coefficient. Three individual single equation regressions were carried out, regressing unit values for imports (UVI), producer prices (PPI) and core consumer prices on the nominal effective exchange rate (NEER) and its lagged values, seasonal dummy variables, oil prices, the output gap and the short-term interest rate. Second, the vector autoregressive model (VAR) generates the pass-through as the mean of the impulse responses of a price index to exchange rate shocks. A system of VAR equations was estimated using three price variables (UVI, PP and core), seasonal dummy variables, the nominal effective exchange rate and oil prices.

The single equation method used monthly data covering the period 2000-2007, while the VAR estimates were based on quarterly data starting in 2003. Data on unit values for imports, producer prices for industrial goods, core consumer prices (HICP excluding energy and unprocessed food) and three-month interest rates were taken from Eurostat; NEER (versus 35 trading partners) and the output gaps are calculated by the Commission services; and data on oil prices (Brent crude oil denominated in USD) are taken from Ecowin.

The exchange rate pass-through in Slovakia seems relatively high …

The two models provided similar results, in particular for the short-term pass-through (after 6-9 months), estimated at 39-40% for import prices, 13-15% for producer prices and 18-19% for core consumer inflation. In the long term, the single equation model suggested a higher pass-through than the VAR method: 42% vs. 27% for

import prices, around 20% for producer prices and 29% vs. 17% for core HICP. As can be seen from Table 1, these results are close to the results suggested by other empirical studies. The degree of pass-through declines and is more sluggish along the distribution chain. While import prices are affected immediately and to quite a strong degree, the effect on producer and consumer prices occurs more slowly and is weaker.

Table 1: Estimates of exchange rate pass-through – aggregate approach

	Import prices	**Producer prices**	**Core consumer prices (HICP, except NBS-CPI)**	**Total consumer prices (HICP)**
EC *,**	0.39 (9m)	0.13 (9m)	0.19 (9m)	
- OLS	0.42 (2y)	0.19 (2y)	0.29 (2y)	
EC *,**	0.41 (6m)	0.15 (6m)	0.18 (6m)	
- VAR	0.27 (2y)	0.20 (2y)	0.17 (2y)	
NBS *	0.16 – 1 (1y)	0.08 – 0.3 (1y)	0.1 (1y)	
– VAR	0.3 – 0.8 (2y)	0.12 - 0.5 (2y)	0.12 - 0.2 (2y)	
IIF *				
- OLS			0.26 (1y)	
- VAR			0.25 (1y)	
Merrill Lynch				
- OLS/SURE		0.69 - 0.73	0.28(3m) – 0.44(LR)	0.25 (3m) - 0.33 (LR)
- VAR		0.92 - 0.84	0.09(3m) – 0.34(2y)	0.28 (3m) – 0.44 (2y)

Notes: * EC = European Commission; NBS = National Bank of Slovakia; IIF = Institute of International Finance, **The estimates should be treated with caution in view of the small sample size.

… if estimated by econometric methods at both aggregate and disaggregate level

As an alternative to aggregate models, the pass-through is also estimated for individual HICP categories (using a simple OLS regression) and subsequently aggregated. The strongest pass-through was obtained for non-energy industrial goods (28%), which typically include a large share of imported goods. Less intuitively, the pass-through to services was also rather high (27%), which can be explained to some extent by the sensitivity of services to energy prices. As the regression did not deliver any significant results for food, we adopted a conservative assumption of a 10-percent pass-through. Within energy, the pass-through to fuels was estimated at 33% and the impact on regulated prices (37%) was calculated mechanically on the basis of information provided by the Slovak Regulatory Office for Network Industries.

By aggregating the results for individual HICP components, we obtained a short-term pass-through of 25% for headline consumer inflation. The short-term pass-through to core inflation calculated with this bottom-up approach (24%) is slightly higher than the coefficients delivered by the aggregate model (18-19%), which is consistent with a longer transmission lag. Again, as for the aggregate estimates, the results are within the range implied by the other empirical studies that use a disaggregated approach.

Table 2: Estimates of exchange rate pass-through – disaggregate approach

	Non-energy industrial goods	Services	Food	Fuels	Energy (heat, gas, electricity)	**Total inflation***
EC** (9m - 1y)	0.28	0.27	0.1	0.33	0.37	**0.25**
NBS (1y)	0.23	0 - 0.1	0.1 - 0.3	0.2 – 0.3	0..34	**0.13 – 0.2**
ING Slovakia (2y)	0.51 -0.76	0.35 – 0.58	n.a.	0.5 - 0.54	0.37	**0.29 – 0.42**
Weight (2007)	25.2%	34.1%	22.4%	3.1%	15.3%	**100%**

Notes: * Weights for the aggregation differ slightly between the studies due to the use of a different consumer price index (CPI for NBS vs. HICP for EC and ING) and a different definition of individual categories (e.g. NBS and ING use the definition of "market services" and "ex-fuel tradables"). The differences are not significant. **The estimates should be treated with caution in view of the small sample size.

What do the recent data reveal?

The pass-though estimated over a long period does not always display itself fully in the recent data

Based on the econometric estimates of the exchange rate pass-through, exchange rate appreciation in Slovakia reduced average inflation in 2007 by more than 1 percentage point. However, an examination of the actual HICP data suggests that the observed response to the strong currency appreciation in some categories of goods, which are typically imported and therefore likely to be highly sensitive to exchange rate movements (vehicles, furniture, clothing and footwear), appeared to be weaker than expected. Conversely, the products, where the influence of exchange rate developments was most visible, include fuels and some other non-energy industrial goods (in particular pharmaceutical and medical products and, to a lesser extent, house appliances, IT equipment and non-durable household goods). As a result, the impact of exchange rate appreciation on average inflation in 2007 may have been somewhat lower.

The transmission tends to be slower in case of appreciation than depreciation

There is no clear evidence of a structural change in the relationship between the exchange rate and inflation, which would explain a smaller exchange rate pass-through in the most recent period. From the perspective of the theoretical determinants of the pass-through, a lower transmission rate would be consistent with the gradually diminishing inflation rate in recent years, as well as with expectations that part of the sharp exchange rate appreciation could be reversed, also in light of the country's participation in ERM II since the end of 2005. The introduction of inflation targeting in 2004 may also have impacted on inflation expectations and thus reduced the pass-through, although in practice reaching inflation targets has not proved very successful.

Domestic demand conditions are key

Nevertheless, other factors may provide a more plausible explanation of the *prima facie* somewhat smaller impact observed in the current data. These include non-linearity of the pass-through (i.e. a lower sensitivity to large and fast exchange rate movements recorded in the last few years), downward rigidity of prices (pointing to a slower pass-through in case of exchange rate appreciation) and offsetting price pressures driven by higher pricing power of firms amid buoyant domestic demand conditions. In particular, in segments with limited competition, retailers could have used the lower import prices to increase profits rather than lower prices. Nor is it excluded that the shallow retailers' reaction to lower import prices reflects an early pre-changeover effect; retailers may have tried to establish a profit reserve for the period of "mandatory" stable prices around the changeover or to cover the cost related to the changeover.

All together, this would imply that the impact of the exchange rate appreciation on inflation could be spread over a longer period than suggested by the empirical models.

Conclusion

Our econometric estimates of the exchange rate pass-through to inflation in Slovakia put it at around 25%, which is roughly consistent with the results of other empirical analyses and with the small size and high degree of openness of the Slovak economy. There is, however, a need for caution in applying the estimated elasticities, based on historical data, to recent inflation developments. An examination of recent HICP data suggests that the actual impact of exchange rate appreciation on inflation in 2007 has probably been lowered by the relatively high volatility of exchange rate movements and the downward stickiness of prices in a context of strong domestic demand and an oligopolistic structure in some product markets. This would indicate that the recent strong appreciation of the Slovak koruna has not yet been fully passed through to prices and will continue to exert a moderating influence on Slovakia's inflation beyond the period suggested by the empirical models.

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