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Transmission of Exchange Rate Shocks into Domestic Inflation: The Case of the Czech Republic

Oxana Babetskaia-Kukharchuk [*]

Abstract

This paper aims at estimating the exchange rate pass-through (ERPT) for the Czech Republic. The existing empirical literature does not come to a consensus about the degree of pass-through to Czech inflation. Since there is no unique approach regarding how to measure ERPT, we use various specifications found in the pass-through literature for the Czech Republic. In addition, we estimate the pass-through along the distribution chain in the spirit of McCarthy (2007). We try to explore the properties of exchange rate shock transmission into Czech consumer prices by comparing impulse responses among 11 specifications estimated on data transformed in monthly differences and in annual rates. Equilibrium pass-through is estimated with the help of the VEC model. In addition, we try to account for possible variation in time. The simplest approach is a re-estimation of VAR models on two sub-periods. Our second strategy is the estimation of the error correction equation with the Kalman filter. Finally, we explore how the pass-through differs between tradable (3 sub-groups) and non-tradable goods. We find that the speed of exchange rate shock transmission to all prices is quite high. However, in absolute terms, ERPT does not exceed 25 – 30%.

JEL Codes: E31, E52, E58, F31.
Keywords: Exchange rate pass-through, inflation, Kalman filter, VAR, VECM.

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Nontechnical Summary

The choice of the optimal monetary policy for the new EU members is not straightforward. On the one hand, future participation in the ERM-II and euro adoption require exchange rate stability vis-à-vis euro. On the other hand, the catching-up process induces real exchange rate appreciation. Furthermore, the exchange rate in the new member states still represents an instrument of adjustment to various shocks. Together with Hungary and Poland, the Czech Republic is in the last group for euro adoption among the new member states of the 2004 wave of enlargement, and assessment of exchange rate pass-through is important on its road toward the euro.

Understanding the pass-through mechanism is also crucial for CPI inflation targeting. As a small open economy, the Czech economy can be sensitive to external shocks. At the same time, the empirical literature finds low pass-through in a low inflation environment or when a country has inflation targeting. In case of a significant exchange rate shock, it is important to know how strongly domestic prices will react to this shock, in other words, how far inflation might deviate from the target and how quickly prices might return to the equilibrium level. Under inflation targeting, the monetary authority tends to maintain price stability, which should reduce the pass-through effect. Finally, understanding exchange rate pass-through could be a useful element for inflation prediction and, more generally, for prediction of real sector behavior.

The paper aims to provide a better understanding of how domestic consumer prices respond to exchange rate shocks. The proposed empirical analysis tends to answer how strong and how fast is the exchange rate pass-through to domestic inflation, whether it changes over time, whether it has the same magnitude for tradables and non-tradables, how it is different from the reaction of import and producer prices, and how robust the results are when alternative specifications are used.

Existing pass-through studies for the Czech Republic report short-run exchange rate pass-through varying from 0 to almost 40 percent. Applying alternative specifications and econometric procedures to two datasets (m-o-m changes and y-o-y changes), we find that the pass-through to the CPI is close to the upper bound of the existing results during 1996–2001, and is almost at the lower bound during 2002–2006. The speed of exchange rate shock transmission to all prices is quite high, which is usual for a small open economy. However, in absolute terms, the peak impulse response does not exceed 25%, and the total reaction to the exchange rate shock is likely to be less than 30% for the estimations performed on the whole sample. The estimations obtained from the whole sample are more significant than those performed on two sub-periods. Longer time span and lower volatility in the data are possible explanations of this result. Notice that it is difficult to find meaningful results when static and time varying vector error correction models (VECM) are used instead of VAR. Finally, in line with the theory, we find that tradable goods react more to an exchange rate shock than do non-tradable goods. Furthermore, the magnitude of the exchange rate pass-through decreases from the initial stage of production to final goods. We found that the pass-through to producer prices is lower than that to consumer prices. High competition on the domestic market or high pass-through to imported goods in the consumption basket could be a possible explanation for this result.

1. Introduction

By joining the European Union, the new EU members take on an obligation to adopt the euro at some point. This is preceded by a required minimum two-year membership in the ERM-II, which imposes certain exchange rate stability criteria. At the same time, the catching-up process in the new member states is reflected in higher productivity growth vis-à-vis the euro area, which, in turn, entails real exchange rate appreciation. Also, the exchange rate still represents a useful instrument of adjustment to various shocks. The new member countries that join the ERM-II might be viewed as balancing their monetary policy between low inflation, as required by the Maastricht criteria, and a stable exchange rate vis-à-vis euro, as imposed by the ERM-II. In this context, the link between the exchange rate and inflation, or, more precisely, the *pass-through effect* of a variation in the nominal exchange rate on domestic inflation, receives particular attention. In the context of euro adoption, high sensitivity to exchange rate shocks may increase the benefits of earlier euro adoption. As a small open economy, the Czech Republic can be sensitive to external shocks. At the same time, the empirical literature finds low pass-through in a low inflation environment or when a country has inflation targeting.

From a policy perspective, understanding the transmission mechanism of exchange rate shocks into domestic inflation is vital for the implementation of a country's monetary and exchange rate policies. In case of a significant exchange rate shock, it is important to know how strongly domestic prices will react to this shock, in other words, how far inflation might deviate from the target and how quickly prices return to the equilibrium level. Under inflation targeting (which is the case of the Czech Republic), the monetary authority tends to maintain price stability, which should reduce the pass-through effect. Finally, understanding exchange rate pass-through could be a useful element for inflation prediction and, more generally, for prediction of real sector behavior.

The proposed empirical study contributes to the clarification of exchange rate shock transmission into domestic inflation. The aim of the present paper, therefore, is to assess the dynamics and magnitude of exchange rate pass-through. Given the high interdependence of economic factors, the transmission mechanism of an exchange rate shock into the domestic economy does not appear simple. It is not surprising that there is no unique model to measure the pass-through effect, and the results vary significantly across studies and across countries.

The existing empirical literature on pass-through for the Czech Republic reports estimates varying in the short run between 0% and almost 40%. The diversity of the previous results gives additional motivation to this study. Furthermore, many of the papers are already out of date. The literature on exchange rate pass-through comes to a consensus that the pass-through to domestic inflation is incomplete. However, the reasons are quite diverse. The low reaction of domestic prices is explained by strong competition, pricing to market, currency invoicing, degree of openness, and other factors. Since it is not clear which factor dominates, the present paper estimates ERPT using numerous specifications; then the results are discussed.

The paper has the following structure. The first section gives a definition of pass-through and discusses its properties. In the second section, we explain the different approaches to modeling ERPT and take corresponding examples from the literature on ERPT to consumer prices estimated for the Czech Republic. The third section explains the estimation methods. The data and preliminary tests are described in the fourth section. Section five shows the results. The main empirical findings are summarized in the conclusion.

2. Definition and Properties of ERPT

Traditionally, exchange rate pass-through is defined as “the percentage change in the local currency price of an imported good resulting from a 1 per cent change in the nominal exchange rate between the exporting and importing countries.”[1] Menon (1995) makes a survey of empirical studies on exchange rate pass-through conducted between 1974 and 1994. Most of these studies analyzed pass-through effects to export and import prices, estimated for large developed economies. Later, the analysis of exchange rate pass-through was extended to consumer and producer prices. Starting from McCarthy (1999), the majority of the ERPT studies focusing on domestic inflation base their analysis on the so-called distribution chain: input prices, intermediate prices, and prices of final goods. The main advantage of this approach is its ability to compare the reaction of prices to an exchange rate shock at different stages of the distribution process.

The standard distribution chain specification contains import prices, producer prices, and consumer prices. Import prices transmit an exchange rate shock into domestic inflation indirectly, via inputs and intermediate goods for domestically produced products, or directly, via imported goods, which constitute a part of final consumption. Consequently, an exchange rate shock affecting one stage of production is transmitted to consumer prices. Since the production and distribution process takes some time, the transmission mechanism is not likely to be immediate. Faruqee (2006) and Choudhri et al. (2005) estimate one of the longest distribution chains. The authors use the three aforementioned price indices, unit labor costs, and export prices. By and large, ERPT is expected to decline along the distribution chain, i.e., consumer prices are expected to react much less than import prices. When the reaction to a shock is less than the initial shock, the pass-through is incomplete.

Most empirical studies find incomplete pass-through. A class of the New Open Economics Models (NOEM) assumes that exchange rate pass-through may be endogenous to the country’s monetary policy and the country’s inflation performance. Starting from Taylor (2000) numerous empirical studies find that exchange rate pass-through declines if the inflation environment turns low-inflationary, because this causes a “decline in the expected persistence of cost and price changes.” Choudhri and Hakura (2006) test this relation empirically in a sample of 71 countries over 1979–2000. The authors argue that ERPT tends to be low in economies where inflation is low and monetary policy is more credible. This finding is also proved by Bailliu and Fujii (2004) and Gagnon and Ihrig (2004) in the long run. The authors use a macroeconomic model and Monte-Carlo simulations for parameterization of their model. Then, the model is fitted for 20 industrial countries using quarterly data over 1971–2003. Flamini (2004) proposes an analytical framework for incomplete or delayed pass-through to CPI inflation in a small-open economy. His approach is based on a dynamic stochastic general equilibrium model. Coricelli et al. (2006) explain differences in the completeness of pass-through also by differences in exchange rate regimes: countries with inflation targeting and flexible exchange rate arrangements have much smaller pass-through that those with less flexible exchange rate regimes. The authors find complete pass-through in Slovenia and Hungary. The impact of an exchange rate shock is smaller

[1] Bailliu and Fujii (2004)

in Poland and the Czech Republic. The other possible explanations of low pass-through include a low share of imported goods, price stickiness of non-tradable goods in the consumption basket, the substitution effect (Burstein *et al.*, 2002), the presence of intermediaries between exporters and consumers, currency invoicing and local distribution costs (Bacchetta and van Wincoop, 2003),[2] and slow adjustment of consumer goods prices in a highly competitive environment. The signal from the exchange rate can also be distorted by menu costs and contracting costs (Devereux and Yetman, 2002) or firms' pricing-to-market strategy (Corsetti and Dedola, 2005). Notice, however, that changes in domestic prices are not necessarily caused by changes in the exchange rate. For this reason, Darvas (2001) proposes to decompose price changes into pass-through and price convergence effects.

Pass-through estimates on the aggregate consumer price index assume that pass-through is the same for all goods in the consumption basket. Parsley (1995), cited in Darvas (2001), criticizes the use of aggregated price indices for the estimation of exchange rate pass-through. Inference from the disaggregated level has some advantages. For example, different industries may have different sensitivities to inflation changes. One explanation for this fact is a different degree of competition among market segments. The use of disaggregated price indices can, furthermore, let us take into account that prices of non-tradables grow faster than prices of tradables. However, due to data availability, most of the existing studies use aggregated price indices, and only a few studies, mostly performed on US data, analyze pass-through using disaggregated data. For developed countries this question was addressed, for example, in Pollard and Coughlin (2003). For transition economies, to our knowledge, there are only two studies on disaggregated pass-through. Dabusinskas (2003) estimates disaggregated pass-through for Estonia, and Bitāns (2004) shows impulse responses of various CPI sub-groups for Latvia. According to these results, the level of price aggregation affects the estimates of pass-through. Last but not least, ERPT is not necessarily symmetric and constant over time.[3]

Based on the general pass-through properties, we expect that the ERPT to Czech inflation is far from complete. This is due to both a low-inflation environment and inflation targeting. Import prices constitute about 25% of the CPI. Furthermore, according to the CNB Inflation Report (2004), in the second quarter of 2004 only 18% of imports were designated for final consumption, as against 63% for intermediate consumption. On the contrary, pass-through to import prices is likely to be very high for at least two reasons. First, the Czech Republic is a small open economy with a ratio of exports/imports to GDP exceeding 60%. Second, according to Kamps (2006), during 1999–2004 around 90% of contracts for imported goods were denominated in foreign currency (mostly in euro). In the empirical sections of the paper, we address most of the properties of ERPT, namely, the speed and magnitude of its transmission into domestic inflation. In addition, we try to test whether the pass-through varies over time. We show how different the reaction of price indices is along the distribution chain, and how different the results are when more disaggregated data are used instead of the aggregated index.

[2] If foreign exporting firms, e.g., euro area firms, establish their prices in euros, and domestic firms, e.g., non-euro area firms, assembling imported goods and selling final products to consumers set their prices in local currency, one can expect the pass-through to consumer prices to be lower than the pass-through to import prices (see Bacchetta and van Wincoop, 2003, and Bailliu and Fujii, 2004, for a discussion about exchange rate pass-through to producer and consumer prices in industrialized countries).

[3] See, for example, Bussière (2006) for asymmetric pass-through and Darvas (2001), Rincon et al. (2005), and Sekine (2006) for time-varying pass-through estimates.

3. Approaches to Modeling ERPT: The Case of the Czech Republic

Pass-through to consumer prices is less transparent than pass-through to import prices. In its most basic form, the pass-through is obtained from interactions among the exchange rate, domestic consumer prices, and the most important transmission channel – import prices. Due to data problems, import prices are sometimes replaced by foreign consumer prices, reflecting the influence of the external economic environment. The advantage of such a model is its simplicity, which preserves the degree of freedom when the time series is short. However, it can suffer from misspecification due to neglect of the possible pass-through determinants. This criticism, however, can also be addressed even at sophisticated pass-through models.

Despite the relatively simple definition of exchange rate pass-through, in practice it is approximated and estimated by various different approaches. One possible method is a simple one-equation regression. However, the most commonly applied method is VAR or structural VAR (SVAR).[4] VAR models account for endogeneity and allow the magnitude and dynamics of the pass-through to be measured. Here it is important to distinguish between long- and short-run pass-through. In a VAR framework, short-run pass-through is measured as an impulse response to a given shock[5], which allows us to infer the magnitude and dynamics of the pass-through. The accumulated impulse responses can be interpreted as long-run pass-through if the time horizon is sufficiently long. In this paper, by short-run pass-through we mean the instant impulse responses and the accumulated impulse responses for the period up to one year. The cointegrated VAR or error correction model allows us to measure equilibrium pass-through. Some time equilibrium pass-through is also called long-run pass-through. According to the definition of the error correction term, equilibrium pass-through represents the equilibrium to which the exchange rate coefficient tends to converge. The advantage of the VEC approach is that it keeps the information in levels taking into account causal relationships and non-stationarity issues.[6]

To sum up, the variety of applied procedures makes it difficult to find any encompassing approach. In addition, there is no single model for measuring pass-through. The pass-through studies for the Czech Republic cover a large spectrum of econometric procedures, including simple univariate methods and more complex systems of equations, such as autoregressive models or models with pre-estimated parameters (e.g., the Quarterly Prediction Model of Beneš et al., 2003). Table 1 shows the variables used in pass-through studies for the Czech Republic. For comparison and further analysis, we also include in Table 1 three specifications with a distribution chain, estimated on a sample containing the euro area countries. In the spirit of McCarthy (2007), we split all the variables into six groups: distribution chain, exchange rate shock, supply, demand and external shocks, and monetary policy variables.

[4] Pass-through estimates can also be obtained from a calibrated structural model. On the one hand, the advantages of this model include its theoretical foundations and the inclusion of monetary policy or central bank reaction functions. On the other hand, one criticism of the structural models concerns the presence of pre-calculated parameters, frequently chosen on an *ad-hoc* basis.

[5] Shocks are usually normalized to one percent or to one standard deviation.

[6] Notice that the VAR approach is criticized by Coricelli et al. (2006) for inconsistency with the definition of pass-through. In particular, the authors emphasize that any type of shock can cause co-movements between the exchange rate and prices.

Table 1: Pass-through Estimates for the Czech Republic and the Euro Area

author	estimation method	short-run and [long-run] ERPT	variables included in the model: supply shock		demand shock		distribution chain					extern. shock	monetary policy	
			pm^{oil}	gap	dgp	**s**	w	pm	px	py	**pc**	pc^f	m	i
EURO AREA														
McCarthy (1999, 2007)	VAR	0 [d]	X	X		**X**		X		X	**X**		X[a]	X[a]
Faruqee (2006)	VAR	0.02				**X**	X	X	X	X	**X**			
Hahn (2003)	VAR	0.08	X	X		**X**		X		X	**X**			X
CZECH REPUBLIC														
Bitāns (2004)	VAR	0.21;0.13		X		**X**				X	**X**		X	X
Ca'Zorzi (2007)	VAR	[0.61;0.55]	X	X		**X**		X			**X**			X
Campa Goldberg (2006)	OLS	0; [0.60]			X	**X**					**X**	X		
Campa Goldberg (2006)	SVAR	0				**X**		X			**X**	X		
Coricelli et al. (2006)[b]	CVAR	[0.46]				**X**				X	**X**			X
Darvas (2001)[c]	VAR,EC	0-0.04; 0.15				**X**					**X**	X		
Darvas (2001)	TVEC	0.10;0.15				**X**					**X**	X		
Korhonen Wachtel (2006)	VAR	0.03;0.09	X			**X**					**X**	X		
Mihaljek Klau (2001)	OLS	0.06		X		**X**		X			**X**			
Beneš et al. (2003)		0.35-0.37	*Structural model*											

pm^{oil}	- oil prices	w	- unit labor costs
m	- broad money	pm	- import prices
i	- interest rate	px	- export prices
gap	- output gap	py	- producer prices
dgp	- real GDP	pc	- consumer prices -CPI
s	- exchange rate	pc^f	- foreign CPI

Note: [a] McCarthy (2007) only. [b] Coricelli et al. (2006) use inflation and interest rate differentials. Therefore, it is difficult to compare the model and the results with other estimations. [c] Darvas (2001) also estimates an equilibrium real exchange rate model with time-invariant parameters. [d] The original model was estimated for industrialized countries. The impulse response of the CPI to an exchange rate shock is insignificant for the majority of the euro area countries included in the sample.

The different econometric methodologies and specifications lead to a variety of pass-through estimates. Short-run pass-through varies from 0 to almost 40 percent (column 3 in Table 1). For comparison, the ERPT to the euro area HICP varies between 2 percent (Faruqee, 2006) and 8 percent (Hahn, 2003). It is mostly insignificant in McCarthy (1999 and 2007). Long-run pass-through is found to be around 0.5–0.6, which is far from complete. Studies with cross-countries analysis find the lowest pass-through for the Czech Republic among the Central European countries (Coricelli et al., 2006, and Darvas, 2001) or the emerging economies (Mihaljek and Klau, 2001). In addition, Mihaljek and Klau (2001) find high inflation inertia for the Czech Republic (the highest in the sample). Most studies estimate pass-through using the effective exchange rate, but others, e.g., Mihaljek and Klau (2001), prefer the bilateral exchange rate, which is more transparent for firms in comparison with the effective exchange rate. Korhonen and Wachtel (2005) estimate pass-through using the euro and dollar exchange rates. Pass-through is found to be higher when the euro is used.

It worth mentioning that such variation in the exchange rate pass-through results may be due to different estimation periods and differences in definitions of pass-through, as well as to different frequency of the data (monthly and quarterly). It may also be partially due to variation in the underlying price indices. For example, Beneš et al. (2003) and Darvas (2001) exclude food, energy, and administered prices from the aggregated price index. Coricelli et al. (2006) and Mihaljek and Klau (2001) use the aggregated index of CPI inflation.

4. General Estimation Strategy

None of the aforementioned approaches can be considered the best. Therefore, the alternative methods should rather be viewed as complementary to each other. With a few exceptions[7] we replicate the specifications already applied to the Czech Republic data. In addition, we estimate McCarthy-type specifications with a distribution chain (see Table 1). If oil prices and the interest rate are included in the model, we consider them first as exogenous and then as endogenous. Therefore, we obtain about 20 specifications, but only 11 passed the stability test. Only stationary specifications are used for the pass-through analysis. These 11 specifications are listed in Table 2.

Table 2: Estimated VAR Specifications

VAR No.	endogenous variables						exogenous variables	
1	**s**	pm	px	py	**pc**	w		
2	pm^{oil}	gap	**s**	$pm^{non\ oil}$	py	**pc**		
3	gap	**s**	$pm^{non\ oil}$	py	**pc**		pm^{oil}	
4	gap	**s**	$pm^{non\ oil}$	py	**pc**		pm^{oil}	i
5	gap	**s**	$pm^{non\ oil}$	**pc**			pm^{oil}	i
6	gap	**s**	**pc**				pc^{EU}	
7	**s**	pm	**pc**				pc^{EU}	
8	**s**	**pc**					pc^{EU}	
9	pm^{oil}	**s**	**pc**				pc^{EU}	
10	**s**	**pc**					pc^{EU}	pm^{oil}
11	gap	**s**	pm	**pc**				

pm^{oil}	- oil prices	w	- unit labor costs
$pm^{non\ oil}$	- oil prices	pm	- import prices
i	- interest rate	px	- export prices
gap	- output gap	py	- producer prices
s	- exchange rate (NEER)	pc	- consumer prices -CPI
		pc^{EU}	- euro area CPI

[7] We do not use, for example, broad money. Also, we do not replicate the model of Coricelli et al. (2006), estimated with inflation and interest rate differentials. Finally, Darvas (2001) estimates the time-invariant equilibrium real exchange rate, but there is no unique approach to estimating the equilibrium exchange rate (for different strategies of equilibrium exchange rate estimation for transition economies, see Égert et al., 2006). In addition, it is not necessarily the case that the equilibrium exchange rate is stable over time. Therefore, we do not follow this approach.

All 11 specifications are estimated for five consumer price indices: pc – aggregated CPI, pc^{tt} – tradables only, pc^{tf} – food only, pc^{to} – other tradables (excluding food and beverages), and pc^{nt} – non-tradables excluding regulated prices. The majority of pass-through studies use the data transformed into month-on-month changes. This data, however, may contain additional noise. For this reason, we complement the estimations on month-on-month changes with estimations done on the data transformed into annual growth rates: $(X_t-X_{t-12})/X_{t-12}*100$ (here and after year-on-year changes). Estimates are performed for three periods: the whole period and two sub-periods. In total, this gives us 11*5*2*3=330 estimated VAR models. Price indices and the exchange rate are transformed into log-differences for the month-on-month (m-o-m) estimates and one-period differences for the year-on-year (y-o-y) estimates. The interest rate is transformed into one-period differences in the y-o-y VARs.

A VAR process is generally described as $y_t = C_0 + C(L)y_{t-1} + u_t$, where y_t is a vector of endogenous variables in first log differences or in annual rates. Short-run pass-through is computed as an impulse response from the VAR model. To compute the impulse responses, Cholesky ordering is selected. Cholesky decomposition implies a predetermined ordering of the impulse responses: in the first period the first variable is affected only by its own shock, the second variable is affected by the first variable's shock and its own shock, etc., and the last variable is affected by the shocks from all the variables. Let y_t be a vector of *n* endogenous variables in log differences. The relation between the variables follows an autoregressive process of the form: $By_t = A_0 + A(L)y_{t-1} + \varepsilon_t$, where *B* is an $n \times n$ matrix with unitary elements along its diagonal, *A(L)* is a lag polynomial of order *p* (we select *p*=2), A_0 is a vector of constant terms, and ε_t denotes a matrix of disturbance terms. The reduced-form VAR is obtained by multiplying both sides by B^{-1}: $y_t = C_0 + C(L)y_{t-1} + u_t$, where $C_0 = B^{-1}A_0$, $C = B^{-1}A$, and $u_t = B^{-1}\varepsilon_t$ are reduced-form residuals, given by the shocks from all six variables. *B* is not observed directly (with unrestricted VAR we can estimate only the C_0 and *C* coefficients). If *B* is not diagonal, innovations u_t will be correlated with each other. This does not allow us to pick out shocks from a particular variable. To ensure orthogonality of the innovations in the model with *n* variables, at least $(n^2 - n)/2$ restrictions should be imposed (for example, for Faruqee's 2006 specification with six endogenous variables the number of restrictions is equal to $(6^2–6)/2=15$). One possible way to do so is to transform the symmetrical residual covariance matrix into a Cholesky lower triangular matrix. Thus, we obtain the following recursive system:

$$\varepsilon_1 = c_{11}u_1$$
$$\varepsilon_2 = -c_{21}\varepsilon_1 + c_{22}u_2$$
$$\varepsilon_3 = -c_{31}\varepsilon_1 - c_{32}\varepsilon_2 + c_{33}u_3$$
$$\varepsilon_4 = -c_{41}\varepsilon_1 - c_{42}\varepsilon_2 - c_{43}\varepsilon_3 + c_{44}u_4$$
$$\varepsilon_5 = -c_{51}\varepsilon_1 - c_{52}\varepsilon_2 - c_{53}\varepsilon_3 - c_{54}\varepsilon_4 + c_{55}u_5$$
$$\cdots\cdots\cdots\cdots$$
$$\varepsilon_n = -c_{n1}\varepsilon_1 - c_{n2}\varepsilon_2 - c_{n3}\varepsilon_3 - c_{n4}\varepsilon_4 - c_{n5}\varepsilon_5 + c_{nn}u_n$$

Notice that the ordering of the endogenous variables matters. In practice, it is difficult to test all the possible combinations, e.g., a system of 6 variables gives 6!=720 possibilities for ordering the variables. We selected the ordering of variables which corresponds to the distribution chain hypothesis. In the spirit of McCarthy (1999 or 2007) we place variables approximating demand and supply shocks before the distribution chain.

The next step after the short-run pass-through estimates is to estimate the equilibrium pass-through. The latter is based on VECM estimates. The cointegrated equation shows the equilibrium to which the integrated variables will converge. Therefore, the equilibrium pass-through is computed as the inverse of the coefficients from the cointegrated equation.

We also try to assess the time-varying pass-through. First, time-varying results can be obtained from a simple break-up of the sample into two sub-periods. The relatively short sample size prevents us from experimenting with more than two sub-periods. An alternative strategy is to estimate a time-variant model. There are three possibilities for estimating the time-varying coefficients: a Kalman filter, a Markov switching process and smooth transition threshold autoregression (STAR). Darvas (2006) argues that the Kalman filter is the best technique, since it preserves flexibility. By contrast, a smooth transition between the beginning and end of the period and the particular path assumed by the STAR model or the several regimes with the possibility of returning to a previous regime (Markov switching) seem to be unrealistic or too restrictive for countries like the Czech Republic. We therefore build a state and space model where changes in the CPI index are explained by changes in the exchange rate and the error correction term. By applying the Kalman filter, we allow the exchange rate coefficient to vary over time.

5. Data Description and Preliminary Tests

Aggregated CPI, export, and import prices are obtained from the Czech Statistical Office. The nominal effective exchange rate[8] and the 3-month interest rate are taken from the ARAD database, while producer prices, labor costs, GDP, and the HICP for the euro area come from Eurostat. Sub-components of the Czech CPI are estimated by CNB staff. GDP, available on a quarterly basis, was converted to monthly frequency. The output gap is estimated from GDP data using the Hodrick-Prescott filter. In order to keep as much information as possible, we start with the estimations over the whole period. Then the data are split into sub-periods: 1996:1–2001:12 and 2002:1–2006:12. The second interval encompasses the period of CPI inflation targeting. We do not divide the second sub-sample into the pre- and post-EU accession periods, in order to keep the time series relatively long.

The original series, apart from GDP and the interest rate, are expressed in indices equal to 100 for the base year 2000. For the CPI, export, and import price indices, there was a methodological change in 2001: the number of representative price categories increased by approximately 20%. Since there is no obvious way of combining the two methodologies, we merge the pre-2001 and post-2001 series using 2000 as the base year.[9]

Before starting the econometric estimations, some commonly used procedures are applied to test the data properties. First, the series are checked for stationarity. Generally, the number of lags for the unit root test is based on the following formula: $k_{max} = \text{int}\left(A * \frac{T}{100}^{\frac{1}{4}} \right)$, where T is the number of observations and A is equal to 12 for monthly data. However, this gives us up to 13 lags. That is too much for a small sample. The unit root tests are estimated with the maximum number of lags set to 6.[10] Tables 3 and 4 summarize the test statistics for the ADF and KPSS tests. For additional unit root tests, see Annex 1 and 2.

[8] The weights account for trade with 23 principal trade partners.

[9] The same approach was applied in the Emerging Market Database (EMED) to construct the series of Czech export and import prices.

[10] Estimation with 2, 4, or 8 lags gives quite similar results.

Table 3: ADF and KPSS Tests on m-o-m Data in Log-levels and Log-differences

	whole period		1996–2001		2002–2006	
	ADF	**KPSS**	**ADF**	**KPSS**	**ADF**	**KPSS**
			Estimation in levels			
s	-2.32	0.27 ***	-2.14	0.17 **	-1.55	0.20 **
px	-1.96	0.25 ***	-1.93	0.08	-1.96	0.16 **
pm	-2.20	0.19 **	-2.16	0.11	-4.01 **	0.09
$pm^{non\ oil}$	-2.48	0.17 **	-2.27	0.12	-3.54 **	0.08
pm^{oil}	-1.86	0.16 **	-1.39	0.20 **	-2.22	0.17 **
py	-2.18	0.23 ***	-1.60	0.11	-2.39	0.11
pc	-1.69	0.33 ***	-1.12	0.24 ***	-2.61	0.18 **
pc^{EU}	-1.35	0.22 ***	-0.58	0.20 **	-2.42	0.20 **
pc^{tt}	-1.84	0.34 ***	-1.98	0.17 **	-3.33 *	0.10
pc^{tf}	-2.48	0.22 ***	-2.03	0.13 *	-3.60 **	0.09
pc^{to}	-1.49	0.35 ***	-1.09	0.23 ***	-3.62 **	0.08
pc^{nt}	-1.52	0.33 ***	-0.84	0.26 ***	-1.91	0.20 **
pc^{no}	-1.75	0.36 ***	-1.21	0.26 ***	-1.31	0.14 *
w	-2.35	0.17 **	-2.17	0.10	-2.78	0.13 *
i	-1.69	0.14 *	-2.01	0.15 **	-3.06	0.20 **
gap	-2.78	0.07	-4.52 ***	0.18 **	-2.10	0.19 **
			Estimation in first difference			
s	-6.38 ***	0.04	-6.30 ***	0.05	-7.37 ***	0.08
px	-6.82 ***	0.04	-3.66 **	0.08	-5.85 ***	0.12 *
pm	-7.42 ***	0.05	-4.59 ***	0.11	-5.79 ***	0.11
$pm^{non\ oil}$	-7.30 ***	0.05	-4.60 ***	0.09	-5.91 ***	0.11
pm^{oil}	-9.98 ***	0.06	-7.03 ***	0.12	-5.61 ***	0.11
py	-4.85 ***	0.08	-7.08 ***	0.09	-2.32	0.14 *
pc	-10.87 ***	0.09	-7.42 ***	0.08	-7.03 ***	0.09
pc^{EU}	-11.58 ***	0.09	-7.49 ***	0.17 **	-8.27 ***	0.09
pc^{tt}	-9.02 ***	0.08	-6.57 ***	0.12	-5.00 ***	0.10
pc^{tf}	-8.59 ***	0.06	-6.26 ***	0.12	-4.94 ***	0.15 **
pc^{to}	-4.80 ***	0.08	-8.25 ***	0.06	-5.12 ***	0.06
pc^{nt}	-12.85 ***	0.13 *	-9.41 ***	0.09	-8.31 ***	0.10
pc^{no}	-9.89 ***	0.08	-6.54 ***	0.10	-7.42 ***	0.08
w	-7.60 ***	0.19 **	-4.75 ***	0.06	-10.23 ***	0.10
i	-8.80 ***	0.15 **	-6.14 ***	0.13 *	-5.82 ***	0.09
gap	-4.35 ***	0.09	-2.63	0.12 *	-2.60	0.08

Note: [a] see Table 2 for the definition of the variables. The upper scripts for the CPI denote the following sub-groups: no upper script – aggregated CPI, tt – tradables only, tf – food only, to – other tradables (excluding food and beverages), and nt – non-tradables excluding regulated prices. [b] H0 in the ADF test assumes non-stationarity of the series. H0 in the KPSS test says the variables are stationary.

By and large, all the variables except the output gap are non-stationary in levels and stationary in first difference. The output gap is stationary by construction. For the interest rate, the ADF and KPSS tests generate controversial results. The unit root test estimated on the sub-sample is less conclusive. Notice that in short samples unit root tests can lack power to reject the null of non-stationarity. Also, as noted by Enders (1995, Chapter 4), the Dickey-Fuller and Phillips Perron tests (see Annex 1 and 2) are unable to distinguish between unit roots and non-linear trends. Since in the majority of pass-through studies the interest rate and the output gap are estimated in levels, we also include these variables in the VAR models in levels. The other variables are estimated in log differences (m-o-m data) or first difference (y-o-y data). According to common practice, it is also possible to have some non-stationary variables if the whole model passes the stability test.

Table 4: ADF and KPSS Tests on Data Transformed into Annual Changes

	whole period				1996–2001				2002–2006			
	ADF		KPSS		ADF		KPSS		ADF		KPSS	
					Estimation in levels							
s	-3.52	**	0.06		-3.27	*	0.06		-2.60		0.11	
px	-3.71	**	0.05		-2.69		0.07		-2.12		0.13	*
pm	-3.20	*	0.06		-2.44		0.10		-2.33		0.10	
$pm^{non\ oil}$	-3.53	**	0.05		-2.74		0.10		-2.84		0.10	
pm^{oil}	-2.75		0.06		-1.79		0.12	*	-0.50		0.13	*
py	-3.93	**	0.09		-2.36		0.10		-3.12		0.16	**
pc	-2.42		0.14	**	-1.71		0.12		-1.45		0.15	**
pc^{EU}	-2.32		0.08		-1.83		0.21	**	-1.97		0.17	**
pc^{tt}	-3.35	*	0.12		-2.52		0.15	**	-1.68		0.14	*
pc^{tf}	-2.93		0.10		-2.16		0.17	**	-2.24		0.15	**
pc^{to}	-2.29		0.12	*	-1.31		0.12	*	-1.99		0.07	
pc^{nt}	-1.99		0.13	*	-1.84		0.11		-1.56		0.14	**
pc^{no}	-3.03		0.09		-1.74		0.11		-2.71		0.14	**
w	-3.13	*	0.08		-2.10		0.18	**	-4.28	***	0.09	
					Estimation in first difference							
s	-5.85	***	0.04		-3.61	**	0.07		-6.45	***	0.12	*
px	-4.66	***	0.04		-3.41	*	0.09		-5.26	***	0.18	**
pm	-4.84	***	0.04		-3.89	**	0.11		-5.84	***	0.06	
$pm^{non\ oil}$	-4.63	***	0.04		-3.68	**	0.10		-5.64	***	0.10	
pm^{oil}	-3.36	*	0.05		-2.67		0.15	**	-5.75	***	0.16	**
py	-4.31	***	0.04		-4.52	***	0.10		-2.74		0.10	
pc	-5.83	***	0.04		-5.09	***	0.11		-7.11	***	0.06	
pc^{EU}	-11.66	***	0.08		-6.54	***	0.13	*	-7.83	***	0.12	*
pc^{tt}	-5.37	***	0.04		-2.54		0.11		-5.73	***	0.10	
pc^{tf}	-4.97	***	0.04		-2.75		0.09		-5.21	***	0.18	**
pc^{to}	-10.76	***	0.04		-5.14	***	0.14	*	-6.32	***	0.07	
pc^{nt}	-11.41	***	0.06		-7.33	***	0.17	**	-7.11	***	0.09	
pc^{no}	-9.25	***	0.04		-5.99	***	0.14	*	-1.81		0.10	
w	-6.83	***	0.29	***	-4.02	**	0.08		-4.58	***	0.05	

Note: [a] see Table 2 for the definition of the variables. The upper scripts for the CPI denote the following sub-groups: no upper script – aggregated CPI, tt – tradables only, tf – food only, to – other tradables (excluding food and beverages), and nt – non-tradables excluding regulated prices. [b] H0 in the ADF test assumes non-stationarity of the series. H0 in the KPSS test says the variables are stationary.

Table 5: Lag Length Selection

	VAR No.:										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
m-o-m											
AIC	6	6	6	6	7	6	6	6	6	6	6
SIC	1	2	1	2	2	1	1	1	0	1	2
y-o-y											
AIC	8	8	8	8	8	8	6	6	6	6	8
SIC	0	2	2	2	2	2	1	2	0	2	2

Note: AIC – Akaike information criterion, SIC – Schwarz information criterion. The numbers in the table show the number of lags in the VAR suggested under the selected information criteria.

Table 5 shows the optimal number of lags for each VAR based on the Akaike and Schwarz information criteria. The Akaike information criterion suggests 6–8 lags. According to the Schwarz information criterion, the number of lags should not be greater than 2. Since for short samples the Schwarz criterion is preferred, we estimate all the VAR models with 2 lags. All 11 VAR models passed the stability test.

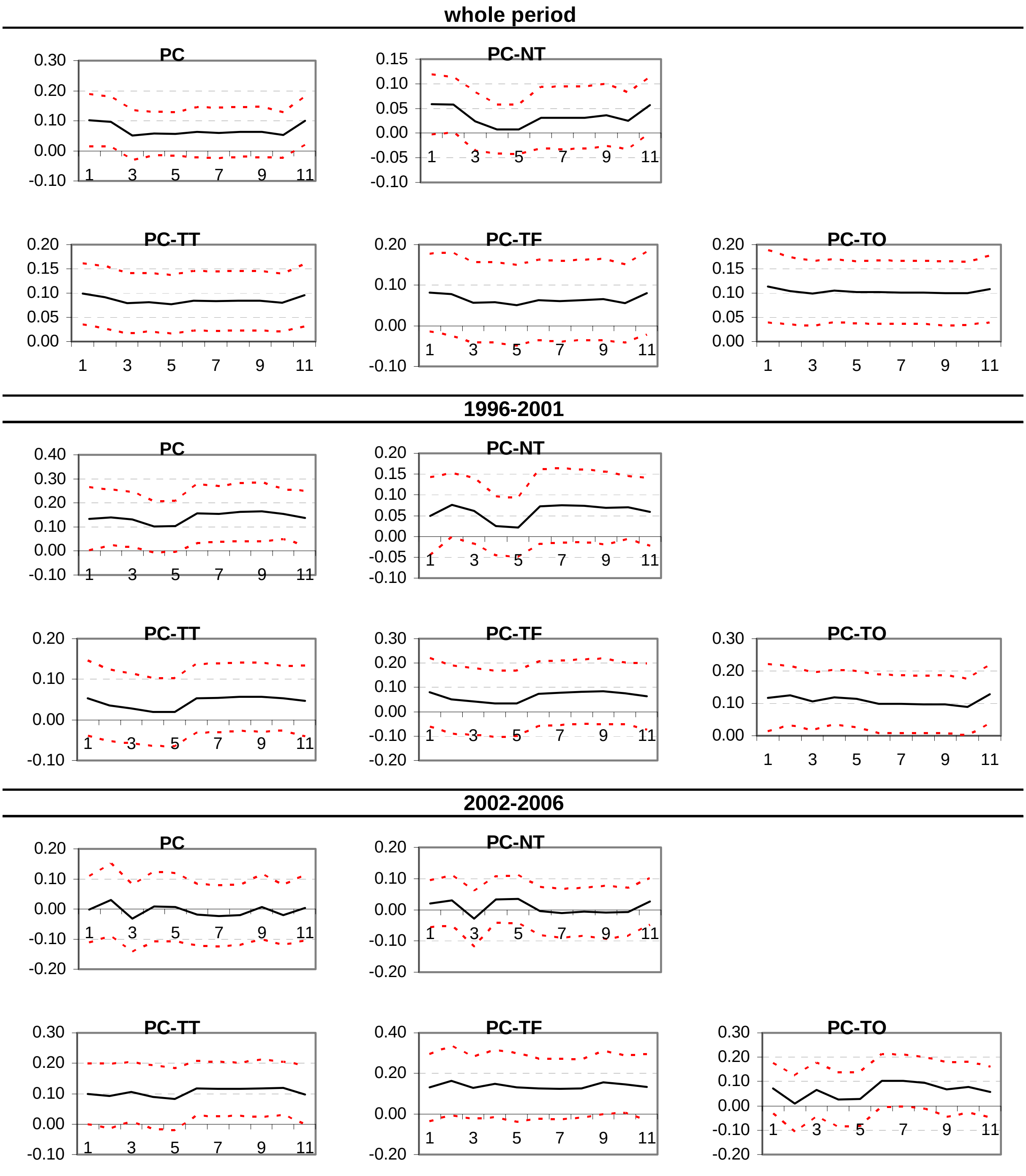
6. Results

The measure of pass-through is based on the approach described in section 3. First, we show the results from the VAR models. Then we present calculations based on VECM. Finally, we discuss possible time variation and asymmetry in the pass-through.

The impulse responses based on VAR models show incomplete and fast short-run pass-through. The effect of the exchange rate shock to the CPI attains its maximum after roughly 6 months, and at least half of this effect occurs during the first 3 months. In other words, if we consider the accumulated impulse response after 12 months as a complete response, the ERPT after 3 months accounts for at least 50% depending on the specification chosen. In order to check how sensitive our results are to the selected specification, we put the results obtained from different specifications in the same figure. Figures 1 and 2 plot the peak impulse response for each specification estimated for 5 CPI indices[11] over 3 periods. The numbers from 1 to 11 on the horizontal axis correspond to the VAR numbering in Table 2. In other words, each small graph in Figures 1 and 2 shows 11 peak impulse responses and their confidence intervals estimated from the 11 different VAR models.

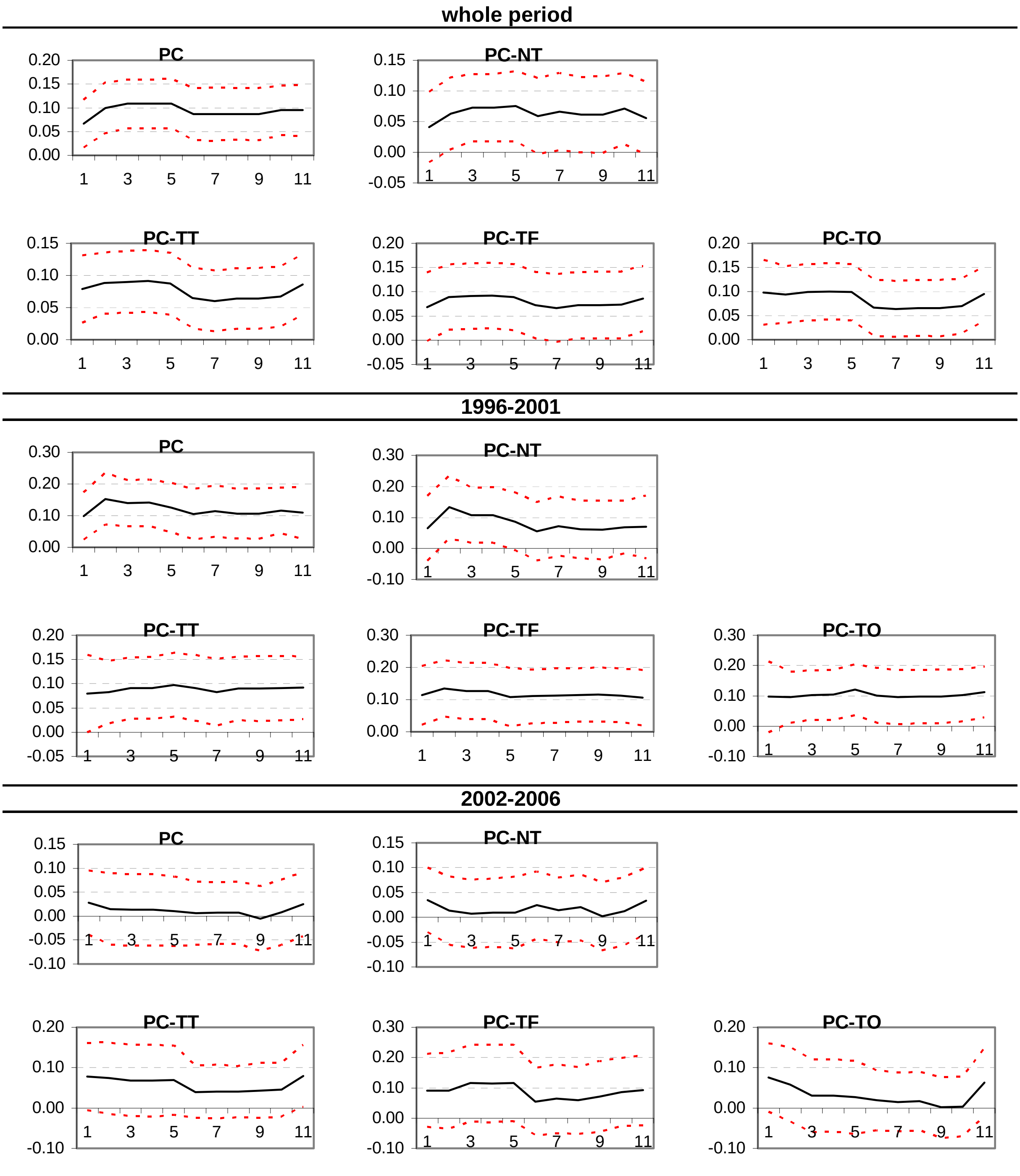
[11] We assume that the exchange rate shock may be transmitted through intermediate inputs that do not necessarily belong to the same group as the final product. Therefore, we keep all other variables unchanged when the disaggregated consumer price index is used instead of the aggregated one.

Figure 1: Peak Impulse Response to a 1% Exchange Rate Shock; m-o-m Data



Note: The upper scripts for the CPI denote the following sub-groups: no upper script – aggregated CPI, tt – tradables only, tf – food only, to – other tradables (excluding food and beverages), and nt – non-tradables excluding regulated prices. The numbers from 1 to 11 on the horizontal axis denote the specification number as in Table 2. The solid line shows the peak impulse response from each specification. The dashed line is the 95% confidence interval. The peak impulse response is observed in the 2nd month for the sub-period 2002–2006 for all prices except other tradables. Otherwise, the peak impulse response occurs in the 3rd month.

Figure 2: Peak Impulse Response to a 1% Exchange Rate Shock; y-o-y Data

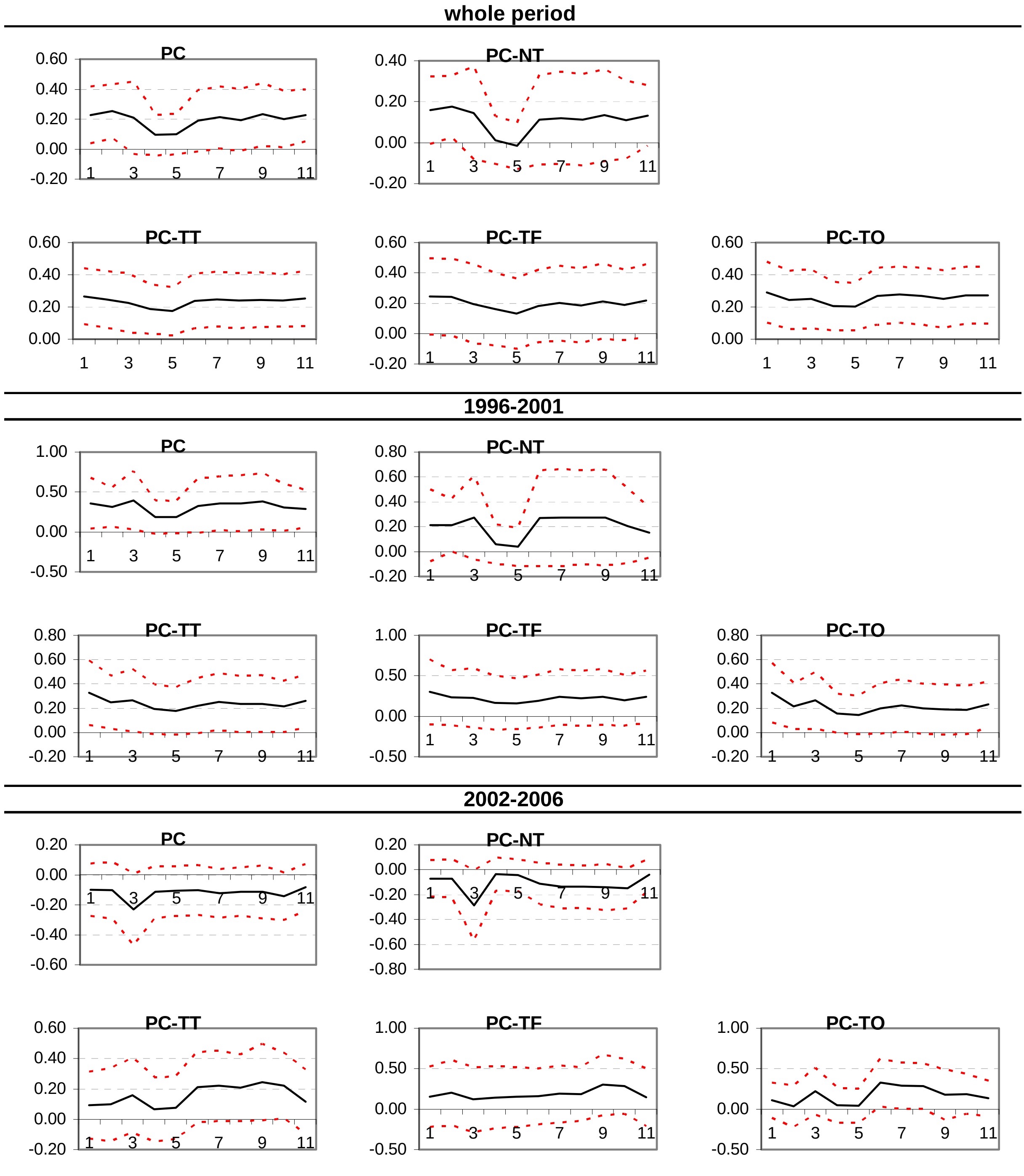


Note: The upper scripts for the CPI denote the following sub-groups: no upper script – aggregated CPI, tt – tradables only, tf – food only, to – other tradables (excluding food and beverages), and nt – non-tradables excluding regulated prices. The numbers from 1 to 11 on the horizontal axis denote the specification number as in Table 2. The solid line shows the peak impulse response from each specification. The dashed line is the 95% confidence interval. The peak impulse response is observed in the 2nd month for the sub-period 2002–2006 for all prices except other tradables. Otherwise, the peak impulse response occurs in the 3rd month.

According to our expectations, the magnitude of the pass-through is not the same for tradables and non-tradables. For non-tradables it is the smallest and is almost insignificant, in line with the theoretical literature. Among the three groups of tradable goods (total index, food, and other tradables), the peak impulse response has more or less the same magnitude. The year-on-year estimates produce more significant results than the estimates done on month-on-month changes. Estimated on the whole sample, the peak impulse response of the y-o-y CPI is between 7% and 12%. For some specifications it is slightly higher during the first period, but it becomes insignificant in the second period. The m-o-m estimates report a peak response of around 10% for the estimates done on the whole sample. In the first period, only the aggregated index and selected specifications for other tradables have a statistically significant impulse response (around 10%–15%). In the second period, the peak impulse is significant in half of the specifications with the total tradables index.

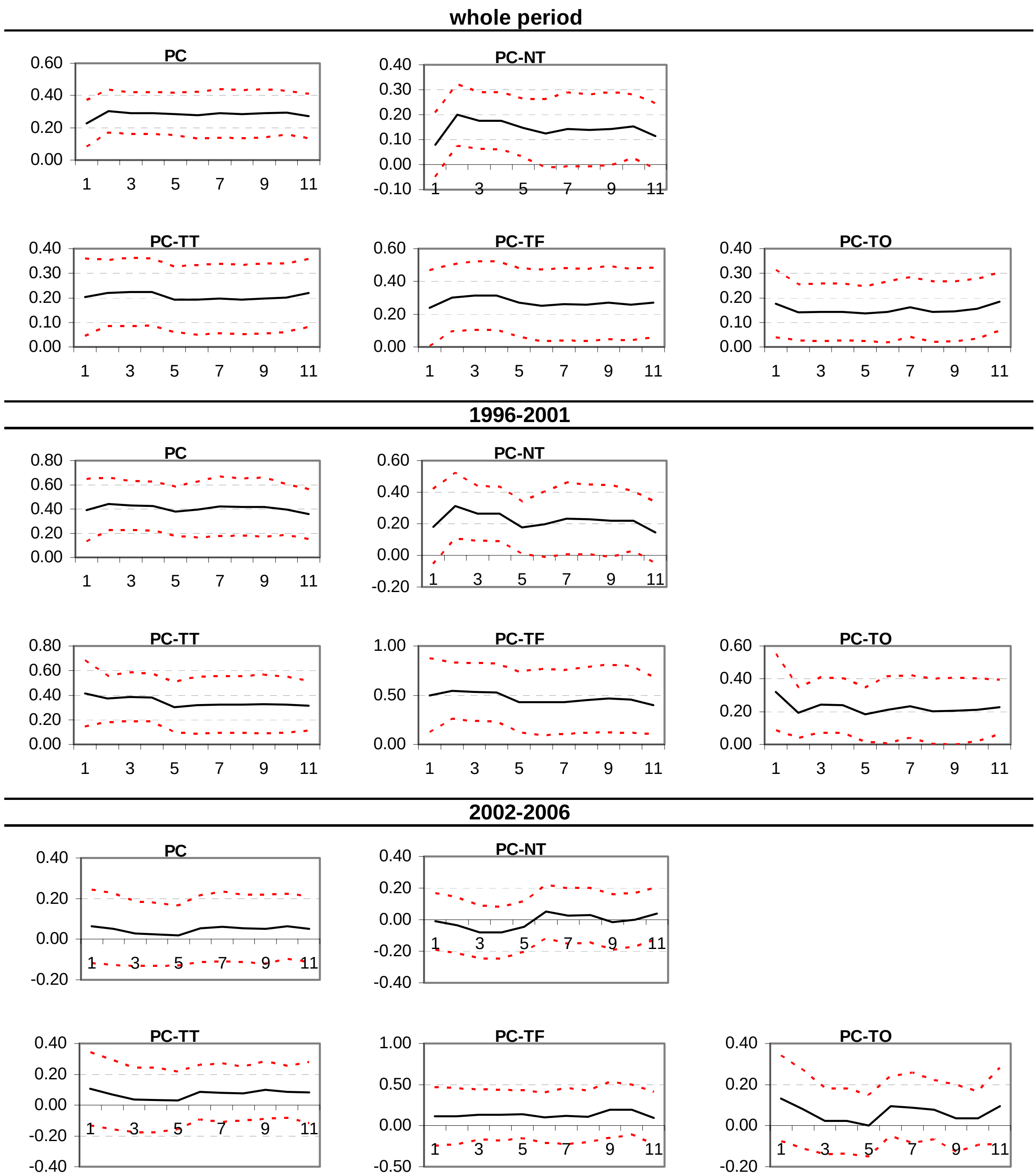
After 6 months, the ERPT is mostly transmitted into consumer prices. Figures 3 and 4 show the accumulated impulse response in the 6th period. We display the results in the same manner as in figures 1 and 2. The ERPT to the aggregated CPI does not exceed 25% for the m-o-m estimates and fluctuates around 30% for the y-o-y results. It is found to be higher in the first period (up to 40%–50%) and lower and insignificant in the second period. The lower pass-through in the second period is in line with the gradual decrease of the target level of inflation during 2002–2005. However, it is very unlikely that there is no ERPT to domestic inflation in the small open economy with a significant share of imported goods in the consumption basket. In case of the estimations done on two sub-periods, shorter data set and possible volatility in the data may hide the true magnitude of the pass-through. For this reason, estimations performed on the whole sample seem to provide more reliable results. Notice that an insignificant accumulated impulse response means that the shock has already been transmitted and no longer affects the variable of interest. However, it can also be insignificant if all the instant impulse responses are insignificant.

Figure 3: Accumulated Impulse Response after 6 Periods; m-o-m Data



Note: The upper scripts for the CPI denote the following sub-groups: no upper script – aggregated CPI, tt – tradables only, tf – food only, to – other tradables (excluding food and beverages), and nt – non-tradables excluding regulated prices. The numbers from 1 to 11 on the horizontal axis denote the specification number as in Table 2. The solid line shows the peak impulse response from each specification. The dashed line is the 95% confidence interval.

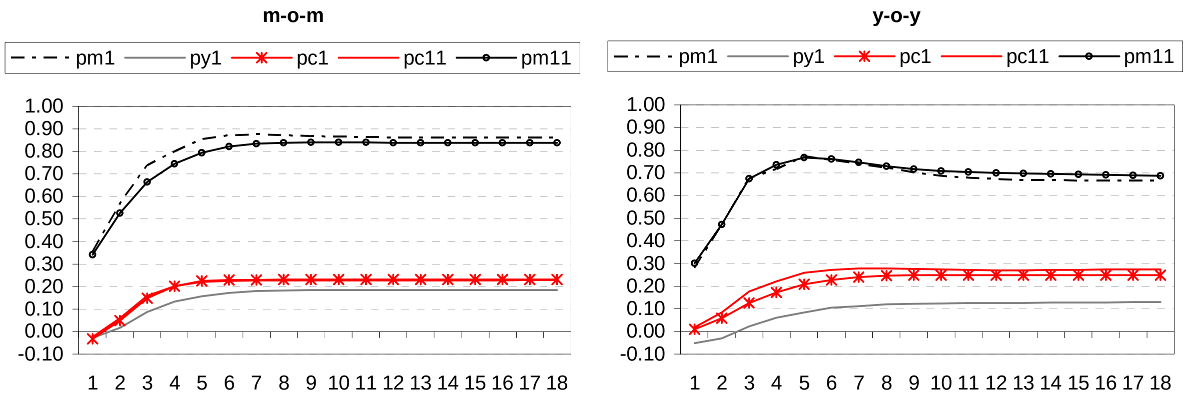
Figure 4: Accumulated Impulse Response after 6 Periods; y-o-y Data



Note: The upper scripts for the CPI denote the following sub-groups: no upper script – aggregated CPI, tt – tradables only, tf – food only, to – other tradables (excluding food and beverages), and nt – non-tradables excluding regulated prices. The numbers from 1 to 11 on the horizontal axis denote the specification number as in Table 2. The solid line shows the peak impulse response from each specification. The dashed line is the 95% confidence interval.

Finally, we show the pass-through evolution along the distribution chain. The vertical axis on Table 5 shows the magnitude of the pass-through (accumulated impulse responses) to import prices, producer prices, and consumer prices. The horizontal axis displays the periods of time. We show the results from the two VAR models where there is an aggregated import price index and the ERPT to consumer prices is significant. The estimations are done on the whole sample.

Figure 5: Pass-through Along the Distribution Chain (accumulated impulse response)



Note: pc is the aggregated consumer price index, py is the producer price index, and pm is the import price index. The numbers 1 and 11 in the legend denote the specification number as in Table 2. The periods (months) are plotted on the horizontal axis.

The results are in line with the general findings of a fading pass-through effect along the distribution chain: the highest – close-to-complete – pass-through is found for import prices; the pass-through is much lower for the PPI and CPI. The pass-through to import prices is around 85% on the m-o-m data, which is close to Faruqee (2006) for the euro area. The pass-through is lower, and the distance between the accumulated impulse responses of import and consumer prices is much narrower, when year-on-year changes are used instead. Interestingly, the reaction of producer prices to the exchange rate shock is lower than the reaction of consumer prices to the same shock. Bacchetta and van Wincoop (2003) explain the high pass-through to import prices and the low pass-through to domestic prices by high competition in the domestic market. In other words, foreign exporting firms sell intermediate goods to domestic firms and set their prices in the foreign currency. Domestic firms produce final goods, which include foreign components. If the degree of competition among local producers in the local market is high, the domestic firm prefers to set its prices in the local currency, which leads to a high pass-through to import prices and low pass-through to consumer prices. Therefore, the main absorption of the exchange rate shock occurs during the production process. The higher pass-through to consumer prices relative to producer prices in this case is a result of the foreign component in the consumption basket.

The majority of VAR-type pass-through estimates are taken in first differences, due to non-stationary of the variables in levels. However, as pointed out by Elbourne *et al.* (2001), if series are non-stationary in levels but cointegrated, the vector error correction model may be more appropriate. Before proceeding to the VEC estimate, we test for a number of cointegrated equations in each specification using the Johansen cointegration test. The results are summarized in Table 6.

Table 6: Number of Cointegrated Equations Based on Johansen Cointegration Test

ECM No.	m-o-m					y-o-y				
	PC	PC^{TT}	PC^{TF}	PC^{TO}	PC^{NT}	PC	PC^{TT}	PC^{TF}	PC^{TO}	PC^{NT}
1	2	1	2	2	2	2	2	2	2	2
2,3	1	1	1	1	1	4*	3	4*	3	3
4	2	1	1	2	2	3*	3	3*	3	3
5	3	2*	-	3	2*	3*	3*	-	3	3
6	2	2*	2	3	2*	3*	3*	3*	3	3
7	2	2	1	2	2	2*	1*	2*	1	1
8	1	1	0	1	1	1	1	1	0	1
9,10	2	2	1	2	2	4	1*	4	1	1
11	1	1	1	1	1	4	2	4	1	1

Note: The upper scripts for the CPI denote the following sub-groups: no upper script – aggregated CPI, tt – tradables only, tf – food only, to – other tradables (excluding food and beverages), and nt – non-tradables excluding regulated prices. The numbers from 1 to 11 in the first column denote the specification number as in Table 2. Initial test assumptions: a linear trend in the data, but only with an intercept and no trend in the cointegrated equations. * denotes the number of cointegrated equations selected under the different test assumptions.

Since the interpretation of equilibrium pass-through becomes very difficult when the number of cointegrated equations is greater than one, we compute the equilibrium pass-through from the specifications where the Johansen cointegration test detects only one cointegrated equation. Therefore, the equilibrium pass-through is estimated for specifications 2, 3, 8, and 11 on the m-o-m data. The results are summarized in Table 7.

Table 7: Equilibrium Pass-through

No.	**PC**	**PCTT**	**PCTF**	**PCTO**	**PCNT**
			whole period		
2	0.00	0.00	0.28	0.82	0.00
3	-1.01	-0.54	0.66	-1.09	-1.96
8	1.12	0.89	0.65	1.31	1.03
11	-0.64	0.00	-0.36	0.31	-1.15
			1996–2001		
2	0.00	0.22	0.00	0.33	0.97
3	1.11	0.42	0.65	0.70	1.28
8	0.98	0.45	0.00	0.00	0.00
11	-1.14	-0.43	-0.42	-0.82	-2.42
			2002–2006		
2	0.00	-0.42	-0.20	-0.61	0.82
3	-0.27	-0.45	-0.20	-0.45	1.31
8	0.00	0.00	0.00	0.00	0.00
11	0.00	0.00	-0.52	0.00	0.00

Note: The upper scripts for the CPI denote the following sub-groups: no upper script – aggregated CPI, tt – tradables only, tf – food only, to – other tradables (excluding food and beverages), and nt – non-tradables excluding regulated prices. The numbers in the first column denote the specification number as in Table 2.

In the strict sense, we cannot interpret the coefficients from the cointegration equation as elasticities, since the relation of the causality is not explicitly accounted for. However, the cointegrating relationship represents some equilibrium state to which the series tend to converge.

Hence, it may be interpreted to some extent as the long-run pass-through. Long pass-through is computed as the inverse of the long-run cointegrating coefficients. The estimated equilibrium pass-through is found to be sensitive to the specification and time period selected. It is also not uniform across different CPI groups. One possible explanation of this result could be instability of equilibrium pass-through over time. We do not test this due to the short time series.

We apply the Kalman filter to the exchange rate coefficient in the equation where changes in the CPI are explained by changes in the exchange rate and the error correction equation. The time-varying coefficient is found to be insignificant in all specifications. Notice that the pass-through is also found to be low or insignificant when the time-varying procedure is applied (see, for example, Darvas, 2001).

It worth noting that the assumption of asymmetry in price adjustments could be important for the pass-through estimates. In general, prices can be more rigid downward (see the menu-cost model of Ball and Mankiw, 1994, for possible theoretical explanations of asymmetric price adjustments in the presence of positive trend inflation, and Pollard and Coughlin, 2003, for estimates of asymmetric pass-through to import prices). This implies that the reaction to exchange rate appreciation is not the same as that to exchange rate depreciation. The standard approach to the estimation of impulse response functions ignores this issue; for example, ERPT is calculated from impulse responses to a negative exchange rate shock, which corresponds to exchange rate depreciation. However, in the case of impulses of the same magnitude but of the opposite sign (exchange rate appreciation), the responses would also have the opposite sign and the same magnitude. In fact, this VAR structure implicitly assumes that prices react to exchange rate appreciation and depreciation with the same magnitude. Some preliminary results obtained from the 3-variable VAR (exchange rate, import prices, and consumer prices) estimated on the whole period with two coefficients for the exchange rate for periods of appreciation and depreciation show very low pass-through (around zero) in the case of exchange rate appreciation and around 9%–12% in the case of exchange rate depreciation. It is not clear, however, how to define periods of appreciation and depreciation and how to distinguish temporary and permanent changes. We already have a broad range of pass-through estimates, and we found a very low pass-through during 2002–2006. Therefore, the results from the time-varying model are in line with the pass-through estimates for the second period. A simple asymmetric model is not sufficient to draw a conclusion on the magnitude of the asymmetric pass-through, and the results obtained do not significantly contribute to the main conclusion. We expect to develop an asymmetric model in the future.

7. Conclusion

In this paper, we measure the dynamics and completeness of the pass-through for the Czech Republic by applying alternative specifications and econometric procedures to two datasets: m-o-m changes and y-o-y changes. The speed of the exchange rate shock transmission to all prices is quite high (at least 50% of the shock is transmitted during the first 3 months and 100% after 6 months), which is usual for a small open economy. However, in absolute terms, the peak impulse response does not exceed 25%, and the total reaction to the exchange rate shock is likely to be less than 30% for the data estimated on the whole sample. The pass-through is found to be somewhat higher than 30% during 1996–2001, but it is mostly insignificant between 2002 and 2006. Insignificant pass-through is also found when the time-varying model is used instead of VAR. Shorter time-series and possible volatility in the data may be responsible for insignificant pass-through estimates. Since it is very implausible that pass-through to domestic prices is zero for the Czech Republic, results based one the whole sample estimates seem to provide more reliable results. We also find that tradable goods react much more to an exchange rate shock than do non-tradable goods, in line with the theoretical foundations. Furthermore, the magnitude of the exchange rate pass-through decreases from the initial stage of production to final goods. However, we found lower pass-through to producer prices than to consumer prices. High competition on the domestic market or the presence of imported goods in the consumption basket could be a possible explanation for this result.

Previous studies find a short run pass-through of around 0–40%. In some cases it is extremely low, but in other cases it is likely to be more than 30%. Therefore, our estimates for 1996–2001 are close to the upper bound and our estimations for 2002–2006 close to the lower bound of the pass-through results available for the Czech Republic. These results are in line with the decrease in the level of target inflation during 2002–2005. Last but not least, as the present research is based on relatively short time series of a fast transforming economy, the estimated exchange rate pass-through should be interpreted in relative terms rather than in absolute values. The results are viewed as emphasizing the general tendencies in pass-through behavior, but thanks to easily updatable data it will be possible to survey further pass-through developments in the future.

References

BACCHETTA, P. AND E. VAN WINCOOP (2003): "Why Do Consumer Prices React Less Than Import Prices to Exchange Rates?" NBER Working Paper No. 9352. *Journal of the European Economic Association*, Vol. 1(2–3), pp. 662–670.

BAILLIU, J. AND E. FUJII (2004): "Exchange Rate Pass-Through and the Inflation Environment in Industrialized Countries: An Empirical Investigation." Bank of Canada Working Paper No. 2004-21.

BALL, L. AND N. G. MANKIW (1994): "A Sticky-Price Manifesto." Carnegie-Rochester Conference Series on Public Policy, Vol. 41, pp. 127–151.

BENEŠ, J., T. HLÉDIK, D. VÁVRA, AND J. VLČEK (2003): "The Quarterly Projection Model and its Properties." in: Coats, W., D. Laxton, and D. Rose (eds.): *The Czech National Bank's Forecasting and Policy Analysis System.* Czech National Bank, Prague.

BITĀNS, M. (2004): "Pass-Through of Exchange Rates to Domestic Prices in East European Countries and the Role of Economic Environment." Bank of Latvia Working Paper, No. 4/2004.

BURSTEIN, A. T., M. EICHENBAUM, AND S. REBELO (2002): "Why Are Rates of Inflation So Low After Large Devaluations?" CEPR Discussion Paper, 8748.

BUSSIÈRE, M. (2006): "Exchange Rate Pass-Through in the G7 Economies: The Role of Nonlinearities and Asymmetries." ECB, mimeo.

CA'ZORZI, M., E. HAHN, AND M. SÁNCHEZ (2007): "Exchange Rate Pass-Through in Emerging Markets." ECB Working Paper, No. 739.

CAMPA, J. AND L. GOLDBERG (2006): "Distribution Margins, Imported Inputs, and the Sensitivity of the CPI to Exchange Rates." NBER Working Paper, 12121.

CAMPA, J. M. AND J. M. GONZALEZ MINGUEZ (2006): "Differences in Exchange Rate Pass-Through in the Euro Area." *European Economic Review*, Vol. 50(1), pp. 121–145.

CHOUDHRI, E. U. AND D. S. HAKURA (2006): "Exchange Rate Pass-Through to Domestic Prices: Does the Inflationary Environment Matter?" *Journal of International Money and Finance*, Vol. 25(4), pp. 614–639.

CHOUDHRI, E. U., H. FARUQEE, AND D. S. HAKURA (2005): "Explaining the Exchange Rate Pass-Through in Different Prices." *Journal of International Economics*, Vol. 65(2), pp. 349–374.

CNB (2004): *Inflation Report*. October.

CORICELLI, F., B. JAZBEC, AND I. MASTEN (2006): "Exchange Rate Pass-Through in EMU Acceding Countries: Empirical Analysis and Policy Implications." *Journal of Banking & Finance*, Vol. 30(5), pp. 1375–1391.

CORSETTI, G. AND L. DEDOLA (2005): "A Macroeconomic Model of International Price Discrimination." *Journal of International Economics*, Vol. 67(1), pp. 129–155.

DABUSINSKAS, A. (2003): "Exchange Rate Pass-Through to Estonian Prices." Eesti Pank Working Paper, No. 1003.

DARVAS, Z. (2001): "Exchange Rate Pass-Through and Real Exchange Rate in EU Candidate Countries." Economic Research Centre of the Deutsche Bundesbank, Discussion Paper, 10/01.

DARVAS, Z. (2006): "Monetary Transmission in the New EU Member States: Evidence from Time-Varying Coefficient Vector Autoregression." OENB Focus on European Economic Integration, No. 1/2006, pp. 140–156.

DEVEREUX, M. B. AND J. YETMAN (2002): "Price-Setting and Exchange Rate Pass-Through: Theory and Evidence." Proceedings of a conference held at the Bank of Canada, November 2002. Ottawa: Bank of Canada.

ÉGERT, B., L. HALPERN, AND R. MACDONALD (2006): "Equilibrium Exchange Rates in Transition Economies: Taking Stock of the Issues." *Journal of Economic Surveys*, Vol. 20(2), pp. 257–324.

ÉGERT, B. AND R. MACDONALD (2006): "Monetary Transmission Mechanism in Transition Economies: Surveying the Surveyable." Magyar Nemzeti Bank Working Paper, No. 2006/5.

ELBOURNE, A., J. DE HAAN, AND E. STERKEN (2001): "Monetary Transmission in EMU: A Reassessment of VAR studies." mimeo.

ENDERS, W. (1995): *Applied Econometric Time Series.* Wiley.

FARUQEE, H. (2004): "Exchange Rate Pass-Through in the Euro Area: The Role of Asymmetric Pricing Behavior." IMF Working Paper, No. 04/14.

FLAMINI, A. (2004): "Inflation Targeting and Exchange Rate Pass-Through." HEI Working Paper, No. 04/2004.

GAGNON, J. E. AND J. E. IHRIG (2004): "Monetary Policy and Exchange Rate Pass-Through." Updated version of FRB International Finance Discussion Paper, No. 704, July 2001. *International Journal of Finance & Economics*, Vol. 9(4), pp. 315–338.

HAHN, E. (2003): "Pass-Through of External Shocks to Euro Area Inflation." ECB Working Paper, No. 243.

KAMPS, A. (2006): "The Euro as Invoicing Currency in International Trade." ECB Working Paper, No. 665.

KORHONEN, I. AND P. WACHTEL (2006): "A Note on Exchange Rate Pass-Through in CIS Countries." *Research in International Business and Finance*, Vol. 20(2), pp. 215–226.

MCCARTHY, J. (1999): "Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies." BIS Working Paper, No. 79.

MCCARTHY, J. (2007): "Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies." *Eastern Economic Journal*, Vol. 33(4), pp. 511–537.

MENON, J. (1995): "Exchange Rate Pass-Through." *Journal of Economic Surveys*, Vol. 9(2), pp. 197–231.

MIHALJEK, D. AND M. KLAU (2001): "A Note on the Pass-Through from Exchange Rate and Foreign Price Changes to Inflation in Selected Emerging Market Economies." in BIS Papers, No. 8 *Modelling Aspects of the Inflation Process and the Monetary Transmission Mechanism in Emerging Market Countries*, pp. 69–81.

POLLARD, P. S. AND C. C. COUGHLIN (2003): "Pass-Through Estimates and the Choice of an Exchange Rate Index." Federal Reserve Bank of St. Louis Working Paper, No. 2003-004B.

RINCON, H., E. CAICEDO, AND N. RODRÍGUEZ (2005): "Exchange Rate Pass-Through Effects: A Disaggregate Analysis of Colombian Imports of Manufactured Goods." Central Bank of Colombia Working Paper, No.330.

SEKINE, T. (2006): "Time-Varying Exchange Rate Pass-Through: Experiences of Some Industrial Countries." BIS Working Paper, No. 202.

TAYLOR, J. (2000): "Low Inflation, Pass-Through, and the Pricing Power of Firms." *European Economic Review*, Vol. 44(7), pp. 1389–1408.

Appendix 1: Unit Root Tests on m-o-m Data

	whole period				1996–2001				2002–2006			
	DFGLS	**PP**	**ERS**	**NP**	**DFGLS**	**PP**	**ERS**	**NP**	**DFGLS**	**PP**	**ERS**	**NP**
						Estimation in levels						
neer	-1.75	-1.76	13.47	-7.28	-2.16	-1.64	6.80 *	-14.89 *	-1.62	-1.75	17.13	-5.11
px	-1.36	-2.17	21.09	-4.81	-2.18	-1.65	5.41 **	-17.53 **	-1.82	-2.07	13.78	-7.05
pm	-1.88	-2.12	10.52	-9.50	-2.35	-1.59	3.03 ***	-29.74 ***	-2.46	-3.27 *	9.64	-12.19
$pm^{non\ oil}$	-1.53	-2.55	11.28	-5.56	-2.39	-1.71	7.06	-22.66 **	-2.33	-3.39 *	11.10	-10.81
pm^{oil}	-1.76	-1.94	14.36	-6.42	-1.38	-1.39	22.92	-3.89	-2.12	-1.62	9.52	-9.75
py	-1.34	-2.45	18.77	-5.61	-1.64	-1.36	9.80	-10.14	-2.14	-2.02	7.32	-14.09
pc	-0.14	-1.69	106.30	-0.15	-0.81	-1.13	30.76	-1.64	-1.81	-2.61	22.38	-5.11
pc^{EU}	-1.38	-1.37	22.21	-3.96	-0.81	-0.70	38.53	-1.81	-1.94	-2.39	17.17	-6.16
pc^{tt}	-0.22	-2.03	88.95	-0.42	-1.31	-1.87	27.37	-3.75	-2.43	-2.88	10.27	-11.46
pc^{tf}	-1.38	-2.49	24.64	-4.23	-1.68	-1.96	17.75	-5.62	-2.35	-2.90	11.47	-11.53
pc^{to}	0.36	-1.53	149.58	0.45	-0.68	-1.01	38.08	-1.47	-3.74 ***	-3.02	3.19 ***	-30.26 ***
pc^{nt}	-0.25	-1.52	76.36	-0.70	-0.66	-0.77	55.29	-1.16	-1.70	-1.84	19.07	-5.05
pc^{no}	-0.26	-1.75	65.51	-0.83	-0.96	-1.03	37.75	-2.20	-1.37	-1.34	21.02	-4.06
w	-2.40	-6.31 ***	8.82	-10.32	-2.09	-4.41 ***	12.40	-7.13	-1.57	-6.36 ***	17.22	-4.40
i	-1.42	-2.68	21.74	-4.04	-1.21	-2.58	29.64	-3.06	-1.53	-2.38	10.89	-6.28
gap	-2.08	-2.67	11.59	-8.56	-4.89 ***	-1.98	10.55	-11.16	-1.72	-2.24	12.90	-9.39
						Estimation in first difference						
neer	-9.75 ***	-9.73 ***	0.45 ***	-68.33 ***	-6.22 ***	-6.36 ***	1.61 ***	-32.32 ***	-7.38 ***	-7.37 ***	3.19 ***	-28.95 ***
px	-3.67 ***	-6.80 ***	2.48 ***	-24.65 ***	-3.72 ***	-3.61 **	5.02 **	-20.26 **	-5.59 ***	-5.79 ***	3.97 ***	-26.47 ***
pm	-3.86 ***	-7.45 ***	1.99 ***	-25.54 ***	-4.64 ***	-4.59 ***	3.70 ***	-25.66 ***	-5.67 ***	-5.80 ***	3.81 ***	-26.78 ***
$pm^{non\ oil}$	-3.37 **	-7.31 ***	2.53 ***	-20.26 **	-4.63 ***	-4.62 ***	3.68 ***	-25.55 ***	-5.68 ***	-5.91 ***	3.99 ***	-26.76 ***
pm^{oil}	-10.03 ***	-10.00 ***	1.31 ***	-69.02 ***	-7.08 ***	-7.04 ***	2.63 ***	-34.12 ***	-5.70 ***	-5.49 ***	3.35 ***	-26.85 ***
py	-2.02	-9.71 ***	6.47 *	-4.60	-3.54 ***	-7.10 ***	3.08 ***	-16.64 *	-2.45	-5.04 ***	9.99	-8.84
pc	-10.87 ***	-10.86 ***	1.30 ***	-70.44 ***	-7.47 ***	-7.39 ***	2.60 ***	-34.60 ***	-7.10 ***	-7.04 ***	3.10 ***	-28.87 ***
pc^{EU}	-11.09 ***	-11.58 ***	1.36 ***	-70.66 ***	-7.47 ***	-7.49 ***	2.71 ***	-34.59 ***	-8.20 ***	-8.29 ***	3.29 ***	-28.74 ***
pc^{tt}	-8.37 ***	-9.02 ***	1.57 ***	-62.92 ***	-6.66 ***	-6.58 ***	2.66 ***	-33.35 ***	-5.01 ***	-4.63 ***	3.81 ***	-24.64 ***
pc^{tf}	-7.82 ***	-8.62 ***	1.83 ***	-60.12 ***	-6.30 ***	-6.26 ***	2.88 ***	-32.53 ***	-4.95 ***	-4.12 ***	2.32 ***	-38.93 ***
pc^{to}	-4.50 ***	-10.54 ***	2.21 ***	-30.88 ***	-8.24 ***	-8.26 ***	2.77 ***	-34.98 ***	-5.58 ***	-5.31 ***	0.95 ***	-26.75 ***
pc^{nt}	-12.89 ***	-12.82 ***	1.29 ***	-70.52 ***	-9.34 ***	-9.41 ***	2.67 ***	-34.51 ***	-2.48	-8.35 ***	3.69 ***	-5.74
pc^{no}	-9.92 ***	-9.88 ***	1.33 ***	-68.77 ***	-6.50 ***	-6.53 ***	2.78 ***	-32.96 ***	-7.54 ***	-7.42 ***	3.06 ***	-29.00 ***
w	-2.61	-24.67 ***	2.99 ***	-1.97	-2.53	-14.58 ***	8.81	-1.67	-4.68 ***	-13.50 ***	1.81 ***	-13.04
i	-5.33 ***	-12.14 ***	0.08 ***	-66.39 ***	-6.22 ***	-7.88 ***	0.31 ***	-307.57 ***	-3.72 ***	-5.96 ***	3.93 ***	-18.40 **
gap	-3.20 **	-4.87 ***	11.68	-5.92	-1.59	-2.43	8.28	-5.35	-2.35	-3.32 *	7.43	-11.33

Note: All tests are performed with an assumption of constant and trend in time series.

Appendix 2: Unit Root Tests on y-o-y Data

	whole period				1996–2001				2002–2006			
	DFGLS	PP	ERS	NP	DFGLS	PP	ERS	NP	DFGLS	PP	ERS	NP
						Estimation in levels						
neer	-3.48 **	-2.87	3.17 ***	-28.40 ***	-2.88 *	-2.39	4.27 **	-22.68 **	-1.99	-2.70	19.25	-5.83
px	-3.75 ***	-2.70	2.30 ***	-39.83 ***	-2.58	-1.97	3.57 ***	-30.66 ***	-1.51	-2.35	25.20	-4.37
pm	-3.23 **	-2.48	3.27 ***	-27.61 ***	-2.54	-1.33	2.87 ***	-31.26 ***	-2.00	-2.30	11.30	-10.48
$pm^{non\ oil}$	-3.48 **	-2.69	2.84 ***	-32.25 ***	-2.80 *	-1.50	2.37 ***	-36.64 ***	-1.93	-2.90	16.70	-7.50
pm^{oil}	-2.78 *	-2.18	4.39 **	-20.58 **	-1.84	-1.33	7.32	-11.26	-0.88	-0.77	27.07	-2.43
py	-3.73 ***	-2.57	1.35 ***	-63.54 ***	-2.46	-1.61	3.50 ***	-25.42 ***	-2.19	-1.55	0.82 ***	-13.01
pc	-2.45	-2.23	6.62 *	-13.79	-1.66	-1.64	15.83	-5.68	-2.17	-1.45	1.33 ***	-64.11 ***
pc^{EU}	-2.13	-2.32	11.01	-8.55	-1.29	-1.90	39.30	-2.63	-2.13	-1.91	10.69	-8.43
pc^{tt}	-3.24 **	-2.39	2.50 ***	-36.14 ***	-2.12	-1.66	6.30 *	-14.37 *	-1.48	-1.74	3.03 ***	-4.49
pc^{tf}	-2.84 *	-2.38	4.97 **	-18.84 **	-2.22	-1.60	7.96	-11.75	-1.50	-2.04	30.33	-3.63
pc^{to}	-2.30	-2.45	9.15	-9.89	-1.52	-1.43	15.78	-5.41	-2.06	-2.22	11.71	-7.72
pc^{nt}	-2.00	-2.12	11.85	-7.61	-1.50	-1.88	25.48	-3.89	-2.23	-1.59	0.13 ***	-195.31 ***
pc^{no}	-3.00 **	-2.59	3.41 ***	-26.60 ***	-1.63	-1.66	16.14	-5.70	-2.76 *	-1.49	0.84 ***	-103.99 ***
w	-2.55	-4.90 ***	9.46	-9.45	-1.98	-2.84	8.20	-10.69	-2.34	-4.40 ***	4.65 **	-13.21
						Estimation in first difference						
neer	-5.88 ***	-9.44 ***	2.16 ***	-41.50 ***	-3.63 ***	-5.60 ***	5.11 **	-17.91 **	-6.53 ***	-6.45 ***	3.89 ***	-22.95 **
px	-4.15 ***	-5.98 ***	3.21 ***	-28.84 ***	-3.46 **	-3.41 *	5.31 **	-16.69 *	-5.15 ***	-5.28 ***	4.56 **	-21.28 **
pm	-4.64 ***	-6.53 ***	2.71 ***	-33.99 ***	-3.94 ***	-3.85 **	4.65 **	-19.70 **	-5.73 ***	-5.83 ***	4.23 **	-22.30 **
$pm^{non\ oil}$	-4.25 ***	-6.04 ***	3.17 ***	-29.59 ***	-3.74 ***	-3.65 **	4.84 **	-18.45 **	-5.54 ***	-5.64 ***	4.28 **	-22.04 **
pm^{oil}	-3.37 **	-9.58 ***	5.28 **	-16.86 *	-2.69	-6.29 ***	9.01	-9.76	-5.80 ***	-5.75 ***	4.01 ***	-22.47 **
py	-3.81 ***	-5.94 ***	3.76 ***	-24.77 ***	-4.40 ***	-4.56 ***	4.32 **	-21.81 **	-2.83 *	-2.61	7.43	-12.14
pc	-5.78 ***	-8.67 ***	2.03 ***	-44.17 ***	-5.18 ***	-5.05 ***	3.49 ***	-25.23 ***	-7.09 ***	-7.11 ***	4.05 ***	-22.89 **
pc^{EU}	-11.71 ***	-11.72 ***	1.39 ***	-64.94 ***	-6.55 ***	-6.54 ***	3.23 ***	-28.38 ***	-7.73 ***	-8.03 ***	4.18 **	-22.47 **
pc^{tt}	-5.27 ***	-8.45 ***	2.38 ***	-37.95 ***	-2.68	-4.20 ***	8.86	-11.32	-5.86 ***	-5.75 ***	3.89 ***	-22.59 **
pc^{tf}	-4.90 ***	-7.26 ***	2.67 ***	-33.95 ***	-2.75 *	-4.08 **	7.52	-11.98	-5.29 ***	-5.21 ***	4.20 **	-21.82 **
pc^{to}	-10.77 ***	-10.76 ***	1.40 ***	-64.81 ***	-4.75 ***	-5.14 ***	6.26 *	-25.87 ***	-6.39 ***	-6.32 ***	3.92 ***	-22.91 **
pc^{nt}	-11.46 ***	-11.41 ***	1.39 ***	-64.99 ***	-7.37 ***	-7.33 ***	3.24 ***	-28.99 ***	-7.12 ***	-7.19 ***	3.98 ***	-22.88 **
pc^{no}	-9.18 ***	-9.29 ***	1.47 ***	-62.15 ***	-6.08 ***	-5.99 ***	3.31 ***	-27.73 ***	-1.86	-5.39 ***	19.47	-4.45
w	-2.18	-19.56 ***	4.07 ***	-2.00	-1.81	-12.37 ***	14.42	-1.12	-3.97 ***	-11.79 ***	0.30 ***	-8.71

Note: All tests are performed with an assumption of constant and trend in time series.

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