MĀRTIŅŠ BITĀNS

PASS-THROUGH OF EXCHANGE RATES TO DOMESTIC PRICES IN EAST EUROPEAN COUNTRIES AND THE ROLE OF ECONOMIC ENVIRONMENT

WORKING PAPER
4/2004

MĀRTIŅŠ BITĀNS

PASS-THROUGH OF EXCHANGE RATES TO DOMESTIC PRICES IN EAST EUROPEAN COUNTRIES AND THE ROLE OF ECONOMIC ENVIRONMENT

RIGA 2005

ABSTRACT

The paper examines the exchange rate pass-through in a set of 13 East European countries during the period of 1993–2003. The pass-through estimates are derived from a recursive VAR model in first differences, and the impact of exchange rate changes on both producer and consumer prices is studied. The estimates obtained for two sub-sample periods generally show an incomplete pass-through over a two-year horizon. In addition, the results imply a considerable cross-country variation and suggest that a significant decline (by nearly 50%) in the pass-through is possible over time. In particular, it is found that the exchange rate pass-through in East European countries is positively and statistically significantly related to the average inflation rate and degree of exchange rate persistence. Moreover, the results confirm the existence of a strong relationship between the pass-through and changes in the import structure. Finally, there is some limited evidence that the magnitude of exchange rate pass-through might be positively related to the degree of country's openness to foreign trade.

Key words: *pass-through of exchange rate, recursive VAR model, Exchange Rate Mechanism II*

JEL classification codes: *C32, E31, E52*

The paper was initiated during the author's stay at the European Central Bank, as part of the Research Visitors Programme in 2003. The author would like to thank the participants of the European Central Bank research seminar for their helpful comments and suggestions.

ISBN 9984–676–17–X

CONTENTS

INTRODUCTION

Soon after the EU accession, the new Member States are facing new challenges stemming from the next step of economic integration, namely monetary integration and the eventual adoption of the euro. Being granted the status of a Member State with derogation, all the ten countries are expected to participate in the monetary union and adopt the common European currency at some stage. Prior to that, however, a sufficient degree of real and nominal convergence with the existing EU Member States must be achieved, with the latter being specified by the Treaty as the ability of a new Member State to comply with the convergence criteria and assessed on the basis of inflation, exchange rate and interest rate dynamics as well as the level of country's fiscal deficit and debt. In addition, although no explicit criteria are laid down in the Treaty, real convergence is likely to be assessed on the basis of structural and cyclical developments in the economies of the new Member States.

So far, the focus has been dominantly on the assessment of the accession countries' ability to achieve a sufficient degree of nominal convergence with the existing EU members, partly because of the existence of clearly defined criteria against which the economic performance of the accession countries can be measured. This paper partly follows suit. As a starting point, it will take the common notion that the achievement of full compliance with the convergence criteria will not be an easy task for acceding countries. Some of the countries are likely to need significant time periods to achieve a considerable convergence with the requirements of the Economic and Monetary Union.

It is often argued that the requirement of sound fiscal positions in the new Member States would be a serious obstacle to participation in the euro area, as several of them have considerable fiscal deficits that are of structural nature and, in addition, are exposed to pressure on government expenditures arising from the EU membership. Yet, equally strong concerns may be raised in the light of inflationary developments in the new Member States after the EU accession. In particular, the need for compliance with convergence criteria would require the achievement of low and sustainable inflation rates at the time when the new Member States are likely to be exposed to various inflationary pressures stemming from both the demand side (e.g. as a result of lower interest rates) and the supply side (e.g. inter-sectoral productivity differentials that could potentially lead to higher inflation in the non-tradables sector). In addition, the effectiveness of the central banks' interest rate policy in coping with these inflationary developments would be significantly limited by the need to comply with the interest rate convergence criteria.

In these circumstances, the exchange rate is expected to play a dual role. On the one hand, the exchange rate is one of the most important economic variables that affect the real economy in the new EU Member States. On the other hand, it is expected that the exchange rate may also become a significant monetary policy instrument that can be used to facilitate nominal and real convergence.

In particular, the design of the exchange rate regime that precedes the adoption of the euro, namely the ERM II, where all new EU Member States are expected to participate for a minimum of two years, puts a strong emphasis on the exchange rate as a monetary policy instrument. Key features of the ERM II include, among others, a central parity rate against the euro and standard fluctuation bands of ±15% around the central rate.[1] Generally, the fluctuation bands are rather wide and leave a sufficient room for exchange rate appreciation, thus, in principle, allowing central banks in the new EU countries to offset or at least to reduce potential inflationary pressures that may arise after the EU accession. Moreover, subject to the mutual agreement, also the central parity against the euro can be adjusted at any time during the participation in the ERM II, thus giving central banks in the acceding countries an additional tool to facilitate nominal and real convergence.

The effectiveness of the new Member States' exchange rate policies within the ERM II framework, however, largely depends on the relationship between exchange rate changes and inflation. For the exchange rate to be an effective tool that can be used to control inflation, changes in the nominal exchange rate have to be transmitted into domestic prices relatively fast, and the relationship between the two must be strong. In other words, there must be a strong exchange rate pass-through to domestic prices. A strong pass-through also implies less concern about the central parity rate at which the country enters the ERM II, as the deviations of the nominal exchange rate from the theoretical "equilibrium" level would have little impact on the real exchange rate in this case. On the other hand, if the exchange rate pass-through in these countries is low, the exchange rate policy is not likely to be effective in terms of enhancing nominal convergence, as exchange rate changes would have little effect on domestic inflation. In this case, a limited price adjustment to exchange rate movements would imply that shocks to the nominal exchange rate would have a significant impact on the real exchange rate and hence also the real economy. Consequently, the level at which the new EU countries enter the ERM II becomes an important policy variable. Thus, different degrees of exchange rate pass-through under different circumstances would require different policy responses from these countries as they approach the ERM II.

Against this background, it is interesting to investigate whether the degree of pass-through is related to the macroeconomic environment facing a country, or whether changes in pass-through can be associated with shifts in policy regimes. This would allow deriving important implications for the new EU Member States' policy challenges in the future. In this regard, countries in Central and East Europe provide rich evidence on various economic environments and policy regimes over the last ten-year period. First, the majority of countries in the region switched from a high inflation environment at the beginning of the 1990s to low and moderate inflation rates at the end of the decade. Cyprus and Malta did not go through these regime shifts, while in Romania

[1] Resolution of the European Council on the establishment of an exchange rate mechanism in the third stage of Economic and Monetary Union, Amsterdam 16 June 1997.

inflation rates remained rather high also in the new millennium. Second, several countries have gone through shifts of exchange rate regimes, with some (the Czech Republic, Poland) moving away from rigid exchange rate pegs towards a more flexible regime, others (Bulgaria) moving in the opposite direction, and still others (the Baltic countries) maintaining the exchange rate regime unchanged throughout the period.(5)

The rest of the paper is organised as follows. Chapter 1 reviews various models that try to explain possible causes of incomplete exchange rate pass-through. Chapter 2 presents an overview of the main empirical studies on the pass-through in individual countries and also some cross-country studies that investigate the links between the degree of pass-through and various macroeconomic variables. Chapter 3 presents estimates of pass-through for a number of Central and East European countries and addresses factors that account for different degrees of pass-through both across countries and over different time periods. The final chapter presents main conclusions.

1. MODELS OF EXCHANGE RATE PASS-THROUGH

The starting point for all models of exchange rate determination is the concept of purchasing power parity that has been actively used in macroeconomic analysis since the 1920s. It argues that in the presence of free movement of goods and perfect competition in international goods markets, the law of one price holds for all major traded goods, and hence their price, expressed in the common currency, should be the same across countries.(23) A less strict version of this concept postulates that the change of the nominal exchange rate between two countries must be equal to the difference in inflation rates. However, in both cases the purchasing power parity concept assumes a close relationship between changes in domestic prices and the exchange rate (although it does not explicitly deal with issues related to potential endogeneity of the right-hand side variables).(43, 28) Assuming the exchange rate as an exogenous variable as would be the case under the fixed exchange rate regime, the purchasing power parity doctrine then implies a complete exchange rate pass-through to domestic prices.

The concept of the purchasing power parity, however, has been increasingly criticised in the economic literature as a very imprecise model of exchange rate behaviour. It was initially designed to study long-term exchange rate determination. However, the main weakness of the purchasing power parity concept appears to be the lack of explanatory power due to a relatively weak link between changes in the exchange rate and domestic price developments, which seems to be quite weak also in the long run as evidenced by large half-life estimates of deviations from purchasing power parity levels.(30) Indeed, deviations from the purchasing power parity have been so large and the adjustment from these deviations so slow that this weak link between exchange rate and price developments is commonly referred to as the purchasing power parity puzzle.(55) The weak link between exchange rate and relative price developments is also highlighted by the low sensibility of major macroeconomic variables with respect to nominal exchange rate volatility.(7)

Given the failure of the purchasing power parity concept to explain the relationship between the exchange rate changes and the domestic price behaviour, several alternative models have been developed that relax some of the assumptions imposed on the original purchasing power parity model.

Thus, for instance, the new Keynesian view explains incomplete adjustment in terms of price and wage stickiness that may arise either due to staggered price adjustment as a result of multiperiod contracts or commitments (as in S. Fischer (27), E. S. Phelps and J. B. Taylor (54), J. B. Taylor (58, 59)), or due to menu costs (as in N. G. Mankiw (46)). According to this approach, nominal frictions that are small at the microeconomic level can, nevertheless, have significant macroeconomic implications.(56) As the importance of menu costs is likely to decline in high inflation environments, this approach implies a positive relationship between inflation and the pass-through.

Other authors have focused on the implications of relaxing the perfect competition assumption. Thus, for instance, R. Dornbusch and J. Menon review various models with a fixed number of firms in the industry and hence an oligopolistic competition.(23, 48) According to these models, the exchange rate pass-through depends on the pricing decisions of firms. As a result, the exchange rate pass-through is related to the degree of substitutability between the domestic and imported goods and the country's market structure (the number of firms in the industry, as well as the ratio of domestic to foreign firms).

P. Krugman relates incomplete pass-through from exchange rates to prices to the degree of "pricing to market" behaviour whereby the exporting firms may set their prices in the importing country's currency and, therefore, adjust profit margins rather than sales as a result of exchange rate changes.(42) P. Krugman argues that the pricing to market behaviour is more common when there are substantial firm-specific costs of entering the market. As this is more likely to be true for complex and very differentiated products, the pricing to market behaviour may explain the low pass-through observed in the machinery and transport equipment sector. K. A. Froot and P. D. Klemperer extend this analysis by considering firms whose future demand depends on their current market share.(29) In their model, the price setting behaviour will differ according to the expected persistence of exchange rate changes. Temporary exchange rate changes do not have a long-lasting impact on the market share, so exporting firms will allow higher profit margins. On the other hand, permanent exchange rate changes would call for price adjustments to retain the market share. As a result, the degree of pass-through depends positively on the expected persistence of exchange rate changes.

Another explanation for incomplete pass-through is provided by M. Obstfeld and K. Rogoff who argue that the assumption of free movements of goods does not hold in the light of limited arbitrage possibilities at the consumer price level, so the introduction of transport costs helps to explain the sluggish adjustment of consumer prices in the event of exchange rate changes.(53) This argument implies that the exchange rate pass-through is diminishing along the product distribution chain. And indeed, the surveys of empirical studies on the exchange rate pass-through have shown that, although still incomplete, the pass-through of exchange rates to import prices is generally larger than the pass-through to producer or consumer prices.(33) A. T. Bursteins, J. C. Neves and S. Rebelo expand the analysis by adding other distribution costs (such as wholesaling and retailing) to the transport costs and argue that these distribution costs account for a large share of the total retail price of any commodity – their estimate is 40% for the US and 60% for Argentina.(10) Thus, large distribution costs may imply low exchange rate pass-throughs even for goods that are internationally tradable.

Finally, there are authors who use the new open economy macroeconomic model framework that includes imperfect competition and staggered price adjustment, and differentiated goods markets (52, 51) and pricing-to-market behaviour (17, 18) to

analyse the exchange rate pass-through under different circumstances. Thus, for instance, J. B. Taylor uses the model of staggered price adjustment to demonstrate that the price setting behaviour of firms depends on the expected change in costs, the change in prices set by other firms and the change in total demand.(60) In this framework, the degree of pass-through depends on expectations: the less any cost changes or changes of other firms' prices are perceived to be permanent, the less any given firm is inclined to change its own price. Given the high correlation between the average inflation rate and inflation persistence, J. B. Taylor argues that the pass-through is likely to be smaller in a low inflation environment.

P. Bacchetta and E. van Wincoop consider the framework of monopolistic competition where import goods are used as intermediate goods that are combined with domestic goods to produce a final commodity that competes in the domestic market with other goods, including non-tradables.(6) In this framework, P. Bacchetta and E. van Wincoop show that the degree of pricing to market depends on the size of the non-tradable goods sector. If the latter is sufficiently large, a likely equilibrium is the one where exporters set prices in their own currency (implying a full pass-through to import prices), while producers of final goods set prices in the local currency, if the elasticity of substitution between tradable and non-tradable goods is high. Thus, a large sector of non-tradables in this model implies a low exchange rate pass-through to consumer prices.

In a similar manner, M. B. Devereux, C. Engel and P. E. Storgaard consider the endogenous exchange rate pass-through and argue that there is a two-way link between the degree of exchange rate pass-through and the exchange rate volatility: a low exchange rate pass-through leads to a high exchange rate volatility, while an increasing exchange rate volatility stimulates the producer currency pricing (PCP), thus increasing the pass-through.(20) The results of their model imply that a successful monetary policy is associated with a lower exchange rate pass-through.

2. EMPIRICAL STUDIES ON PASS-THROUGH

Propositions stemming from theoretical models of the exchange rate pass-through have been extensively tested empirically using a wide range of estimation techniques. Not surprisingly, the results have been sensitive to the different estimation methods, the estimated sample periods and the set of countries that are included in the analysis.

Initial studies focused on the exchange rate pass-through across different industries and within a single country by using a single equation estimation technique. The studies generally show an incomplete pass-through, with exchange rate movements having a larger impact on import prices than producer prices, and the pass-through across different industries depending positively on the degree of product differentiation.(62, 26, 63, 48)

The findings of these studies, however, have largely ignored the time series properties of data, and, therefore, suffer from misspecification problems and biased estimates. Therefore, more recent studies use the cointegration analysis and error correction models to provide statistically more robust estimates. K. H. Kim uses the cointegration analysis and estimates that the long run pass-through coefficient for US producer prices is around 24%.(41) G. Kenny and D. McGettigan use the Johansen cointegration technique and find a strong evidence of a close to full pass-through to Irish import prices in the long run.(40) T. Hampton uses an error correction framework and finds that the long run pass-through of import prices to consumer prices in New Zealand is around 14%.(37)

Similar estimation techniques have been applied to study the exchange rate pass-through in the euro area. B. Anderton uses the error correction framework and reports long-term exchange rate pass-through estimates to import prices ranging from 50%-70%.(4) E. Hahn studies the effects of external shocks on producer and consumer prices in the euro area in an unrestricted VAR framework and finds that the pass-through to producer prices reaches 10% after one quarter and 28% after three quarters.(36) The pass-through estimates for consumer prices are 2.5% and 8%, respectively.

Regarding developing countries, C. J. García and J. E. Restrepo use the error correction framework to estimate the exchange rate pass-through in Chile.(32) Depending on the cyclical position of the economy, the long-term pass-through to net consumer prices is estimated between 13% and 33%. Finally, A. Belaisch estimates the pass-through to consumer prices in Brazil and finds it at 6% after three months, 17% after twelve months and 23% in the long run.(8)

Many authors have also conducted a cross-country analysis in order to study factors that account for different degrees of pass-through across countries and over time. J. McCarthy uses the VAR model that incorporates a distribution chain of pricing in

order to estimate the exchange rate pass-through in nine developed countries during 1976–1998.(47) He finds that the pass-through is significantly and positively correlated with the exchange rate and GDP volatility and is stronger in countries with larger import shares. The pass-through also declines along the distribution chain. In addition, the results imply some weakening of the pass-through effect, at least for some countries.

I. Goldfajn and S. R. C. Werlang estimate the pass-through in a large sample of countries (both developed and developing) during the period of 1980–1998.(34) Their panel estimates indicate an average pass-through of 17% after three months, 42% after six months and 73% after twelve months. However, the effect of pass-through is found to be different across regions, with countries in Europe generally exhibiting a lower degree of pass-through than other countries. Moreover, the degree of pass-through, according to this study, is affected by the country's inflation rate, degree of openness, real exchange rate appreciation and GDP gap.

E. U. Choudhri and D. S. Hakura use a similar set of countries and a similar estimation period.(13) They classify all countries into three groups (low, moderate and high inflation) and find a significant and positive relationship between the inflation rate and the pass-through. The average estimated pass-through to consumer prices after four quarters is 14% in low inflation countries, 33% in moderate inflation countries, and 50% in high inflation countries. Also, for countries with several inflation regimes, it is found that the pass-through has been higher during high inflation periods than during the periods with moderate or low inflation. Cross-country regression estimates imply that a 10% increase in the average inflation rate would increase the pass-through by 5 to 6 percentage points.

F. P. Hüfner and M. Schröder estimate vector error correction models for five EU countries.(39) Their estimated coefficients of the pass through to consumer prices after twelve months range from 7% in France to 12% in the Netherlands. According to the authors, differences in import shares explain the variance in the pass-through.

J. E. Gagnon and J. Ihrig consider 20 industrial countries and report a decline in the pass-through for most countries in the sample.(31) They find that both the cross-country and intertemporal differences in pass-through within a country over different sample periods are explained by the standard deviation and the mean of the exchange rate, thus highlighting the importance of monetary policy.

Finally, J. M. Campa and L. S. Goldberg study the effect of pass-through to import prices in OECD countries.(11) Their average unweighted short-term pass-through coefficient is 61%, while the long term coefficient is 77%. Some evidence of a declining pass-through over time is presented, although the decline is not always statistically significant. Performing the panel regression, they find that macroeconomic factors (such as inflation rate) account for only a small part of the total observed variation of pass-through. Instead, since the estimates of pass-through across different industry

groups are more stable than the total estimated pass-through, the authors argue that changes in pass-through are the result of a changing import structure. In particular, declining pass-through estimates are the result of a declining share of energy and raw materials in total imports. Yet, when analysing the pass-through to import prices for 12 EMU member countries, J. M. Campa and J. M. González Mínguez find that, although the pass-through effect varies substantially across different industries, at least in the short run, a cross-country variation in the estimated pass-through is related to various degrees of openness of countries rather than their different import structures.(12)

Compared to the OECD countries, there is only a limited number of empirical pass-through studies in East European countries, and often these studies consider individual countries or narrow country groups, thus not allowing for systematic cross-country comparison. In addition, just as in the case with industrial countries, the degree of pass-through depends considerably on the applied estimation techniques.

Thus, L. Kuijs constructs a framework where long-run relationships are estimated separately and included as error correction terms in a vector autoregression (VAR) model.(44) This framework is used to study inflation dynamics in Slovakia during the period of 1993–2000. He finds that the short-term pass-through reaches 40% but then declines gradually as the exchange rate appreciates. Using a first difference VAR model for the period of 1997–2002, N. Gueorguiev estimates the maximum pass-through to market-determined consumer prices in Romania at around 30%–40% (depending on the choice of the exchange rate), with most of the impact taking place within 12 months.(35) A. Billmeier and L. Bonato use a similar framework to estimate the pass-through for Croatia during the period of 1994–2001 but do not find a significant link between the exchange rate and domestic price changes.(9) The pass-through coefficient obtained using a cointegration approach suggests that roughly 33% of exchange rate changes are transmitted to domestic prices in the long run.

Turning to the cross-country analysis, D. Mihaljek and M. Klau estimate the exchange rate pass-through in several emerging market economies, including Poland, Hungary and the Czech Republic, using a single equation estimation technique.(49) They find that the exchange rate pass-through varies from 6% in the Czech Republic to 45% in Poland and 54% in Hungary. This study, however, does not consider possible endogeneity of the right-hand variables and, in addition, estimates the pass-through over a sample period that includes different exchange rate regimes and different inflationary environments.

Z. Darvas models exchange rate and price dynamics for four Central European countries (Hungary, the Czech Republic, Poland and Slovenia) in a time varying parameters framework to account for regime shifts that have been observed in these countries during the 1990s.(16) His results point to the estimates of the long run pass-through ranging from 15% for the Czech Republic and 20% for Poland to 40% in

Hungary and Slovenia. The estimates of the short-term pass-through, however, are much lower and range from 0% to 10%. Due to the small country sample, the author has not been able to perform a cross-country analysis, and his conclusion that the degree of pass-through is positively related to the average inflation rate is highly tentative.

F. Coricelli, et. al. use the cointegrated vector autoregressive model to estimate the long-term pass-through for the four Central European countries mentioned above.(15) They report a full long-term pass-through from exchange rate to domestic prices for Slovenia and Hungary, around an 80% pass-through for Poland, and a 50% for the Czech Republic. While the cointegration analysis assumes stable long-term relationships between the variables that, in the face of regime shifts, may not be a fully appropriate assumption, the estimates of long-term exchange rate pass-through are also less relevant in terms of providing the information for economic policy decisions due to the sluggish adjustment process.

3. PASS-THROUGH IN EAST EUROPEAN COUNTRIES

In the first part of this chapter, the estimates of exchange rate pass-through are derived from a recursive VAR model. In the second part, the obtained pass-through estimates will be compared across countries and across sub-sample periods to investigate whether the degree of exchange rate pass-through is related to changing macroeconomic environment in East European countries during the last ten years.

3.1 Pass-Through Estimates

Different techniques used in the studies described above do not allow a comprehensive cross-country comparison due to the non-robustness of the results with respect to different estimation techniques. Therefore, in this study the exchange rate pass-through is estimated for a set of 13 countries in Central and East Europe, including nine countries that joined the European Union in 2004[1], in an integrated framework, thus making the results more directly comparable across the countries and different time periods. Specifically, the pass-through estimates for these countries are obtained applying a recursive VAR model with similar sets of endogenous variables for each country. The VAR framework is preferred to the single equation estimation technique because it allows for a simultaneous determination of the exchange rate and prices and hence eliminates possible problems related to endogeneity of explanatory variables. In addition, the VAR framework provides a convenient way to derive the impact of the exchange rate on prices through impulse response functions. The disadvantage of this method is that the relatively short sample periods analysed here tend to reduce its effectiveness. Moreover, impulse response parameters are rather imprecisely measured for the long forecasting horizons. Nevertheless, the VAR model still seems to be the most appropriate estimation framework for the particular exercise.

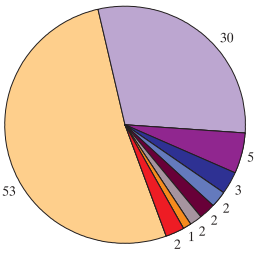
The vector of endogenous variables consists of the following macroeconomic time series. First, it includes both the consumer and the producer price indices.[2] By including producer and consumer prices, the VAR model incorporates some features of a distribution chain pricing framework design by J. McCarthy.(47) Thus in this setting, exchange rate shocks affect consumer prices both directly and indirectly through the changing producer prices. However, due to poor data availability, import prices are not included in the model. The analysis thus implicitly assumes a full exchange rate pass-through to import prices. The assumption is based on the observation that the currency structure of foreign trade in East European countries generally captures little of the local currency pricing, as the bulk of foreign trade is invoiced in foreign currencies (the currency structure of imports in Latvia is given in Chart 1 as an example). This absence of local currency pricing would tend to imply a rather high pass-

[1] The country sample includes Cyprus but excludes Malta for data availability reasons. Along with the new EU states, the country set includes Croatia, Macedonia (FYR), Bulgaria and Romania.
[2] For Cyprus, Romania and Croatia, a wholesale price index is used instead of the producer price index.

through to import prices. Unfortunately, the (limited) empirical evidence on the import price pass-through in small open economies so far has failed to provide a clear-cut answer to this issue.[1]

Chart 1

CURRENCY STRUCTURE OF GOODS IMPORTS IN LATVIA
(2002; %)

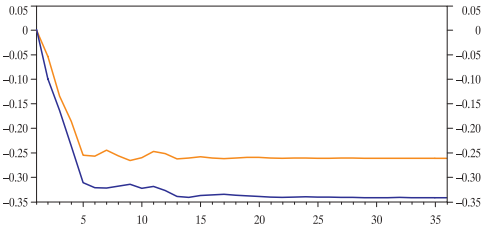


Source: Central Statistical Bureau of Latvia.

Consumer prices are expressed in the CPI terms for all countries. However, a specific feature for most countries in Central and East Europe is that a significant share of prices that are included in the consumer basket are not determined by the market forces but rather set administratively by the government. To the extent that decisions about changes in these prices are often made independently of currency movements, they should be excluded from the analysis. As not all countries explicitly calculate a price index that excludes these administratively regulated prices, it was impossible to calculate a price index that would include only the prices that are determined by market forces. The use of CPI thus introduces a downward bias in the pass-through estimates (as Chart 2 illustrates, in the case of Latvia using CPI instead of a market-based price index lowers the estimated pass-through by about 10 percentage points).

Chart 2

ACCUMULATED RESPONSE OF CONSUMER PRICES TO 1% INCREASE OF NOMINAL EFFECTIVE EXCHANGE RATE IN LATVIA
(estimation period 01.01.1998–01.06.2003; in percentage points; months)



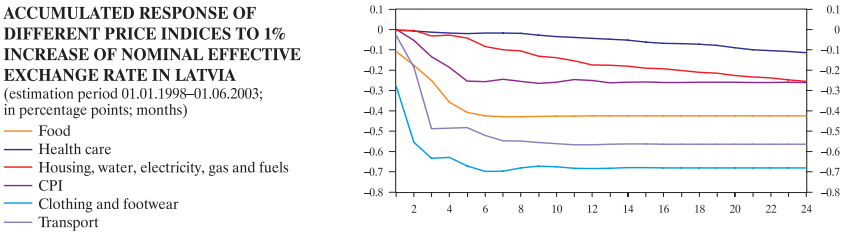
In addition, cross-country differences of the estimated pass-through might be caused by different structures of the CPI basket. As shown in Chart 3 using Latvia as an

[1] J. M. Campa and L. S. Goldberg in their study are able to reject the hypothesis that the long run pass-through is significantly different from one at conventional significance levels for Czech Republic and Poland, but not for Hungary.(11) Also, J. Lee (1997) demonstrates that exchange rate fluctuations are not fully passed through into import prices in Korea, even though Korea is a small and open economy.(45)

example, the response to exchange rate changes generally varies across different product groups, with both the size and the speed of adjustment related to the degree of international tradability of the specific product group. The implicit assumption in the following cross-country analysis is that the structure of the CPI basket is generally similar across countries, but this does not necessarily hold in practice.

Chart 3

ACCUMULATED RESPONSE OF DIFFERENT PRICE INDICES TO 1% INCREASE OF NOMINAL EFFECTIVE EXCHANGE RATE IN LATVIA
(estimation period 01.01.1998–01.06.2003; in percentage points; months)



The next variable that enters the VAR model is the nominal effective exchange rate. Even though some countries have opted for a fixed exchange rate regime thus limiting nominal exchange rate movements, there is still a considerable degree of variation in the effective nominal exchange rate that allows the exchange rate pass-through estimation even for these countries. Using the effective rate that is based on the country rather than currency shares could, however, introduce a bias. In particular, for countries with closer than average trade relations with other emerging and transition economies, the calculated effective nominal exchange rate is presumably more volatile than the underlying exchange rate relevant for pass-through calculations. Thus, for countries whose import share from Russia is relatively high, the trade weighted nominal effective exchange rate will be more volatile due to strong fluctuations of their exchange rate against the Russian currency. However, to the extent that trade with Russia and other CIS countries is invoiced predominantly in other currencies (mainly the US dollar), these fluctuations would not affect the pricing decisions of firms. Thus, the weighted effective exchange rate of a respective import currency would be more relevant. Unfortunately, apart from the Baltic countries, data limitations prevented the calculation of the currency-weighted exchange rate. As a result, for all other countries, the estimated degree of pass-through again may be biased downwards.

As additional variables, the VAR model includes the measure of the output gap that accounts for possible demand side shocks to inflation[1], and interest rates to account for a possible impact of monetary policy. In addition, the model includes a measure of the broad monetary aggregate. The inclusion of money in the model was necessary to account for the fact that in several East European countries up to the mid-1990s,

[1] The output gap is calculated by applying the Hodrick-Prescott filter to a seasonally adjusted three months moving average index of industrial production.

inflation/hyperinflation was caused by a rapid monetary expansion, so that the close link between the growth of money and inflation was observed not only in the long but also in the short run. Finally, instead of oil prices that are commonly used in the literature, the model includes the Harmonised Index of Consumer Prices (HICP) for the euro area as an exogenous variable that accounts for various supply side shocks.

The model is based on monthly observations during the sample period of January 1993–June 2003.[1] The whole sample period for each country, however, is broken into two sub-sample periods in order to assess changes in pass-through in each country over time. In addition, the estimation over various time periods is motivated by the fact that during the last ten years, most of East European countries have experienced changes in either the inflation rate, the exchange rate regime, or, indeed, both.

Thus, for countries where the fixed or managed exchange rate regime was replaced by the direct inflation targeting regime, or the floating exchange rate regime was replaced by fixed or managed exchange rates, the date of the introduction of the new regime serves as a breaking point. For countries that during the whole sample period did not experience formal exchange rate regime shifts, the estimates of pass-through are obtained for two periods of broadly equal length, with the first period stretching from 1993 to 1997, and the second lasting from 1998 to mid-2003. These sub-samples are also broadly in line with an observed pattern of transition from high/moderate inflation rates to the environment of moderate/low inflation rates for most of the sample countries. Hence, the estimation of pass-through over these two periods would allow comparing the degree of pass-through in East European countries under different inflationary environments.

Prior to the estimation stage, the time series properties of the variables were assessed using the Augmented Dickey–Fuller (ADF) unit root tests. The results of these tests are given in Table 1[2] (see Appendix). The unit root tests generally indicate a maximum of one integration order for most variables in most countries. The hypothesis of the variable being I(1) is rejected for the CPI in the case of Hungary, and for the monetary aggregate in the case of Hungary, Bulgaria and the Slovak Republic; in all cases the variables refer to the first sub-sample period. Moreover, for 8 out of 13 sample countries the ADF tests could not convincingly reject the hypothesis that the nominal interest rate is a stationary variable in the second sub-sample period. However, to facilitate the comparison across countries and different time periods, all variables (except the output gap) will be treated as being I(1) over the whole sample period in the following analysis.[3]

[1] For Latvia, Lithuania, Croatia and Macedonia (FYR) the sample period starts from January 1994.

[2] The output gap variable is stationary given the way it is constructed, and is therefore not included in the stationarity analysis.

[3] The estimation exercise with different assumptions about the degree of integration for the interest rate variable showed little variation in the estimates of exchange rate pass-through. E. Hahn reports similar results.(36) In addition, the low power of the unit root tests in samples with relatively short time series must be noted, hence making this estimation strategy plausible.

The results of the unit root tests imply that the VAR model must be estimated in first differences of the I(1) variables. In addition, the results may indicate the existence of one or several cointegration vectors that capture long-term relationships between the nonstationary variables. The Johansen cointegration tests indeed tend to confirm the existence of several cointegration vectors for many sample countries. Nevertheless, the model is still estimated in an unrestricted first difference VAR framework. First, the time period analysed here is still relatively short and certainly too short to argue that stable long-term relationships existed in all East European countries, especially considering their status of transition economies. Second, the slow speed of adjustment to the long-term equilibrium values grants those long-term relationships only limited value from the policy maker's perspective. For the purpose of this study, however, the response of domestic prices to the exchange rate over relatively short time horizons is of most relevance, hence the estimation of the VAR in first differences seems to be appropriate.

Against this background, the model incorporates the following vector of endogenous variables for the country j: $X_t^j = (\Delta neer_t^j, \Delta m_t^j, \Delta i_t^j, gap_t^j, \Delta ppi_t^j, \Delta cpi_t^j)'$, where *neer* is the nominal effective exchange rate, *m* is the broad monetary aggregate, *i* denotes the money market interest rate (usually measured as a 3 month interbank rate), *gap* is the measure of the output gap, *ppi* denotes the producer price index, *cpi* stands for the consumer price index, and Δ is a first difference operator. In addition, the model includes an exogenous foreign price variable that is common to all countries, Δpf_t . All variables, except interest rates, are transferred into natural logarithms.

The Cholesky decomposition method is applied to identify the structural shocks in the model. For the first sub-sample period, the ordering of variables for most of the countries that had a strictly managed exchange rate regime was chosen as described above. This ordering implies a contemporaneous impact of nominal exchange rate shocks on all other variables, with no contemporaneous impact from other shocks to the nominal exchange rate. A similar ordering of variables is used for the countries that maintained their fixed exchange rate regimes or adopted fixed exchange rates in the second period (e.g. Bulgaria). However, for the countries that either had a flexible exchange rate regime over both sample periods or replaced the exchange rate targeting with direct inflation targeting, the nominal exchange rate variable was moved between the output gap and the producer price index variables in order to account for the independent monetary policy and the possibility of contemporaneous impact of real and nominal shocks on the exchange rate. Generally, different ordering schemes did not change the results in any meaningful way, so the estimated degree of pass-through is rather robust with respect to assumptions about the nature of structural shocks under the chosen decomposition method.

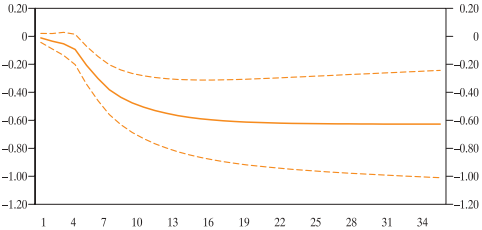
The estimates of exchange rate pass-through obtained from the above-described model are given in Table 2 (see Appendix). These estimates are derived as standardised (accumulated) responses of producer price and consumer price inflation as a result of

a 1% shock to the nominal exchange rate over a two-year (24 months) period. Additionally, Chart 4 presents the Latvian sample of pass-trough estimates together with Monte Carlo standard errors with 1 000 repetitions for both the full sample and the last sub-sample. As is seen from the Chart, standard errors surrounding the estimates are typically rather large, thus complicating the derivation of precise pass-through estimates.

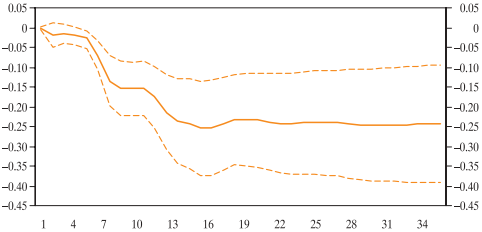
Chart 4

ACCUMULATED RESPONSE OF CPI INFLATION TO CHOLESKY NOMINAL EFFECTIVE EXCHANGE RATE DEVIATION: THE CASE OF LATVIA
(in percentage points; months)

Period: 1993–2003



Period: 1998–2003



Theoretically, these estimates should fall in the range from 0 to 1. In practice, for some countries in the first sub-sample period the estimated pass-through exceeds 1, thus suggesting that the estimates obtained from the VAR model are possibly rather imprecise. They could, however, also describe the overshooting behaviour of price setters in the event of anticipated cost shocks, given that most cases when the degree of the estimated pass-through exceeds 1 occur in the first sub-sample period for the countries with relatively high inflation rates at that time.

Several observations can be made on the basis of the results given in Table 2 (see Appendix). First, the estimated degree of exchange rate pass-through varies considerably across countries. Thus, the estimated pass-through to consumer prices one year after the exchange rate shock ranges from 14% in the Czech Republic to over 60% in Cyprus (i.e. the estimates for the most recent period). However, the estimates still indicate an incomplete pass-through to both producer and consumer prices.

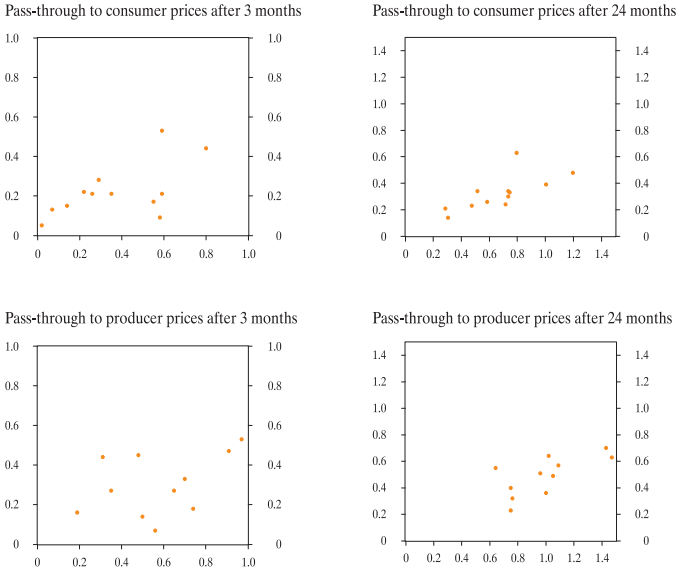
Second, the degree of pass-through to producer prices is constantly higher than the pass-through to consumer prices. Hence, the estimates are in line with the observation

that transport and distribution costs may significantly affect the final price of many consumer goods sold in East European countries.

Third, the estimated pass-through appears to have been declining in most countries over time in terms of both the producer and consumer prices, and in many cases the decline in pass-through seems to be significant. Thus, during the first sub-sample period, the exchange rate shocks were on average fully transmitted to producer prices over a twelve months period, whereas during the second sub-sample period only around 50% of the exchange rate changes were transferred to producer prices. Similarly, the pass-through to consumer prices over a twelve-month horizon has declined from an average of 62% to an average of 31%. In both cases, the results imply a decline in pass-through by about a half. As illustrated in Chart 5, the estimated decline of the exchange rate pass-through to both consumer and producer prices has been rather robust with respect to different time horizons, but it is particularly strong for the estimated long term pass-through.

Chart 5

EXCHANGE RATE PASS-THROUGH OVER VARIOUS SUB-SAMPLE PERIODS
(period 1/period 2)



Fourth, even though the degree of pass-through has declined in all East European countries, these estimates are generally higher than the ones obtained for industrial countries using similar methodology (e.g. E. Hahn, J. McCarthy (36, 47)). This may

be due to the fact that countries in East Europe generally tend to be more open to international trade than advanced industrial countries.

Fifth, the higher degree of openness of East European countries and the widespread use of short-term contracts in international transactions may also explain why the response of prices to exchange rate changes is on average more rapid than in the case of the industrial countries. For East European countries considered in this study, over 50% of the estimated long-term response occurs during the first three months after the exchange rate shock, and most of the response is passed-through over a six months period.

Finally, countries with rigid exchange rate regimes (e.g. the Baltic States) appear to have a somewhat higher exchange rate pass-through than countries with at least some exchange rate flexibility (e.g. the Czech Republic, Hungary). This, however, does not necessarily imply that higher exchange rate flexibility should lead to a lower exchange rate pass-through, since, as is seen from Table 2 (see Appendix), for the latter group of countries the estimated degree of pass-through was rather low also during the period of fixed exchange rates. Moreover, the pass-through appears to have declined also for countries like Bulgaria that switched from a flexible to a fixed exchange rate regime.

To sum up, the general overview of pass-through developments in East European countries during 1993–2003 shows a consistent and significant decline in the pass-through over a broad range of time horizons and different price indices. The observed decline in conjunction with a considerable cross-country variation forms the basis for the next investigation stage where the observed pass-through behaviour is related to various macroeconomic factors emphasised by the economic theory.

3.2 Pass-Through Determinants

As discussed in Chapter 2, various theories developed in the economic literature up to date offer several complementary factors that might help to explain the observed behaviour of the exchange rate pass-through in industrial countries. Some of them, like inflation rate and inflation persistence (J. B. Taylor (60), exchange rate flexibility (K. A. Froot and P. D. Klemperer (29), M. B. Devereux and C. Engel (20), or the existence of trade costs (M. Obstfeld and K. Rogoff (53), A. T. Burstein, et. al.(10)) are macroeconomic factors. Others, like menu costs (N. G. Mankiw (46)), market structure, the degree of substitutability between foreign and domestic goods (R. Dornbusch (23), J. Menon (48)), the size of the non-tradables sector (P. Bacchetta and E. van Wincoop (6)), or the structure of imports (P. Krugman (42), J. M. Campa and L. S. Goldberg (11)) are based on microeconomic foundations. In this chapter, a cross-country comparison will hopefully provide an answer whether those factors are also relevant for East European countries.

To this end, the estimated pass-through elasticities are regressed against the average values of various economic variables during the two sub-sample periods. Thus, the regression will capture cross-country differences and within-country changes of pass-through over time. The following set of variables is considered for the analysis.

Variables of the average inflation rate and inflation rate persistence (obtained from the autoregression on inflation) capture different aspects of relationship between inflation and the pass-through. According to theory, the pass-through is positively related to the former and negatively related to the latter. Similarly, a positive relationship between the exchange rate persistence and the pass-through is expected. The degree of openness is measured as the ratio of imports to GDP. The positive link between the degree of openness and the pass-through follows from the trivial assumption that a more extensive volume of imports implies a larger group of goods that are affected by changes in the exchange rate. However, a positive relationship between the two variables may also be derived from theories that emphasise the market structure, as a larger share of imports plausibly implies lower elasticity of substitution between foreign and domestic goods. Moreover, a share of machinery and electronic equipment in total imports of goods is used as a proxy variable to capture the possible impact on the pass-through arising from the changing structure of foreign trade. As indicated by the pricing-to-market models, a higher share would lead to a lower overall pass-through. The importance of trade costs in East European countries is already highlighted by the different responses of producer and consumer prices to exchange rate shocks. However, to further capture possible effects that are caused by the presence of the non-tradables sector, the analysis also includes the share of services in the total value added.

Table 3 (see Appendix) first shows the correlation matrix for the above-mentioned variables in cases of both the full sample and a narrower one that consists only of the new EU Member States (NMS). The service variable appears to have a rather high correlation with other variables in the system, so it would be difficult to isolate the impact of this variable on the pass-through in the regression. Moreover, the average inflation rate is significantly correlated with the inflation persistence variable. Nevertheless, the correlation in both cases is not sufficiently high to exclude these variables from the analysis ex ante.

The behaviour of estimated pass-through coefficients reported in Table 2 (e.g. the decline in pass-through over time is related to the degree of pass-through in the first period; see Appendix) suggests a log linear specification of the regression. Given that the sample consists of 13 countries and two sub-sample periods, final results are more likely to be affected by cross-country variation rather than variation over time. Therefore, along with other explanatory variables the regression also includes a dummy whose value is 0 in the first sub-sample period and 1 in the second period. This allows determining whether changes in pass-through can be successfully explained by the selected variables, or whether they are caused by other factors not included in the

model. Moreover, an additional dummy is included for countries that have adopted an inflation-targeting regime in order to account for the possibility that along with economic variables changes in monetary policy may also affect the behaviour of pass-through. Given the small sample of data, the final specification, in addition, includes only statistically significant variables to preserve the maximum degree of freedom.[1]

The results of the regression for both the full country sample and the sample consisting only of the new Member States are presented in Table 4 (see Appendix). Furthermore, robustness of the results is checked across different time horizons and price indices.

According to the economic theory and empirical studies on industrial countries, a higher average inflation rate is consistent with a stronger exchange rate pass-through also in the East European countries. This result is significant across different country samples and different time horizons at which the pass-through is measured. It is insignificant only in the case of producer price pass-through for the full sample, though it becomes significant again if only NMS are considered. On average, a 10% decline of the average inflation rate is associated with a 2% decline in the pass-through.

Similarly, with the exception of producer prices for the full sample, there is a positive and statistically significant link between the exchange rate persistence and the degree of the pass-through. Estimates for the full sample imply that an increase in the exchange rate persistence by 10% leads to an increase in the exchange rate pass-through by about 2%–3%. In the case of the new EU countries, this relationship is even stronger and ranges from 3% to 4%.

The regression results also indicate the importance of microeconomic factors affecting the pass-through behaviour. Thus, an increase of 10% in the share of machinery and electronic equipment in total imports in both country samples is associated with a decline in the exchange rate pass-through to producer prices by 5%–6% and to consumer prices by 8%–10%.

The results of the importance of the degree of openness are rather mixed. The share of imports appears to be significantly linked with the exchange rate pass-through in the full sample, but it is not significant for the narrow sample of the new EU Member States. A possible explanation for this result may be that, on the one hand, increasing imports imply a higher pass-through to the larger volume of goods whose prices depend on exchange rate movements, while, on the other hand, higher imports also imply tightening of competition in the domestic market and hence tend to reduce the likely impact on the exchange rate pass-through.

[1] The relatively low number of observations also does not allow testing for the presence of the fixed effects in the data. However, as the time dimension of the data has been broken down into two sub-periods with rather different behaviour of the macroeconomic variables across these periods even for one single country, the regression can be viewed as pure cross-section estimation. Data averages in this cross-section specification implies that the results may be interpreted as long-term relationships between the variables, as in the case of the between group estimates (see, e.g. J. Ventura (61)).

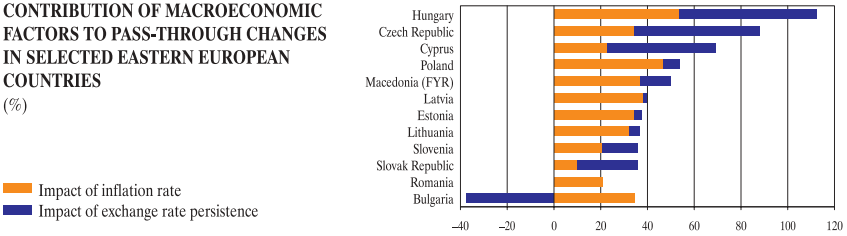
The inflation rate persistence and service variables do not appear to have any explanatory power regarding the pass-through behaviour in East European countries, although this result may be explained, at least partly, by possible multicollinearity of these variables.[1] In addition, the dummy for inflation targeting regime does not enter significantly in any of the regression results, thus suggesting that even if the change of the monetary policy regime matters for the exchange rate pass-through, its impact is likely to have been captured by the selected macroeconomic variables. Finally, apart from producer prices in the full sample, the dummy for the second sub-sample period is insignificant, suggesting that the variables considered in the regression can explain not only a cross-country variation but also changes in the pass-through over time. On average, in terms of the consumer price pass-through over a medium term horizon, various economic factors explain some 60%–80% of the observed variation within the sample.

Overall, the regressions thus indicate several variables that have a significant impact on the pass-through in East European countries. However, such variables as the degree of openness and the structure of imports usually are not subject to significant changes during short time periods. Such macroeconomic variables as the inflation rate and the exchange rate persistence, on the other hand, could potentially be more volatile and thus affect also the pass-through in the short term. As a result, these variables are likely to be more important from the policy makers' perspective.

Against this background, Chart 6 shows the contribution of the two macroeconomic variables to the observed percentage changes of the estimated exchange rate pass-through over the two sub-sample periods for several East European countries. As is seen from the Chart, macroeconomic factors explain on average 48% of the observed weakening of pass-through in these countries, with declining average inflation rates explaining 32% of the reduction and lower exchange rate persistence accounting on average for 16%. However, these averages do not reveal the considerable variation in

Chart 6

CONTRIBUTION OF MACROECONOMIC FACTORS TO PASS-THROUGH CHANGES IN SELECTED EASTERN EUROPEAN COUNTRIES
(%)



Note: Estimates are based on the pass-through to consumer prices over the 12-month horizon.

[1] One has to note, however, a relatively short time period in which the possible impact of inflation targeting regime in the East European countries can be measured. It is plausible that the impact of monetary policy changes might be detected over longer time horizons.

both the total contribution of macroeconomic factors and their relative importance across countries.

Thus, for instance, for the Baltic countries the contribution of the exchange rate persistence to pass-through changes is insignificant, reflecting the fact that their exchange rate regimes have actually remained unchanged during the whole sample period. As a result, most of the impact on the exchange rate has come from the declining inflation rate and other factors, e.g. a changing trade structure and an increasing degree of openness. In the case of Bulgaria, the effect of the declining inflation rate is largely offset by the impact of a higher exchange rate persistence resulting from the fixed exchange rate regime introduced in the second sample period. For two countries that have adopted a direct inflation targeting regime (the Czech Republic and Hungary), the resulting decline in the exchange rate persistence has actually been the most important factor behind the observed reduction in the exchange rate pass-through. By contrast, the contribution of the exchange rate to the declining pass-through in Poland has been relatively small despite the introduction of the inflation-targeting regime, possibly highlighting the fact that despite formal changes in monetary policy framework many countries in East Europe are still hesitant to let their currencies float freely.

CONCLUSIONS

The paper examines the exchange rate pass-through in a set of 13 East European countries during the period of 1993–2003. The pass-through estimates are derived from a recursive VAR model in first differences, and the impact of exchange rate changes on both the producer and the consumer prices is studied.

The estimates obtained for two sub-sample periods generally show an incomplete pass-through over a two-year horizon. In addition, the results imply a considerable cross-country variation and suggest that a significant decline (by nearly 50%) in the pass-through is possible over time. However even for the most recent period, the estimated degree of pass-through in East European countries is on average larger than similar estimates obtained for industrial countries. Moreover, the speed of the exchange rate transmission to domestic prices is relatively high in these countries when compared to the estimates for industrial countries.

Across different periods, the exchange rate pass-through seems to decline along the product distribution chain, thus implying that trade and distribution costs can have considerable impact on the degree at which exchange rate changes are transmitted to domestic prices. However, the regression results reveal that there are more factors that account for the observed differences in pass-through across both the countries and the periods.

In particular, it is found that the exchange rate pass-through in East European countries is positively and statistically significantly related to the average inflation rate and the degree of exchange rate persistence. Moreover, the results confirm the existence of strong relationship between the pass-through and changes of the import structure. Finally, there is some limited evidence that the magnitude of the exchange rate pass-through might be positively related to the degree of openness to foreign trade of a country.

The observed behaviour of the exchange rate pass-through has several implications for monetary policy. There is a reasonably large amount of studies that address issues of the monetary policy design in the presence of an incomplete pass-through.(21, 57, 2, 3, 50) For the countries considered herein, especially those that recently joined the EU, arguably the most important aspect in this regard is the relationship between the exchange rate pass-through and the exchange rate policy.

It may be argued, for instance, that in the environment of high inflation rates observed in many East European countries, when the exchange rate pass-through was relatively high, the adoption of the fixed exchange rate policy was completely justified. The high exchange rate pass-through enhanced the effectiveness of exchange rate-based stabilisation policies. The high degree of pass-through also implied that the level at which the exchange rate was fixed had little impact on the real economy. However,

when inflation rates in these countries declined over time, the stabilising role of the exchange rate diminished along with the decreasing pass-through effect. On the other hand, the role of the exchange rate in the real economy gradually increased as shocks to the nominal effective exchange rate produced increasingly persistent deviations of the real exchange rate from the equilibrium level. In these circumstances, several countries opted for abandonment of their fixed exchange rate regimes as the central banks in these countries became less concerned about the impact of exchange rate fluctuations on the inflation rate, and instead allowed their currencies to respond to various economic shocks. The move towards more flexible exchange rate regimes tended to reduce the degree of the exchange rate pass-through even further. For countries, which retained rigid exchange rate regimes either explicitly or implicitly, the decline in pass-through was relatively less pronounced. As a result, exchange rate fluctuations are relatively more important in determining inflation and relatively less important for the real economy in these countries.

These observations have several implications for the design of the exchange rate policy in the new EU countries in the light of their envisaged ERM II participation, as the conclusions derived from the analysis of the pass-through can be used to determine the optimal level of the central parity and possible fluctuation bands. For instance, a widely shared argument that the appreciation of the nominal exchange rate in the context of considerable capital inflows would support the disinflation process and thus enhance the compliance with the Maastricht inflation criterion could not be fully appropriate in the case of a low exchange rate pass-through. On the other hand, a low exchange rate pass-through implies that nominal exchange rate fluctuations have a long-lasting impact on the real exchange rate, so it is crucial that the chosen central parity is broadly consistent with the equilibrium real exchange rate. Hence for the new EU members with flexible exchange rate arrangements it is more appropriate to enter the ERM II with relatively wide fluctuation margins, if the optimal level of the exchange rate is not known. However, as soon as the decisions regarding the optimal level of the central parity are made, the adoption of narrower fluctuation margins seems reasonable. For countries with fixed or more rigid exchange rate regimes and, therefore, a higher implied degree of the exchange rate pass-through the level of the central parity is relatively less important. Hence the entry into the ERM II at current market rates or market rates on the day of joining the ERM II is arguably the most appropriate policy option. Moreover, taking into account the relatively close link between nominal exchange rate changes and inflation, the adjustment of the central parity within the ERM II is likely to be an effective policy tool in the event of rising inflationary pressures.

APPENDIX

Table 1

ADF TEST STATISTICS FOR ENDOGENOUS VAR VARIABLES

	neer	*Δneer*	*ppi*	*Δppi*	*cpi*	*Δcpi*	*m*	*Δm*	*i*	*Δi*
Bulgaria										
(01.1993–06.1997)	–0.57	–6.17**	1.25	–4.56**	2.12	–4.29**	3.44	–2.11	–2.32	–3.65**
(07.1997–06.2003)	–3.25*	–6.99**	–2.08	–6.17**	–1.94	–5.46**	0.99	–5.23**	–1.99**	–10.7**
Cyprus										
(01.1993–12.1997)	–2.58	–4.84**	–2.13	–7.86**	–0.51	–9.93**	–6.20**	–7.18**	–2.33	–2.18**
(01.1998–06.2003)	–0.64	–6.17**	–2.50	–5.66**	–3.42*	–11.1**	–1.68	–11.8**	–1.59	–9.43**
Czech Republic										
(01.1993–12.1997)	–1.47	–4.36**	–1.64	–6.65**	–2.97	–7.32**	–0.61	–4.79**	–3.27*	–7.27**
(01.1998–06.2003)	–1.89	–7.42**	–2.60	–6.08**	–3.15	–2.20**	–2.91	–2.82**	–3.84**	–6.39**
Croatia										
(01.1998–06.2003)	–2.19	–6.11**	–1.02	–9.77**	–2.78	–6.27**	–1.99	–7.61**	–3.17*	–9.19**
Estonia										
(01.1993–12.1997)	–1.86*	–5.45**	–1.05	–6.14**	–0.01	–4.08**	–3.51*	–5.66**	–2.31	–8.69**
(01.1998–06.2003)	–1.83	–6.65**	–1.12	–5.85**	–1.56	–5.82**	–1.97	–8.73**	–4.07**	–9.91**
Hungary										
(01.1993–03.2001)	–0.27	–8.03**	–1.70	–6.05**	–0.13	–2.31	–2.64	–2.44	–2.77	–7.07**
(04.2001–06.2003)	–2.21	–4.31**	–1.85	–4.88**	–3.29*	–3.66**	–3.14	–3.60**	–1.50	–3.41**
Latvia										
(01.1994–12.1997)	–1.86	–5.01**	2.18	–3.48**	2.81	–4.12**	–1.89	–5.29**	–1.25	–10.7**
(01.1998–06.2003)	–1.57	–5.28**	0.22	–6.53**	–0.79	–7.11**	–2.13	–7.75**	–2.55*	–9.06**
Lithuania										
(01.1993–12.1997)	–1.39	–6.90**	–0.52	–7.95**	2.22	–4.98**	–2.40	–4.41**	–1.37	–8.14**
(01.1998–06.2003)	–2.56	–6.47**	–0.99	–6.59**	–2.80	–8.49**	2.16	–6.76**	–5.18**	–10.8**
Macedonia (FYR)										
(01.1994–12.1998)	–1.39	–6.98**	n.a.	n.a.	–3.12*	–6.08**	–2.75*	–8.64**	–2.34	–16.9**
(01.1999–06.2003)	–6.46	–6.96**	n.a.	n.a.	–7.01**	–13.2**	–3.83**	–8.01**	–2.11	–6.46**
Poland										
(01.1993–12.1999)	–2.60	–6.60**	–2.14	–7.97**	–1.02	–6.85**	–1.07	–12.2**	–2.94	–13.8**
(01.2000–06.2003)	–2.28	–4.29**	–2.61	–4.07**	–3.10*	–3.92**	–1.06	–2.62*	–2.97	–8.13**
Romania										
(01.1993–12.1997)	–2.61	–4.12**	–2.62	–4.77**	–2.45	–3.79**	–2.98	–9.38**	–1.58	–3.99**
(01.1998 –06.2003)	–0.64	–6.45**	–1.00	–3.78**	–3.01*	–4.43**	–2.19	–9.11**	–3.69**	–7.24**
Slovak Republic										
(01.1993–09.1998)	–2.44	–6.36**	–2.20	–4.99**	–2.00	–6.48**	–1.81	–0.57	–2.10	–8.52**
(10.1998–06.2003)	–2.25	–3.51**	–0.78	–3.26**	–1.10	–4.51**	–1.93	–9.72**	–4.90**	–16.7**
Slovenia										
(01.1993–12.1997)	–1.37	–4.72**	–0.35	–6.91**	–1.59	–7.35**	–1.84	–12.2**	–2.73*	–9.03**
(01.1998–06.2003)	–2.58	–4.84**	–2.13	–7.86**	–0.51	–9.93**	–6.20**	–7.18**	–2.33	–2.18**

Notes: ** (*) indicate significance of the ADF test statistic at the 5% (10%) level.
n.a. – no data available.
The number of lags was chosen on the basis of the Schwarz information criteria.
All specifications in levels include a constant and, where necessary, also a deterministic trend.

Table 2

ESTIMATES OF EXCHANGE RATE PASS-THROUGH FOR SELECTED EAST EUROPEAN COUNTRIES

	Number of lags in VAR	Pass-trough to producer prices after:				Pass-trough to consumer prices after:			
		3 months	6 months	12 months	24 months	3 months	6 months	12 months	24 months
Bulgaria									
(01.1993–06.1997)	4	0.97	1.11	1.25	1.47	0.8	0.98	1.11	1.19
(07.1997–06.2003)	2	0.53	0.64	0.63	0.63	0.44	0.47	0.47	0.48
Cyprus									
(01.1993–12.1997)	3	0.91	1.00	1.02	1.02	0.59	0.72	0.79	0.79
(01.1998–06.2003)	2	0.47	0.63	0.64	0.64	0.53	0.60	0.63	0.63
Czech Republic									
(01.1993–12.1997)	4	0.19	0.35	0.60	0.75	0.02	0.14	0.21	0.30
(01.1998–06.2003)	2	0.16	0.18	0.22	0.23	0.05	0.09	0.13	0.14
Croatia									
(01.1998–06.2003)	2	0.26	0.33	0.34	0.34	0.18	0.23	0.35	0.36
Estonia									
(01.1993–12.1997)	2	0.70	1.05	1.08	1.09	0.59	0.67	0.72	0.73
(01.1998–06.2003)	2	0.33	0.55	0.57	0.57	0.21	0.35	0.34	0.34
Hungary									
(01.1993–03.2001)	2	0.65	0.72	0.75	0.75	0.14	0.24	0.27	0.28
(04.2001–06.2003)	1	0.27	0.36	0.39	0.40	0.15	0.20	0.21	0.21
Latvia									
(01.1994–12.1997)	3	0.74	0.96	0.99	1.00	0.07	0.47	0.51	0.58
(01.1998–06.2003)	3	0.18	0.27	0.33	0.36	0.13	0.25	0.26	0.26
Lithuania									
(01.1993–12.1997)	2	0.35	0.68	1.11	1.43	0.22	0.44	0.73	1.00
(01.1998–06.2003)	2	0.27	0.39	0.58	0.70	0.22	0.24	0.28	0.39
Macedonia (FYR)									
(01.1994–12.1998)	3	n.a.	n.a.	n.a.	n.a.	0.26	0.44	0.66	0.73
(01.1999–06.2003)	2	n.a.	n.a.	n.a.	n.a.	0.21	0.29	0.30	0.30
Poland									
(01.1993–12.1999)	3	0.48	0.61	0.64	0.64	0.29	0.47	0.51	0.51
(01.2000–06.2003)	2	0.45	0.54	0.55	0.55	0.28	0.31	0.34	0.34
Romania									
(01.1993–12.1997)	3	0.56	0.74	0.74	0.76	0.58	0.70	0.70	0.71
(01.1998–06.2003)	3	0.07	0.16	0.26	0.32	0.09	0.14	0.23	0.24
Slovak Republic									
(01.1993–09.1998)	2	0.31	0.90	0.96	0.96	0.35	0.47	0.47	0.47
(10.1998–06.2003)	1	0.44	0.48	0.50	0.51	0.21	0.21	0.23	0.23
Slovenia									
(01.1993–12.1997)	3	0.50	0.89	1.09	1.05	0.55	0.71	0.71	0.74
(01.1998–06.2003)	3	0.14	0.38	0.47	0.49	0.17	0.23	0.32	0.33
Average: period 1		**0.58**	**0.82**	**0.93**	**0.99**	**0.37**	**0.54**	**0.62**	**0.67**
Average: period 2		**0.30**	**0.41**	**0.46**	**0.49**	**0.22**	**0.28**	**0.31**	**0.33**

Notes: The choice of the number of lags is based on the Schwarz information criteria and lag exclusion tests.
The degree of pass-through is estimated as percentage deviation of a given price index from the baseline following a 1% change in the nominal effective exchange rate.
n.a. – no data available.

Table 3

CORRELATION MATRIX FOR EXPLANATORY VARIABLES

a. Full sample

	ainf	*mach*	*open*	*service*	*infpers*	*erpers*
ainf	1	–0.336	–0.297	–0.636	0.477	0.248
mach		1	0.234	0.290	–0.009	–0.169
open			1	0.531	–0.287	–0.449
service				1	–0.403	–0.353
infpers					1	0.386
erpers						1

b. New EU Member States

	ainf	*mach*	*open*	*service*	*infpers*	*erpers*
ainf	1	–0.226	–0.027	–0.493	0.576	0.325
mach		1	0.131	0.269	0.014	–0.359
open			1	0.182	–0.191	–0.388
service				1	–0.404	–0.059
infpers					1	0.304
erpers						1

Notes: All variables are expressed in natural logarithmic terms.
The variables are defined as follows: *ainf* – average inflation rate, *mach* – the share of machinery and electronic equipment in total goods imports, *open* – the ratio of imports to GDP, *service* – the share of services in total value added, *infpers* – inflation persistence, *erpers* – exchange rate persistence.

Table 4

REGRESSION ESTIMATES

a. Full Sample

	Dependent variable:							
	Pass-through to producer prices after 12 months		Pass-through to consumer prices after 6 months		Pass-through to consumer prices after 12 months		Pass-through to consumer prices after 24 months	
	Coeff.	*t*-statistic	Coeff.	*t*-statistic	Coeff.	*t*-statistic	Coeff.	*t*-statistic
ainf	0.022	0.40	0.177**	2.34	0.202**	3.64	0.215**	4.35
mach	–0.486**	–3.03	–0.804**	–4.48	–0.753**	–5.71	–1.087**	–5.62
erpers	0.042	0.39	0.280*	1.77	0.262**	2.13	0.207*	1.81
open	0.350**	2.81	0.220	0.96	0.264*	1.96	0.318**	2.14
infpers	–0.006	–0.04	–0.124	–0.43	0.110	0.65	0.208	1.36
service	0.322	0.86	0.629	1.06	0.411	1.66	0.587	1.27
D_2	–0.718**	–6.44	–0.473	–1.39	–0.234	–1.22	–0.257	–1.23
D_IT	0.109	0.34	0.142	0.29	0.018	0.07	0.046	0.20
Adjusted R^2	0.703		0.428		0.609		0.694	
Jarque–Bera statistic	0.499 [0.799]		2.109 [0.348]		3.471 [0.176]		0.712 [0.700]	
White test statistic	10.03 [0.187]		1.164 [0.884]		7.040 [0.317]		8.967 [0.345]	

b. New EU Member States

	Dependent variable:							
	Pass-through to producer prices after 12 months		Pass-through to consumer prices after 6 months		Pass-through to consumer prices after 12 months		Pass-through to consumer prices after 24 months	
	Coeff.	*t*-statistic	Coeff.	*t*-statistic	Coeff.	*t*-statistic	Coeff.	*t*-statistic
ainf	0.225**	3.75	0.147*	1.65	0.195**	2.87	0.208**	3.68
mach	–0.647**	–6.30	–0.931**	–5.65	–0.884**	–7.61	–0.906**	–9.36
erpers	0.314**	3.20	0.426**	2.71	0.393**	3.55	0.425**	4.61
open	0.038	0.27	0.038	0.14	0.052	0.32	0.095	0.71
infpers	0.237	1.55	0.111	0.44	0.108	0.70	0.228	1.58
service	–0.452	–1.16	0.307	0.63	0.187	0.90	0.042	0.17
D_2	–0.315	–1.71	–0.079	–0.22	0.021	0.09	–0.076	–0.37
D_IT	–0.033	–0.16	0.128	0.32	0.164	0.64	0.188	0.84
Adjusted R^2	0.705		0.543		0.722		0.809	
Jarque–Bera statistic	0.872 [0.646]		1.056 [0.586]		1.173 [0.556]		2.114 [0.347]	
White test statistic	4.801 [0.569]		3.182 [0.785]		4.520 [0.607]		5.293 [0.507]	

Notes: ** (*) indicate significance of the variable at the 5% (10%) level.
All variables are expressed in natural logarithmic terms.
Final coefficient estimates for the significant variables are obtained from the regression with all the insignificant variables dropped. The coefficients for insignificant variables are given for illustration purposes only.
p-values are given in brackets.
The variables are defined as follows: *ainf* – average inflation rate, *mach* – the share of machinery and electronic equipment in total goods imports, *open* – the ratio of imports to GDP, *service* – the share of services in total value added, *infpers* – inflation persistence, *erpers* – exchange rate persistence, *D_2* – dummy for period 2, *D_IT* – dummy for inflation target regime.

BIBLIOGRAPHY

1. Adolfson, M. "Monetary Policy with Incomplete Exchange Rate Pass-Through." *Working Paper*, No. 127, Sveriges Riksbank, 2001.

2. Adolfson, M. "Implications of Exchange Rate Objectives under Incomplete Exchange Rate Pass-Through." *Working Paper*, No. 135, Sveriges Riksbank, June, 2002 a.

3. Adolfson, M. "Incomplete Exchange Rate Pass-Through and Simple Monetary Policy Rules." *Working Paper*, No. 136, Sveriges Riksbank, June, 2002 b.

4. Anderton, B. "Extra-Euro Area Manufacturing Import Prices and Exchange Rate Pass-Through." *ECB Working Paper*, No. 219, March, 2003.

5. Arratibel, O.; Rodriguez-Palenzuela, D.; Thimann, C. "Inflation Dynamics and Dual Inflation in Accession Countries: A "New Keynesian" Perspective." *ECB Working Paper*, No. 132, March, 2002.

6. Bacchetta, P.; van Wincoop, E. "Why Do Consumer Prices React Less Than Import Prices to Exchange Rates?" *NBER Working Paper*, No. 9352, November, 2002.

7. Baxter, M.; Stockman, A. C. "Business Cycles and the Exchange Rate Regime: Some International Evidence." *Journal of Monetary Economics*, Vol. 23, No. 3, 1989, pp. 377–400.

8. Belaisch, A. "Exchange Rate Pass-Through in Brazil." *IMF Working Paper*, No. 03/141 May, 2003.

9. Billmeier, A.; Bonato, L. "Exchange Rate Pass-Through and Monetary Policy in Croatia." *IMF Working Paper*, No. 02/109, June, 2002.

10. Burstein, A. T.; Neves, J. C.; Rebelo, S. "Distribution Costs and Real Exchange Rate Dynamics during Exchange-Rate-Based Stabilization." *CEPR Discussion Paper*, No. 2944, September, 2001.

11. Campa, J. M.; Goldberg, L. S. "Exchange Rate Pass-Through into Import Prices: A Macro or Micro Phenomenon?" *NBER Working Paper*, No. 8934, May, 2002.

12. Campa, J. M.; González Mínguez, J. M. "Differences in Exchange Rate Pass-Through in the Euro Area." *Working Paper*, No. 0219, Bank of Spain, 2002.

13. Choudhri, E. U.; Hakura, D. S. "Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter?" *IMF Working Paper*, No. 01/194, December, 2001.

14. Choudhri, E. U.; Faruqee, H.; Hakura, D. S. "Explaining the Exchange Rate Pass-Through in Different Prices." *IMF Working Paper*, No. 02/224, December, 2002.

15. Coricelli, F.; Jazbec, B.; Masten, I. "Exchange Rate Pass-Through in Candidate Countries." *CEPR Discussion Paper*, No. 3894, May, 2003.

16. Darvas, Z. "Exchange Rate Pass-Through and Real Exchange Rate in EU Candidate Countries." *Discussion Paper*, No. 10/01, Deutsche Bundesbank, May, 2001.

17. Devereux, M. B. "Real Exchange Rates and Macroeconomics: Evidence and Theory." *The Canadian Journal of Economics*, Vol. 30, No. 4a, 1997, pp. 773–808.

18. Devereux, M. B.; Engel, C. "Monetary Policy in the Open Economy Revisited: Price Setting and Exchange Rate Flexibility." *NBER Working Paper*, No. 7665, April, 2000.

19. Devereux, M. B.; Engel, C. "Exchange Rate Pass-Through, Exchange Rate Volatility, and Exchange Rate Disconnect." *NBER Working Paper*, No. 8858, April, 2002.

20. Devereux, M. B.; Engel, C.; Storgaard, P. E. "Endogenous Exchange Rate Pass-Through when Nominal Prices Are Set in Advance." *NBER Working Paper*, No. 9543, March, 2003.

21. Devereux, M. B.; Lane, P. R. "Exchange Rates and Monetary Policy in Emerging Market Economies." *CEPR Discussion Paper*, No. 2874, July, 2001.

22. Dornbusch, R. "Purchasing Power Parity." *NBER Working Paper*, No. 1591, March, 1985.

23. Dornbusch, R. "Exchange Rates and Prices." *American Economic Review*, Vol. 77, Issue 1, March, 1987, pp. 93–106.

24. Engel, C. "The Responsiveness of Consumer Prices to Exchange Rates and the Implications for Exchange-Rate Policy: A Survey of a Few Recent New Open-Economy Macro Models." *NBER Working Paper*, No. 8725, January, 2002.

25. Engel, C.; Morley, J. C. "The Adjustment of Prices and the Adjustment of Exchange Rate." *NBER Working Paper*, No. 8550, October, 2001.

26. Feinberg, R. M.; Kaplan, S. "The Response of Domestic Prices to Expected Exchange Rates." *Journal of Business*, Vol. 65, Issue 2, 1992, pp. 267–280.

27. Fischer, S. "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule." *Journal of Political Economy*, Vol. 85, Issue 1, 1977, pp. 191–205.

28. Frenkel, J. A. "The Collapse of Purchasing Power Parities During the 1970's." *European Economic Review*, No. 16, 1981, pp. 145–165.

29. Froot, K. A.; Klemperer, P. D. "Exchange Rate Pass-Through when Market Share Matters." *American Economic Review*, Vol. 79, No. 4, 1989, pp. 637–654.

30. Froot, K. A.; Rogoff, K. "Perspectives on PPP and Long-Run Real Exchange Rates." *NBER Working Paper*, No. 4952, December, 1994.

31. Gagnon, J. E.; Ihrig, J. "Monetary Policy and Exchange Rate Pass-Through." *Finance Discussion Paper*, The Federal Reserve Board International, No. 704, July, 2001.

32. García, C. J.; Restrepo, J. E. "Price Inflation and Exchange Rate Pas-Through in Chile." *Working Paper*, No. 128, Central Bank of Chile, 2001.

33. Goldberg, P. K.; Knetter, M. M. "Goods Prices and Exchange Rates: What Have We Learned?" *Journal of Economic Literature*, Vol. 35, No. 3, September, 1997, pp. 1243–1272.

34. Goldfajn, I.; Werlang, S. R. C. "The Pass-Through from Depreciation to Inflation: A Panel Study." *Texto Para Discusao*, No. 423, Departamento de Economia Puc-Rio, April, 2000.

35. Gueorguiev, N. "Exchange Rate Pass-Through in Romania." IMF *Working Paper*, No. 03/130, June, 2003.

36. Hahn, E. "Pass-Through of External Shocks to Euro Area Inflation." *ECB Working Paper*, No. 243, July, 2003.

37. Hampton, T. "How Much Do Import Price Shocks Matter for Consumer Prices?" *Reserve Bank of New Zealand Discussion Paper*, No. DP 2001/06, November, 2001.

38. Herzberg, V., Kapetanios, G.; Price, S. "Import Prices and Exchange Rate Pass-Through: Theory and Evidence from the United Kingdom." *Working Paper*, No. 182, Bank of England, 2003.

39. Hüfner, F. P.; Schröder, M. "Exchange Rate Pass-Through to Consumer Prices: A European Perspective." *ZEW Discussion Paper*, No. 02–20, 2002.

40. Kenny, G.; McGettigan, D. "Exchange Rate Pass-Through and Irish Import Prices." *Technical Paper*, No. 6/RT/96, *Central Bank of Ireland*, December, 1996.

41. Kim, K. H. "US Inflation and the Dollar Exchange Rate: A Vector Error Correction Model." *Applied Economics*, Vol. 30, Issue 5, 1998, pp. 613–619.

42. Krugman, P. "Pricing to Market When the Exchange Rate Changes." *NBER Working Paper*, No. 1926, May, 1986.

43. Krugman, P. "Purchasing Power Parity and Exchange Rates: Another Look at the Evidence." *Journal of International Economics*, No. 8, 1978, pp. 397–407.

44. Kuijs, L. "Monetary Policy Transmission Mechanisms and Inflation in the Slovak Republic." *IMF Working Paper*, No. 02/80, May, 2002.

45. Lee, J. "The Response of Exchange Rate Pass-Through to Market Concentration in a Small Economy: The Evidence from Korea." *The Review of Economics and Statistics*, Vol. 79, No. 1, February, 1997, pp. 142–145.

46. Mankiw, N. G. "Small Menu Costs and Large Business Cycles: A Macroeconomic Model of Monopoly." *Quarterly Journal of Economics*, Vol. 100, Issue 2, May, 1985, pp. 529–537.

47. McCarthy, J. "Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Countries." *BIS Working Paper*, No. 79, November, 1999.

48. Menon, J. "The Degree and Determinants of Exchange Rate Pass-Through: Market Structure, Non-Tariff Barriers and Multinational Corporations." *Economic Journal*, Vol. 106, Issue 435, 1996, pp. 434–444.

49. Mihaljek, D.; Klau, M. "A Note on the Pass-Through from Exchange Rate and Foreign Price Changes to Inflation in Selected Emerging Market Economies." *BIS Papers*, No. 8, 2001, pp. 69–81.

50. Monacelli, T. "Monetary Policy in a Low Pass-Through Environment." *ECB Working Paper*, No. 227, April, 2003.

51. Obstfeld, M. "International Macroeconomics: Beyond the Mundell-Fleming Model." *NBER Working Paper*, No. 8369, July, 2001.

52. Obstfeld, M.; Rogoff, K. "New Directions for Stochastic Open Economy Models." *NBER Working Paper*, No. 7313, August, 1999.

53. Obstfeld, M.; Rogoff, K. "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" *NBER Working Paper*, No. 7777, July, 2000.

54. Phelps, E. S.; Taylor, J. B. "Stabilizing Powers of Monetary Policy under Rational Expectations." *Journal of Political Economy*, Vol. 85, Issue 1, February, 1977, pp. 163–190.

55. Rogoff, K. "The Purchasing Power Parity Puzzle." *Journal of Economic Literature*, Vol. 34, No. 2, June, 1996, pp. 647–668.

56. Romer, D. *Advanced Macroeconomics*. The McGraw-Hill Companies, Inc., 1996.

57. Smets, F.; Wouters, R. "Openness, Imperfect Exchange Rate Pass-Through and Monetary Policy." *Working Paper*, No. 19, National Bank of Belgium, March, 2002.

58. Taylor, J. B. "Staggered Wage Settings in a Macro Model (in Wages and Employment)." *The American Economic Review*, Vol. 69, No. 2, May, 1979, pp. 108–113.

59. Taylor, J. B. "Aggregate Dynamics and Staggered Contracts." *Journal of Political Economy*, Vol. 88, No. 1, February, 1980, pp. 1–23.

60. Taylor, J. B. "Low Inflation, Pass-Through, and the Pricing Power of Firms." *European Economic Review*, Vol. 44, Issue 7, June, 2000, pp. 1389–1408.

61. Ventura, J. "Towards a Theory of Current Accounts." *NBER Working Paper*, No. 9163, September, 2002.

62. Woo, W. T.; Hooper, P. "Exchange Rates and the Prices of Nonfood, Nonfuel Products." *Brookings Papers on Economic Activity*, Vol. 1984, No. 2, 1984, pp. 511–536.

63. Yang, J. "Exchange Rate Pass-Through in U.S. Manufacturing Industries." *The Review of Economics and Statistics*, Vol. 79, Issue 1, 1997, pp. 95–104.

Latvijas Banka (Bank of Latvia)
K. Valdemāra ielā 2a, Riga, LV-1050, Latvia
Phone: +371 702 2300 Fax: +371 702 2420
http://www.bank.lv
info@bank.lv
Printed by *Premo*