Exchange Rate Pass-Through to Estonian Prices

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December 2003

The objective of the paper is to further our understanding of the relationship between changes in the nominal exchange rate and prices in a small open economy. The paper uses data from 1995 Q1–2003 Q1 for Estonia to investigate the exchange rate pass-through to import, producer and consumer prices, both total and disaggregated. Although the currency board arrangement eliminates exchange rate fluctuations from a very significant share of the Estonian effective currency basket, the remaining variation in the nominal exchange rate can be regarded as exogenous (determined by the anchor currency), a useful feature when estimating the pass-through. In the case of import unit values, the pass-through tends to be statistically significant for textiles and commodity-type goods, such as petroleum, non-metal mineral products and basic metals. In the case of producer prices, the long-run pass-through is evident in textiles and chemical products. Point estimates of the long-run pass-through to aggregate import and producer prices fall between 40 and 50%, though the precision of these estimates is low. In contrast, no significant exchange rate pass-through is estimated to consumer prices, measured by total CPI or its tradable component.

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* CERGE-EI, Charles University, Prague. This research was carried out during the three months that the author spent as a visiting researcher at Eesti Pank. The author is grateful to Marit Hinnosaar, Reimo Juks, Rasmus Kattai, Peeter Luikmel, Hannes Kaadu, Martti Randveer, Tairi Rõõm, Lenno Uusküla as well as seminar participants at Eesti Pank for helpful comments and suggestions. The author also thanks Dina Kazakova, Pille Palojärv, Merle Saaliste, Eveli Sokman, Aive Veelmaa, Natalja Viilmann for help with data. The usual disclaimer applies.

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1. Introduction

Lately there has been a significant increase in the amount of research on the exchange rate pass-through to prices. This interest is stimulated by theoretical advancements in open economy macroeconomics. On the other hand, implementing now increasingly popular inflation targeting or intentions to adopt it call for up-to-date information on the link between changes in the exchange rate and prices. The discussion surrounding the choice of the best monetary strategy for acceding countries on their way to the EMU has also contributed to the renewed interest in the exchange rate pass-through.

Recent theoretical research within the new open-economy macroeconomic framework based on optimising behaviour has placed a new emphasis on the importance of pricing decisions in international economics[1]. Explicit modelling of price setting has shown that different pricing practices in international markets imply not only different patterns of adjustment to economic shocks but also different optimal policy responses to those shocks. If prices of goods are preset in the currencies of destination markets (local currency pricing, LCP), the exchange rate pass-through is low and changes in exchange rates do not influence relative international prices. In this case, exchange rate flexibility matters little and, in fact, is undesirable because it brings about deviations from the law of one price (Engel, 2002). Alternatively, if prices are set in exporters' currencies (producer currency pricing, PCP) and thus the exchange rate pass-through is complete, floating exchange rates serve a crucial role in macroeconomic adjustment[2]. These considerations have prompted a new discussion on what degree of exchange rate pass-through prevails empirically and which of the two assumptions – LCP or PCP – should be followed in theoretical models[3].

Since neither complete nor zero exchange rate pass-through is usually supported empirically, price and/or wage stickiness and a number of other hypotheses have been proposed to explain the prevalence of partial pass-through. For instance, a higher degree of exchange rate pass-through to import prices and lower pass-through to consumer prices may be the result of a significant domestic component in retail prices due to local distribution or bundling of final goods (Obstfeld, 2001). Engel (2002) provides a general discussion on the issue of partial pass-through and reviews several explanations suggested in the literature. More recently, Choudhry et al (2002) develop a unifying framework in which a number of proposed explanations of partial pass-through can be examined as special cases. They use this general set-up to assess the ability of different models to match several price impulse responses estimated by VAR. Choudhry et al (2002) conclude that a model incorporating a number of features suggested in the literature fits actual price dynamics best.

The discussion surrounding the exchange rate pass-through was much influenced by Taylor (2000), who suggested that the degree of pass-through must be endogenous to macroeconomic conditions and, in particular, should be positively related to the rate of inflation. He argued that in a world where firms adjust prices infrequently, forward-

[1] Theoretical research in new open economy macro is already abundant. See Lane (2001) for a survey of this literature. Engel (2002) surveys theoretical developments on the exchange rate pass-through.
[2] Corsetti and Pesenti (2001) analyse the dependence of optimal monetary policy on the degree of pass-through.
[3] For an early discussion on this, see, for example, Obstfeld, and Rogoff, K (1999). For a model of endogenous exchange rate pass-through, see Devereux and Engel (2001) and Corsetti and Pesenti (2002).

looking price setting would result in more pass-through if changes in costs (prices) were more persistent. After showing that the latter is positively related to the rate of inflation, Taylor (2000) went on to suggest that a recent decline in the degree of exchange rate pass-through in industrialised countries could be the result of unusually low inflation in these countries. Choudhri and Hakura (2001) investigated the hypothesis empirically and concluded that data for a broad sample of countries with various inflation experiences supported Taylor's hypothesis. In contrast, Campa and Goldberg (2002) find only minimal evidence on the link between the level of inflation and pass-through to import prices in OECD countries. Instead, they emphasise the importance of microeconomic factors, such as changing structure of imports, for the evolution of exchange rate pass-through in these countries[4].

Finally, empirical papers on the exchange rate pass-through may also be motivated by monetary policy makers' practical needs. In a number of cases, such research focuses on transition economies. Darvas (2001) studies the pass-through in four Central European acceding countries in order to assess the potential of using the exchange rate as an instrument to manage inflation. Practical reasons also motivate Billmeier and Bonato (2002), who examine the pass-through in Croatia, and Kuis (2002), who investigates monetary policy transmission and inflation developments in the Slovak Republic. Gueorguiev (2003) assesses the contribution of exchange rate changes to Romanian inflation as the Bank of Romania plans to adopt inflation targeting in 2004.

Not surprisingly, empirical research on the exchange rate pass-through focuses mostly on countries with floating exchange rates. First, the exchange rate elasticity of domestic prices becomes of primary interest when active domestic monetary policy is in place. Second, as variation in the exchange rate is necessary to estimate the pass-through, a floating currency seems to be a natural choice.[5] In contrast, this paper investigates the exchange rate pass-through in Estonia, who runs a currency board arrangement. What motivates studying the pass-through in a country with a strictly pegged exchange rate? Moreover, what if domestic monetary policy is absent because of the currency board arrangement in place?

A peg of domestic currency to some anchor currency does not eliminate fluctuations in the effective exchange rate completely, since the domestic currency and its anchor continue to float against the currencies of other trade partners of the pegging country. In this respect, the exchange rate pass-through is defined, meaningful and can be measured. Perhaps more importantly, however, the estimation of exchange rate pass-through under a strict currency peg is likely to help mitigate the endogeneity problem that arises when estimating the effect of exchange rates on prices in countries with floating exchange rates. Under float, both exchange rate and price changes are affected by domestic monetary policy. To get around this effect, it is necessary to model nominal exchange rates and/or monetary policy explicitly, but that is not an easy task. Darvas (2001), for example, adopts a system of two equations, one equation to estimate the pass-through and the other to model the nominal exchange rate, but reports that the

[4] See also McCarthy (2000) who investigates the exchange rate pass-through in order to assess the contribution of external factors to lowering inflation in a number of industrialised countries.

[5] When the Breton Woods system was in place, the exchange rate pass-through was studied by examining the effects of devaluations, see Goldberg and Knetter (1997).

latter performs poorly[6]. For a similar reason, McCarthy (2000) adds an explicit monetary policy function to his VAR model and then assumes that exchange rate shocks enter the policy function but not the exchange rate equation. In contrast, Choudhri et al (2002) choose to exclude the exchange rate from the policy reaction function.

Provided that the integration of Estonian economy with the euro area is not yet complete, investigation of the exchange rate pass-through under the currency board has the benefit that fluctuations in the exchange rate of the Estonian kroon vis-à-vis other currencies can be taken as exogenous. Whether or not these fluctuations feed into Estonian prices and if they do, how much, is an empirical question. Hence, answering this question is one of the main goals of this paper.

There is also a closely related practical motivation to investigate the degree of the exchange rate pass-through to Estonian prices. One of the main reasons for introducing the currency board was to obtain price stability by eliminating (the money-supply-related) domestic sources of inflation. No doubt the currency board arrangement has served this role well. However, once the currency board is in place, fluctuations in the nominal exchange rate become external shocks to which the system adjusts automatically. In this context, changes in the exchange rate represent just another source of inflationary or deflationary pressure. It is thus legitimate to ask how much it mattered for the evolution of Estonian prices, if at all.

Finally, as the strict peg of the Estonian kroon to the euro essentially mimics full euroisation, the results of this paper may provide some valuable insights on the nature of the exchange rate pass-through that will prevail in the EU accession countries after they join the EMU. For example, all the pitfalls of drawing generalised conclusions from a one-country study, notwithstanding, the finding that the sectoral composition of imports may be a more important determinant of the exchange rate pass-through than the distribution of imports by trade partners can be quite general.

The paper is organised as follows. Section two deals with methodology and data issues. Section three presents estimation results. It is divided into four subsections. The first two describe estimation results on the exchange rate pass-through to disaggregate import and producer prices, respectively. The third subsection considers the pass-through to aggregate import and producer prices as well as aggregate and several disaggregated consumer prices. Section four concludes.

2. Methodology and Data

In a survey paper, Goldberg and Knetter (1997) note that most of empirical research on the relationship between exchange rates and prices, including the exchange rate pass-through, is carried out by considering the following generic relationship:

$$P_t = \alpha + \delta X_t + \gamma E_t + \phi Z_t + \varepsilon_t , \tag{1}$$

[6] Moreover, he uses time varying coefficients to account for changes in exchange rate regimes that took place during transition. In the case of Estonia, there have been no such regime changes.

where P_t is the price index of interest, X_t is the primary control variable, usually some proxy for foreign cost, E_t is the nominal exchange rate, and Z_t is a set of other controls, for example, income variables as demand shifters[7]. In the present paper, the exchange rate pass-though to three categories of Estonian prices (P_t) – import, producer and consumer – is investigated, and the analysis is carried out at both aggregate and sectoral levels. As a consequence, other variables that appear in equation (1) are constructed in accord with these two levels of aggregation. Total and sector-specific (effective) foreign producer price indexes are calculated to serve as primary control variables (X_t), while economy-wide and sector-specific effective nominal exchange rates are computed to play the role of impulse variables. Finally, Estonian GDP growth and GDP gap are used to control for possible demand effects on domestic prices[8].

In the majority of cases, the data cover the period from 1995 Q1 to 2003 Q1, although a number of time series are shorter due to non-availability of data[9]. Data on Estonian CPI, its component covering tradable goods and bilateral exchange rates vis-à-vis major world and Western European currencies were provided by Eesti Pank. Estonian import unit values, which are available from 1996 Q1 only, and foreign trade data were provided by the Statistical Office of Estonia[10]. Import unit values for total imports and 18 sub-categories (NACE) of imports will be considered (Table A.1 in Appendix A lists all the categories)[11]. Estonian PPI series were obtained from Eesti Pank and the Statistical Office of Estonia. These include the total PPI, PPI of the manufacturing sector and eight sectoral (NACE) producer price indices. Finally, the IMF International Financial Statistics was the source for foreign producer price indices, the oil price index (Brent) and other (mostly CIS) exchange rates[12]. In a number of cases, IMF country reports and web sites of national statistical offices were used to update series to 2003 Q1.

In order to choose a proper econometric technique for investigating the relationship described by equation (1), statistical properties of the data must be investigated[13]. Table A.2 (see Appendix A) presents the results of unit root tests for the aggregate variables examined in this paper: the nominal effective exchange rate (ER), effective foreign

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[7] Of course, as can be inferred even from the short literature review in the previous section, various generalisations and much more complicated treatments of this relationship are available. Nevertheless, it is still useful to think about the exchange rate pass-through in terms of equation (1).

[8] GDP gap is calculated using the Hodrick-Prescott filter.

[9] In fact, the data were collected for period 1994 Q1–2003 Q1, but year 1994 was excluded in the majority of estimations because inflation in this year was still very high, reflecting the initial price shock of transition. See the details of individual estimations for the exact number of observations used.

[10] A more preferable measure of import prices – an import price index – could not be used because it is available from 1998 only. The import price deflator is available from 1994, but at least initially, it was based on averaging price indexes of foreign trade partners. Since that would imply just another version of the effective foreign price index calculated in the paper, the imports deflator was not used in estimation.

[11] It is worth noting that Estonian import prices and trade data are much influenced by the flow of goods which do not enter the Estonian market but constitute the items brought to Estonia for processing (subcontracting). To mitigate this problem, data on normal imports instead of overall imports were used to calculate weights for the effective nominal exchange rate and effective foreign PPI indexes. Unfortunately, a similar adjustment could not be made in the case of import unit values.

[12] There were only a few countries for which PPI data were available in the IFS. When PPIs were not available, other price indexes, such as wholesale prices, domestic supply, etc, were used.

[13] Originally, equation (1) would be considered in levels, but today's stationarity and cointegration analysis usually indicates that that is not the way to proceed (Goldberg and Knetter,1997; Campa and Goldberg, 2002).

producer price index (P*), total import unit value (IUV), total PPI (PPI), PPI in manufacturing (PPI_D), total CPI (CPI) and, finally, the CPI of tradable goods (CPI_T). Although the overall impression from Table A.2 is that the series are not trend stationary in levels, there are two instances when the ADF test gets close to rejecting the null of unit root. At 10% significance level, the ADF test rejects unit root for the effective foreign price index (P*). At the same margin, it also rejects unit root in the CPI series. Since in both cases the ADF test is not strongly conclusive and, more importantly, its implications are not supported by the Phillips-Perron test, the stationarity of the variables in first-differences is investigated (see Table A.2). For five out of seven first-differenced series, the presence of unit root is rejected by both tests. The tests disagree in the case of total CPI and its tradable component, however. The Phillips-Perron (PP) test maintains the null of unit root, while the ADF test rejects it strongly. Since the issue could not be settled decisively, the CPI series were assumed to be first-difference stationary[14].

Having decided that the series are best characterised as unit root processes, it remained to check whether relationships among them should be modelled using cointegration techniques. In particular, Engle-Granger and Johansen (trace) tests were applied in search for cointegration between the same five aggregate Estonian price indices (import unit value, producer prices in total industry and manufacturing, total CPI and tradable CPI), the nominal effective exchange rate and the effective foreign price index. In none of the five three-variable combinations did the Engle-Granger procedure indicate cointegration (see Table B.2 in Appendix B). Table B.2 also shows that the Johansen trace tests led to the same conclusion in the case of import and producer prices. It suggested one or more cointegrating vectors in the case of CPI and tradable CPI, but these results were very much dependent upon the lag-structure chosen for the test and often implied nonsensical long-term relationships. All in all, the cointegration tests suggested that the series in consideration should not be modelled within the error-correction framework.

A similar investigation of the statistical properties of time series was performed for disaggregated prices[15]. Here, however, a number of complications arose. At 5% significance level, either the ADF or PP test indicated that 6 out of 18 disaggregated import unit value (IUV) series are trend stationary in log-levels[16]. Although in none of these cases trend stationarity was implied by the two tests simultaneously, this relatively high rate of rejecting the null hypothesis cannot be attributed to the statistical error alone. Hence, it is very likely that some of the IUV series are trend stationary. At the same time, however, the ADF procedure suggested that only one of the corresponding NEER series and two foreign price series are trend stationary in log-levels at 5% significance[17]. The latter variables turn out to be first difference stationary. Given these results of unit root testing for aggregate as well as disaggregated price series, in what way the relationship described by equation (1) should be modelled?

[14] The KPSS test has not helped clarify the issue either, suggesting that the CPI and CPI_T series might be nonstationary in both levels and first differences (the latter results are available from the author upon request). Since the reliability of these unit root tests, when the series contain 30 observations, is very low anyway, it is perhaps more reasonable not to take the test results very seriously and proceed to model the series along the lines suggested in the related literature, which is dominated by estimations in first differences. Below, a very similar problem arises when disaggregated prices are analysed.

[15] These results are not reported but are available from the author upon request.

[16] Four times trend stationarity is suggested by the ADF and two times by the PP test.

[17] None, according to the PP test.

In this paper, all estimations are carried out in first differences, and this decision is driven by the following three reasons. Although formal tests indicate that several disaggregated prices are very likely to be trend rather than difference stationary, putting together variables transformed into stationary ones by different methods would definitely obscure the economic content of equation (1). Not only the nature of the relationship expressed by equation (1) would become unclear, but also the easy and convenient interpretation of the estimated parameters as elasticities would not be possible. In addition, first differencing several series that actually might be trend stationary can hardly cause problems when the estimation period is 30 quarterly observations. Finally, a number of recent empirical papers on the exchange rate pass-through that use considerably longer time series find that first differencing the variables under consideration is the most appropriate way to proceed. Hence, taking into account the former conclusion that cointegration methods are not applicable in the present exercise, an unrestricted autoregressive distributed lag model (ARDL) in first differences is applied:

$$\Delta P_{it} = \alpha_{i0} + A_i(L)\Delta P_{it-1} + B_i(L)\Delta E_{it} + C_i(L)\Delta P_{it}^* + D_i(L)(GDPg_t) + \varepsilon_{it}\,, \tag{2}$$

where P_{it} is a log price index (import unit value, PPI or CPI), E_{it} is the log effective nominal exchange rate (NEER), P_{it}^* is the log effective foreign PPI (EFP) and ε_{it} is the white noise disturbance term. The term $GDPg_t$ stands for one of the two control variables included in estimations: GDP growth or GDP gap. The subscript i is meant to indicate not only that various price indices will be considered, but also that other variables – NEER and EFP – will be sector-specific once the exchange rate pass-through to disaggregated price indexes is examined. Finally, the terms $A_i(L)$, $B_i(L)$, $C_i(L)$ and $D_i(L)$ denote lag polynomials.

The effective exchange rate and effective foreign price indices are computed as geometric averages using changing weights:

$$\Delta \log X_{it} = \sum\nolimits_{j=1}^{N_i} w_{ijt} \Delta \log x_{ijt}\,, \tag{3}$$

where X_{it} (x_{ijt}) is either the effective nominal exchange rate E_{it} (bilateral nominal exchange rate of foreign country j) or the effective foreign price index P_{it}^* (the PPI of foreign country j), while w_{ijt} is the moving average share of trade partner j in the imports of Estonia over the four-quarters prior to quarter t[18]. Nominal exchange rates are expressed as the quantity of Estonian kroons per unit of foreign currency, so that an increase in E_{it} implies depreciation of the kroon.

In what follows, the parameters of interest will be the coefficients of polynomials $B_i(L)$, further referred to as pass-through coefficients or elasticities. More specifically, empirical inference will be based on the following procedure. First, the presence or absence of the exchange rate pass-through is examined by testing the null hypothesis

[18] Data on normal imports were used to calculate the weights in equation (3). As mentioned in footnote 11, this definition of imports excludes subcontracting.

that all the parameters of $B_i(L)$ are jointly zero. Then, the short- and long-run exchange rate pass-through elasticities are investigated. Following Campa and Goldberg (2002), the short-run pass-through is defined as the contemporaneous coefficient of $B_i(L)$, while the expression for the long-run elasticity, $B_i(1)/1-A_i(1)$, follows from the ARDL model itself. In both cases, the null hypotheses of complete (elasticity equal to one) and partial (elasticity between zero and one) pass-through will be tested.

3. Estimation and Results

The fact that the time series under consideration are short greatly complicates the very first step of ARDL modelling, the selection of the appropriate lag structure of the model. In the case of consumer and producer prices, ARDL(4,4) specification was assumed to be the most general, the basis for the general-to-specific modelling approach. In the case of shorter import unit value series, ARDL(4,3) was taken as the starting model[19, 20]. The procedure for optimal lag selection was based on minimising the Schwarz B.I. criterion, but the Breusch/Godfrey LM and Ljung-Box tests for up to five-lag autocorrelation were also performed to assure that model (2) is properly specified. If the latter tests rejected no autocorrelation in residuals, additional lags were included even if that meant loosing in terms of the Schwarz B.I. criterion. Finally, a joint test of all the restrictions imposed when going from the most general to the final specification was performed in each case.

Given that the data series are short, single-equation estimations are likely to feature large standard errors and, if the above strategy for selecting optimal lags is followed, the general-to-specific modelling approach may lead to overly parsimonious specifications. Some efficiency can potentially be gained by applying the seemingly unrelated regression (SUR) estimator, which utilises information contained in the contemporaneous correlation of cross-equation residuals. However, once several equations are joined into a system, it is common to apply the lag selection procedure to the system as a whole. Consequently, certain individual equations may remain overly parameterised. Since both single equation and SUR estimations will be applied below, the following strategy will be followed if the two estimation procedures generate conflicting results. If the difference between estimation outcomes is seen to be due to more efficient estimation under SUR, the results of the latter will be considered. However, if the equation in the SUR system appears to be over-parameterised relative to the one chosen by the single equation estimation, the implications of the latter will be considered. The next section starts the description of results by discussing the exchange rate pass-through to Estonian import prices.

3.1. Exchange Rate Pass-Through to Import Prices

The analysis of the exchange rate pass-through to disaggregated import prices follows the general strategy described above. First, equation (2) is estimated for each of the 18

[19] Constant was also included in the most general model. In several cases, however, restricting the maximum lag order to 4 seemed inappropriate (see Table B.4.1 in Appendix B). In such cases, the fifth lag was added.

[20] Since quarterly data were used, it was preferable to keep the fourth lag in the autoregressive part of the most general model to account for possible seasonal effects.

categories of imports[21]. Then, these individual equations are joined into several groups, and SUR estimation is applied in an attempt to gain estimation efficiency. Estimation of equation (2) for the total import unit value index is postponed till subsection 3.3.

Detailed results of single equation (SE) estimation are presented in Table B.3.1 (see Appendix B). The striking feature of Table B.3.1 is the high number of import categories for which estimated equations have very low fit. Indeed, half of the regressions have adjusted R-squared below 25%, while in three cases, this measure of fit is even negative[22]. In this respect, the variable that shows very little explanatory power is foreign effective inflation, which is individually significant in only six import price regressions. In the case of two categories of imports – mining of energy producing materials (CA) and manufacture of coke and refined petroleum products (DF) – the explanatory power of regressions improved considerably when the originally constructed foreign price index was replaced by the price of oil (Brent). As a result, the oil price index was substituted for foreign prices whenever estimation concerned sectors CA and DF. However, no other commodity price index included in the IFS dataset seemed to have significant explanatory power with respect to prices in other import categories. In a final attempt to gain efficiency, SUR estimation was adopted.

To apply SUR estimation, sector-specific import price equations were joined into five groups. The cross-sector correlation matrix of import price changes was used as a guide when forming these groups. Given that in a number of instances the cross-sector price correlations were 50% and higher, the systems of equations were formed by trying to combine import categories that share high cross-price correlation. As a result, the following five groups of equations were estimated by SUR: DA-DC-DH-DJ, DB-DG-DI-DM, DD-DK-DN, DE-DL-DF-CA and A-B-CB. Table B.3.2 (see Appendix B) provides detailed information about these estimation results.

Since it is difficult to see the message contained in Tables B.3.1 and B.3.2 directly, Table A.3 (see Appendix A) presents the most relevant information regarding the exchange rate pass-through to import prices. Table A.3 is constructed in the following way. Firstly, those sectors are selected for which either single equation (SE) or SUR estimation or both imply that the hypothesis of jointly zero exchange rate pass-through (ERPT) coefficients is rejected. This step reduces the number of import categories from 18 to 11. Next, the sectors are selected for which under any of the two estimation procedures either the short run or the long run or both pass-through elasticities are significantly different from zero. The latter step excludes sector DL (electrical and optical equipment) and reduces the number of remaining categories to 10. Table A.3 summarises the short- and long-run pass-through estimates for these 10 sectors.

Let us consider the short-term pass-through elasticities first. Remember that following Campa and Goldberg (2002), the short-run pass-through is defined as the immediate elasticity, measured by the contemporaneous coefficient of polynomial $B(L)$ in equation (2). What does Table A.3 say about the short-term pass-through elasticities, and are there contradictions between the results from the single equation (SE) and SUR estimations? In terms of short-run elasticities, most of the results match quite well. As could be expected, a number of insignificant elasticities in SE estimation become

[21] These categories are listed in Table A.1 in Appendix A.
[22] Those sectors are: agriculture (A), machinery (DK) and electrical and optical equipment (DL).

significant under SUR, but their point estimates remain broadly in line. There are two exceptions though. In the case of food products (DA), the short-term pass-through elasticity of 1.6 under SE estimation becomes insignificant in SUR (although the standard errors of the coefficients are about 0.6 in both procedures). As can be seen from the estimation details presented in Table B.3.1 and Tale B.3.2 (see Appendix B), very different ARDL models are estimated for sector DA under SE and SUR[23]. As both the estimation results and models are so different, it is difficult to say which of the two pass-through estimates might be preferable.

The second notable difference between the SE and SUR estimates of short-run pass-through elasticities concerns petroleum products (DF). In both cases, the elasticity is estimated to be significant, but the point estimate is rather different. The coefficient increases from 34% (SE) to 78% (SUR), while its standard error remains at 13.4 and 14.5%, respectively. The detailed estimation results reported in Table B.3.1 and Table B.3.2 reveal, however, that SUR estimation is able to capture somewhat richer dynamics than the corresponding individual regression. Perhaps the SUR estimate should be preferred in this case.

In sum, Table A.3 shows that both SE and SUR estimations imply significant short-term pass-through in four import categories: leather products (DC), petroleum (DF), non-metallic mineral products (DI) and other manufacturing (DN). In the latter case, both estimations indicate that the pass-through is *negative* and rather strong (-3.7). For leather products (DC), the estimate of pass-through is correctly signed and equal to 3, which is significantly greater than unity. In the remaining two cases – petroleum (DF) and non-metallic mineral products (DI) – the elasticity is not statistically different from unity[24].

Several other short-term pass-through elasticities are estimated to be statistically significant only by SUR procedure. In the case of mining of non-energy materials (CB), unitary elasticity is implied. The remaining four estimates – 39% for fishing (B), 22% for mining of energy materials (CA), 44% for textiles (DB) and 26% for manufacture of basic metals (DJ) – point to partial short-run pass-through, that is, the estimates are significantly different from both zero and one.

Let us consider the long-run pass-through elasticities next. Table A.3 (see Appendix A) summarises these elasticities in exactly the same way as the short-run estimates just discussed. Again, the results from the two estimation procedures broadly agree in all but two cases. The first discrepancy concerns the long-term pass-through to the prices of leather products (DC). In the case of SE estimation, this elasticity is estimated to be 3.1, and the estimate can be verified to be significantly greater than one. In contrast, SUR implies that the long-term elasticity is not different from zero. The estimation details contained in Table B.3.1 and Table B.3.2 (see Appendix B) clearly show the source of this discrepancy. According to SUR estimates, the short-run effect of the exchange rate on leather product prices is reversed after three quarters. In the SE estimation case, however, this delayed effect is not captured, since the lag selection procedure has led to a more parsimonious specification. The second disagreement between estimated long-run elasticities concerns petroleum (DF) imports. The elasticity obtained by SE estimation is not different from zero, while that estimated by SUR is not only greater

[23] ARDL(1,1) is selected for single equation estimation while ARDL(4,3) is estimated by SUR.
[24] As mentioned in the text, the focus is on the SUR estimate in the case of petroleum products (DF).

than zero but also not statistically different from one. However, it has already been noted that the SE estimation for DF does not capture some important dynamics and that the SUR based pass-through estimate should be preferable.

In the case of five out of ten long-run pass-through estimates, both estimation procedures imply identical results. In two sectors – mining of non-energy materials (CB) and manufacture of furniture (DN) – both estimation procedures agree that the long run pass-through is zero. For food products (DA), the point estimate is estimated to be about 2, although the null of unity cannot be rejected due to large standard errors. In the remaining two cases, the estimates are considerably more precise and indicate that the pass-through is partial, that is, significantly below one. The long-run pass-through is estimated to be 25% and 50% in sector CA (mining of energy materials) and DJ (basic metals), respectively. In four sectors, however, estimates are significant only under SUR. In three sectors – textiles (DB), petroleum (DF) and non-metallic mineral products (DI) – full or complete long-term pass-through cannot be rejected, while in the case of fishing (B), the elasticity is significantly below one, estimated to be about 30%.

At this point, it is worth summarising the main findings on the exchange rate pass-through to import prices. Table 1 helps in this as it distils the most relevant information from Table A.3 (see Appendix A). The fact that Table A.3 includes only 10 out of the 18 import categories under examination implies that neither short- nor long-term pass-through was detected in the remaining eight groups. Import categories for which exchange rate changes do matter are: food products, mining products, textiles and leather products, energy products and basic commodities (non-metallic mineral products and basic metals). In the case of four categories, namely, mining of non-energy materials, leather products, petroleum and (other) non-metallic mineral products there is evidence of strong short-term pass-through, that in all but one case cannot be statistically distinguished from the complete one[25]. In the case of non-energy mining and leather products, the initial effects seem to be reversed over time, so that no significant long-term pass-through is estimated. In the remaining two sectors (petroleum and non-metallic mineral products), the effect of exchange rate changes is long-lived, so much so that the complete pass-through cannot be rejected in the long run. Finally, partial short-run pass-through translates into complete long-run pass-through in the case of textile products, while the remaining three sectors – fishing, energy mining products and basic metals – feature partial pass-through both in the short and long run.

[25] For leather products, the elasticity exceeds one.

Table 1. Summarising the exchange rate pass-through to import prices

	Category	Share, %	Short run	Short run <1,=1, >1	Long run	Long run <1,=1,>1
B	Fishing	0.2	0.39	<1	0.28	<1
CA	Mining energy producing materials	2.2	0.10-0.22	<1	0.25	<1
CB	Mining non-energy producing materials	0.4	0.95	=1	0	<1
DA	Food, beverages and tobacco	11.9	0-1		2.2	=1
DB	Textiles	5.2	0.44	<1	0.84	=1
DC	Leather products	1.6	2.6-3.2	>1	0	
DF	Petroleum products	6.6	0.78	=1	1.1	=1
DI	Other non-metallic mineral products	2.6	0.9-1.3	=1	1.1	=1
DJ	Basic metals	8.6	0.26	<1	0.54	<1
DN	Manufacturing n.e.c., furniture	2.6	-3.7	<-1	0	

Notes: this table summarises information provided in Table A.3 (Appendix A). <1 means partial pass through, =1 means full pass-through, while >1 or <-1 denote elasticities that exceed 1 in absolute value. Share refers to the share of category in total normal imports.

How important are the sectors of Table A.3 in terms of total imports (see also Table 1)? The entries under "share" indicate the relative shares of different product categories in total imports. The collective weight of sectors for which significant short-term pass-through is estimated, amounts to 27%[26]. Since the same categories of imports tend to feature significant long-term pass-through as well, the share of imports subject to long term exchange rate pass-through is roughly the same or higher, if food products are included (food products, category DA, account for 10% of imports). Although this share is considerable, it remains to check to what extent the exchange rate pass-through matters for the total import unit value index[27].

3.2. Exchange Rate Pass-Through to Producer Prices

In this section, the exchange rate pass-through to Estonian producer prices is examined. The methodology used here is identical to that applied before: single-equation (SE) and SUR based estimations of price equation (2) are carried out for different manufacturing sectors, and then the implied short- and long-run pass-through elasticities are investigated. Since the details of the approach are known from the previous section, it is enough to consider a summary Table A.4 (see Appendix A), which was constructed in exactly the same way as Table A.3 [28]. Firstly, the sectors were selected for which the hypothesis that all the pass-through coefficients are jointly zero is rejected. Then, the sectors for which neither short- nor long-run pass-through elasticities were estimated significantly were left aside. Table A.4 lists the remaining sectors and summarises the most relevant information about the short- and long-run pass-through to the prices of these sectors.

[26] These sectors are B, CA, CB, DB, DC, DF, DI and DJ.
[27] It is tempting to try to evaluate the potential degree of pass-through to aggregate import prices based on the evidence obtained from sector-specific pass-through estimates. Since sector-specific effective nominal exchange rates are used in the latter estimations, it is difficult to see how the result from such an exercise would relate to the pass-through elasticity estimated using aggregate variables.
[28] Estimation details are presented in Appendix B, Table B.4.1 and Table B.4.2.

Out of eight manufacturing sectors considered, five appear in Table A.4 (see Appendix A). The three product categories excluded were leather products (DC), wood products (DD) and non-metallic mineral products (DI). In the latter two cases, the hypothesis of jointly zero pass-through coefficients could hardly be rejected, and neither short- nor long-run elasticities were estimated to be significant. The situation was somewhat different in the case of leather products, for which the hypothesis that all pass-through coefficients are jointly zero could be rejected, but this category was excluded from Table A.4 on the grounds that neither short- nor long-run pass-through was estimated significantly. This leaves six manufacturing sectors, in which price dynamics is found to be influenced by changes in the nominal exchange rate. Significant short-term pass-through is estimated in three sectors[29]. The short-term elasticity of 55% is estimated in the case of textiles (DB), and this estimate is precise enough to reject the hypothesis of complete short-term pass-through in this sector. A similar point estimate of 57% is obtained for prices in sector DN (manufacture of furniture, manufacture n.e.c.), but this estimate is much less precise and cannot be distinguished from unity statistically. Finally, a rather high short-run elasticity of 2.6 is estimated in the case of machinery and equipment (DK).

For these three sectors (DB – textiles, DK – machinery and equipment, DN – furniture, etc), the exchange rate pass-through is significant in the long run as well. The two other categories that feature significant long-run elasticities are food products (DA) and chemical products (DG). A notable characteristic of these five long-run elasticity estimates is that the hypothesis of unit elasticity (complete pass-through) cannot be rejected in four out of five cases. The long-run elasticity is estimated to exceed one in the case of textiles (DB).

Until now, equation (2) was estimated without attempting to control for possible aggregate demand effects. Since output in manufacturing constitutes tradable goods, it is not obvious that Estonian aggregate demand must necessarily be an important determinant of prices in this sector. To allow for such a possibility, however, two control variables were included in equation (2): the growth rate of Estonian GDP and domestic GDP gap, calculated using the Hodrick-Prescott filter. Table A.5 in Appendix A illustrates the effects that adding GDP growth rates have for SUR estimation[30]. As can be seen from Table A.5, the inclusion of the control variable has basically no effect on the estimates of short-run pass-through elasticities, but it turns the long-run pass-through insignificant in three manufacturing sectors: food products (DA), manufacturing of machinery and equipment (DK) and manufacturing of furniture and other goods (DN). Note, however, that GDP growth is itself jointly insignificant in these cases. As such, the variable might be adding “noise” rather than accounting for some important piece of correlation between demand shifts and price changes. In contrast, GDP growth is a significant explanatory variable for prices in textiles (DB) and chemical products (DG), but its presence has no qualitative effects on the estimates of exchange rate pass-through in these sectors. Thus, producer prices in at least two sectors – textiles and chemical products – show strong and robust response to changes in the exchange rate. Table 2 summarises the most important quantitative as well as qualitative results regarding the exchange rate pass-through to producer prices.

[29] In this section, SUR procedure leads to considerably more precise estimates than SE estimation. As a result, the text describes mostly the implications of the former.

[30] Up to two lags of control variables were included. Controlling for GDP gap instead of GDP growth produced very similar results, which are not reported.

Table 2. Summarising the exchange rate pass-through to producer prices

	Sector	Share, %	Short run	Short run <1,=1, >1	Long run	Long run <1,=1,>1
DA	Food, beverages and tobacco	28.5	0.07 (.24)	<1	1.37 (.84)	=1
DB	Textiles	9.4	0.71 (.09)	<1	4.18 (.72)	>1
DG	Manufacture of chemicals	8	0.41 (.24)	<1	1.57 (.70)	=1
DK	Manufacture of machinery and equipment	2	2.6 (.57)	>1	3.3 (1.6)	=1
DN	Manufacture of furniture and other	5.3	0.57 (.23)	<1	1.1 (.54)	=1

Notes: this table summarises the implications of SUR estimation presented in Table A.4 and Table A.5 in Appendix A. Notation <1 means partial pass through, =1 means full pass-through, while >1 or <-1 denote elasticities that exceed 1 in absolute value. DA, DK, DN estimates reported without controlling for GDP growth (since the latter was not significant jointly). "Share" refers to the share of a sector in the PPI of total industry. Numbers in parentheses denote standard errors.

How important are the sectors included in Table A.4 (see Appendix A) and Table 2 with respect to the total price index of Estonian manufacturing? The entries under "Share" provide the relative weights of different sectors in the calculation of total producer price index in Estonia. The collective share of the sectors for which significant short-term pass-through has been estimated is close to 17% (DB – 9.4, DK – 2.0 and DN – 5.3). Since manufacturing prices account for 82% of total PPI, it follows that about 20% (=17/82) of manufacturing prices are subject to an immediate exchange rate pass-through. In the long run, the pass-through is found marginally significant also in the case of food products (DA). This raises the collective share to 45% of total PPI or 55% of manufacturing prices. It is thus quite possible that changes in the nominal exchange rate matter for the whole producer price index as well. The exchange rate pass-through to aggregate price indices is addressed in the next section.

3.3. Exchange Rate Pass-Through to Aggregate Import and Producer Prices

In the two previous sections, the exchange rate pass-through to disaggregated import and producer prices was investigated. In both cases, different nominal effective exchange rates and effective foreign price indices were calculated for each category of goods. Since the peg of the Estonian kroon to euro covers a very significant share of the Estonian effective foreign currency basket, sector-specific nominal effective exchange rates and foreign prices were constructed to have a close look at whether changes in the exchange rate matter for Estonian prices at all. It appeared that the exchange rate pass-through is relevant for a number of disaggregated import and producer prices. Earlier results indicate that almost 30% of import and 20–45% of industry prices are influenced by changes in the exchange rate. It remains to see if these effects can be detected at the aggregate level, when aggregate price indices are considered. In this section, the economy-wide effective exchange rate and effective foreign price index are used to assess the exchange rate pass-through to aggregate import and producer prices. Aggregate and disaggregated consumer prices are analysed in the next sub-section.

To start, let us consider the exchange rate pass-through to the total import price (unit value index). The most general model applied in this estimation was ARDL(4,4) with a constant and, as can be seen from Table A.6 (see Appendix A), ARDL(4,4) without the constant term chosen as the best final alternative. Although none of the coefficients associated with the foreign price index is estimated to be statistically significant, the hypothesis that these coefficients are jointly zero cannot be accepted. A similar test that all the pass-through coefficients are jointly zero appears to be inconclusive. The Chi-sq based Wald test suggests that they are marginally significant (at 10% significance level), but the F-test indicates that the coefficients are jointly zero[31]. If nevertheless the long-run pass-through elasticity is calculated, it turns out to be 49%, more than two standard deviations above zero. Of course, in light of the above F-test, the latter result should be regarded with considerable caution, but the findings that the Wald test marginally rejects the joint exclusion of the pass-through coefficients and that two of these coefficients tend to be significant individually should not be ignored either. Moreover, according to the results obtained using disaggregated import prices, some degree of the exchange rate pass-through to the aggregate import price is, in fact, likely. In sum, the results seem to suggest that some pass-through to aggregate import prices actually does take place.

This conclusion is also indirectly supported by the following "experiment". Notwithstanding the fact that the available time series were short even for estimating the ARDL model with a pair of exogenous variables, two lags of GDP growth or GDP gap were added to account for possible demand effects. These estimation results are also reported in Table A.6 (see Appendix A). Although, after including GDP growth/gap, the joint significance of the pass-through coefficients is no longer supported even by the Wald test (p-values are 0.12 and 0.22 when controlling for GDP growth and gap, respectively), a closer look at the results reveals that the inclusion of control variables affects the estimates only marginally. As regarding the pass-through coefficients, their point estimates change very little, and even the long-run pass-through elasticity remains relatively stable (43 and 47% for the estimation with GDP growth and gap, respectively). Moreover, the joint significance of neither GDP growth nor GDP gap can be established by formal statistical tests[32]. Therefore, it can be concluded that none of the previous results, including the belief about the actual presence of pass-through to import prices, is affected by this "experiment."

In the case of the exchange rate pass-through to aggregate producer prices, two price indices were considered: the total producer price index (PPI), which covers the whole industry of the Estonian economy, and the PPI of the manufacturing sector (PPI_D), which excludes the mining and energy sectors. Since these two sectors are dominated by state monopolies, the PPI of manufacturing sector can be broadly regarded as the market-based part of total PPI. The weight of PPI_D in the total PPI is about 82%.

The latter estimation results are presented in the remaining six right-hand-side columns of Table A.6. For each of the two producer price indices – PPI and PPI_D – three different regressions are reported: without a control variable, with GDP growth and with GDP gap, respectively. The first thing that stands out in Table A.6 is that the coefficients of control variables are never significant but once: contemporaneous GDP growth and GDP gap coefficients are statistically significant in the regression for total PPI. In all other cases, their coefficients are significant neither jointly nor individually.

[31] This F test is not reported in Table A.6 (see Appendix A). The p-value of the test is 0.16.

[32] Table A.6 shows that the p-values of Chi-sq(3) tests that GDP growth and GDP gap coefficients are jointly zero are 0.6 and 0.8, respectively.

Whether the estimates of exchange rate pass-through are robust to the inclusion of control variables or not depends also on which producer price index is considered. In this respect, GDP growth and GDP gap appear to matter in the case of total PPI. Once either of the two control variables is included into the ARDL equation for total PPI, the joint significance of the exchange rate coefficients disappears. Note that the implied long-run pass-through estimate is also affected: the estimate declines somewhat and becomes insignificant.

In contrast, the inclusion of GDP growth or GDP gap matters little for the pass-through estimates in the case of manufacturing PPI (PPI_D). Firstly, the set of slope coefficients corresponding to the nominal effective exchange rate is jointly significant whether or not GDP growth/gap is included. Secondly, the point estimate of the short-run (contemporaneous) exchange rate pass-through remains quite stable, at 14–20%, and tends to be marginally significant in all runs. Finally, although the estimated long-run exchange rate elasticity fluctuates somewhat – from 51% when no controls are included to 46 and 60%, respectively, once GDP growth and then GDP gap are added – differences among the estimates constitute about one second of their standard errors. In sum, the method used to asses the degree of exchange rate pass-through in this paper fails to estimate robust and statistically significant pass-through to the total producer price index, but it does find evidence of both short- and long-run pass-through to prices in the manufacturing sector. For this sector, the short- and long-run pass-through estimates fall between 15–20% and 46–60%, respectively.

3.4. Exchange Rate Pass-Through to Consumer Prices

Many recent studies of the exchange rate pass-through pay particular attention to the link between exchange rates and consumer prices. On the one hand, this interest arises from the practical needs of monetary policy makers. On the other, there is a considerable academic interest to understand why the exchange rate pass-through to consumer prices tends to be low. After investigating the pass-through to import and producer prices in detail, it is natural to ask whether changes in the exchange rate matter for Estonian consumer prices. Hence, the remainder of the paper is devoted to this final question.

This last part of the analysis will be carried out in two stages. Firstly, by considering the exchange rate pass-through to two consumer price *aggregates* – the total CPI and its tradable component – and then by investigating the pass-through to four selected components of CPI, namely: food, clothing and footwear, furnishing and household equipment, and transport and communication[33]. These consumption categories are closest to what can be called tradable goods. Since it is the pricing of such goods that is characterised by equation (1), it seems appropriate to restrict the analysis to the prices of tradables and avoid applying model (2) to those of non-tradables. In other respects, the approach is going to be virtually the same, except that the two control variables, GDP growth and GDP gap, will be included into the ARDL model from the very start. Given that a significant part of the CPI includes non-tradable goods, fluctuations in the domestic aggregate demand must be taken into account.

[33] Taken together, these four categories account for more than 60% of consumer expenditures: food – 37.8%, clothing and footwear – 7.6%, furnishing and household equipment – 3.3% and transport and communication – 13%.

It turns out that the ARDL model of maximum lag order 4 is not enough to apply general-to-specific modelling to the CPI series. Because of the non-tradable component of the CPI, the lag order of the most general ARDL has to be increased to at least 5. Since ARDL (5,5) becomes too large with respect to the time series at hand, the model selection procedure was performed starting from ARDL (5,4), and ARDL(5,3) was chosen as the best specification. The latter estimation results are presented in column "dCPI" of Table A.7 (see Appendix A). Note that both control variables (GDP growth and GDP gap) do pick some positive correlation between inflation and economic activity; however, this cannot be said about the exchange rate. The exchange rate coefficients are significant neither individually nor jointly.

Perhaps it is more likely that the exchange rate pass-through would show up in the tradable component of the consumer basket (CPI_T). Hence, the exercise for the consumer tradable inflation is repeated (see Table A.7 in Appendix A). Note that once the non-tradable component is eliminated, the fifth lag introduced into the ARDL specification when modelling total CPI inflation becomes redundant. As can be seen from Table A.7, a more parsimonious ARDL(3,3) specification is chosen to model CPI_T. Interestingly, the estimation results imply no role for the two control variables: their coefficients are jointly insignificant. Thus, estimation without control variables is also presented in Table A.7 (the last column). However, regardless of whether GDP growth or GDP gap is included in estimation or not, no evidence of the exchange rate pass-through can be seen in Table A.7[34]. Differently from aggregate import and producer prices, even the tradable component of the CPI seems to be immune to exchange rate fluctuations.

The absence of the exchange rate pass-through to consumer prices in the estimations above is somewhat surprising. It is well known that the exchange rate pass-through to consumer prices is usually low, but the finding that there is none is puzzling, especially that some degree of pass-through to import as well as producer prices was already confirmed in previous sections. To get some additional insights on the issue, the pass-through to the following four constituents of CPI is examined: prices of food, clothing and footwear, household goods and transport and communication services. Table A.8 (see Appendix A) presents the details.

For each of the four CPI sub-indices, optimal lag selection was carried out starting from the ARDL(5,4) specification. In the case of clothing and footwear, a parsimonious ARDL(2,2) was selected, while the remaining three time series were modelled as ARDL(3,3). GDP gap was jointly insignificant for food and clothing/footwear prices and only marginally significant for the remaining two categories – household goods and transport and communication services. For that reason, Table A.8 also contains estimation results that were obtained without controlling for GDP gap.

What does Table A.8 say about the exchange rate pass-through to the selected four components of CPI? Somewhat unexpectedly, the group of goods for which changes in the exchange rate seem not to matter at all is clothing and footwear. As columns 3 through 5 show, changes in these prices are best described by an autoregressive process that is not influenced by the variables considered in this analysis. Similarly, joint significance of the exchange rate coefficients cannot be established also for prices of

[34] The only exception is the short-run exchange rate pass-through coefficient that is significant at 10% level in the regression for CPI_T in the fourth column of Table A.7 (see Appendix A).

household goods. Again, the results seem to suggest that the set of variables used in estimation is not particularly relevant for the dynamics of prices in this group.

In contrast, exchange rate fluctuations appear to matter for prices in the remaining two groups – food products and transport and communication services. If GDP gap is excluded from estimation as an insignificant determinant of food prices, estimation results imply that food prices are subject to about 20% exchange rate pass-through in the short run and about 30% pass-through in the long run. This result seems to agree, at least qualitatively, with the previous findings that both import and producer prices of food products are affected by changes in the exchange rate. However, sorting out the determinants of transport and communication prices turns out to be somewhat more complicated. According to the last columns of Table A.8 (columns 8–10, see Appendix A), GDP gap and foreign price developments are not significant determinants of prices in this category, but exchange rate seems to play a more robust role, especially in the short run. Depending on specification, the point estimate of short-run exchange rate pass-through runs from 34 to 64%, suggesting that the short-run pass-through is rather strong for this category of consumer expenditures[35]. Importantly, these short-run effects are eliminated in the long run, so that the long run elasticity is not different from zero.

Given the findings discussed in sub-sections 3.2 to 3.4 regarding the exchange rate pass-through to import, producer and consumer prices, what role did the exchange rate pass-through play in the evolution of aggregate Estonian prices quantitatively? Since no significant pass-through was estimated to the CPI index, let us consider the implications of the equation estimated for the producer prices in the manufacturing sector (PPI_D). According to the point estimates in this equation, the short-run pass-through to producer prices in manufacturing is 14%, while the long-run elasticity is approximately 50%. In other words, about half of a change in the nominal effective exchange rate translates into producer prices in the long run. Given that from 1995 Q1 to 2003 Q1 the Estonian effective exchange rate appreciated by about 14%, the pass-through effect must have dampened producer price inflation by about 7% during this period (or by a bit less than one percentage point per year).

These implications of the model can be demonstrated graphically. Figure A.1 (see Appendix A) depicts the paths of manufacturing PPI that are implied by the contribution of either the nominal exchange rate or foreign prices taken alone. As shown by the curve labelled “IF NEER only”, the nominal appreciation of the kroon exercised deflationary pressure on manufacturing prices, “lowering” the index by 7%. In contrast, the effect of foreign price inflation was to raise producer prices by about 30%. If taken together, these effects imply a 23% increase in producer prices. The model does not explain the difference between this figure and the actual rise in prices by 39%.

4. Concluding Remarks

The issue of exchange rate pass-through has attracted considerable attention recently. The surge in research has been motivated both by advancements in macroeconomic theory and by central bankers’ practical needs. The objective of this paper was to get additional insights on the exchange rate pass-through by investigating the phenomenon

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[35] Although the corresponding standard errors are also large – about 20% or more. See Table A.8 in Appendix A.

in the macroeconomic environment for which, one might believe, the exchange rate pass-through matters rather little, if at all. In particular, the paper examined the pass-through to prices in Estonia, the country that trades mainly with the EU countries and whose currency has been pegged to the euro (DM) via a currency board arrangement for more than a decade.

Estonian data for the period from 1995 Q1 (1996 Q1) to 2003 Q1 was used to investigate the exchange rate pass-through to import, producer and consumer prices, both aggregate and by sectors of activity. In the case of import unit values, the pass-through to the disaggregated prices of 18 categories of goods was examined. It was found that the exchange rate pass-through tended to be statistically significant for food products, textiles and leather products, as well as for commodity-type goods, such as chemical products, petroleum, non-metal mineral products and basic metals. Overall, the results showed that about 30% of Estonian imports were subject to statistically significant short- and long-run pass-through.

In the case of producer prices, the long-run pass-through was evident in textiles and chemical products. Point estimates of the long-run pass-through to aggregate import and producer (manufacturing) prices fell between 40 and 50%, though the precision of these estimates was not high. If GDP growth was included to control for aggregate demand effects, the pass-through effects became insignificant in the case of total PPI, but remained statistically significant for producer prices in manufacturing.

In contrast, no significant exchange rate pass-through was estimated to aggregate consumer prices, measured by total CPI or its tradable component. A closer look at the pass-through to the prices of four less aggregated consumption categories, namely, food products, clothing and footwear, household equipment, transport and communication, revealed that food and transport and communication prices tended to respond to the exchange rate but the prices of the other two groups did not. And, although food and transport and communication expenditures accounted for more than 40% of consumer spending, the exchange rate pass-through to *aggregate* consumer prices was not detected.

How much has the exchange rate pass-through contributed to Estonian inflation? Since no exchange rate pass-through was estimated to consumer prices, only producer price inflation may be considered here. According to the estimates, the nominal appreciation of the kroon by approximately 14% from 1995 Q1 to 2003 Q1 had a dampening effect on (manufacturing) producer prices amounting to 7 percentage points, or a little less than 1 percentage point of deflation per year.

Overall, the exchange rate pass-through in Estonia seems to be a micro phenomenon rather than a macro one. Importantly, no exchange rate pass-through to aggregate consumer prices was estimated. Moreover, the pass-though to import prices tends to concentrate in those sectors that can be characterised as commodity-type goods. Even in the case of pass-through to producer prices, the two industries that stand out are textiles and chemical products. If these industries use imported commodity-type goods as their inputs, the pass-through to both import prices and producer prices may have the same microeconomic origin. If that is indeed the case, the strength of the exchange rate pass-through to (producer) prices will depend on the sectoral structure of imports, that is, on the relative importance of the sectors that tend to have high exchange rate pass-through.

Finally, it is worth noting that the results reported above are conditional upon the currency board system being in place. In this respect, the results should not be interpreted as suggesting that, for example, Estonian CPI would remain unresponsive to the exchange rate even if the latter were allowed to float. The results are conditional on the existing exchange rate/monetary regime, and that is, in fact, one of the reasons why this research was carried out using Estonian data. In particular, the automatism of the currency board makes it possible to avoid the common factor problem that classical central banks are likely to create in the dynamics of prices and exchange rates.

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APPENDICES

Appendix A

Table A.1. Distribution of normal imports by NACE groups

		1995	1998	2000	2002	Average	Change
		(1)	(2)	(3)	(4)	(1):(4)	(4)-(1)
A	Agriculture, hunting and forestry	0.041	0.035	0.036	0.035	0.037	-0.006
B	**Fishing**	0.001	0.001	0.003	0.002	**0.002**	**0.001**
CA	**Mining and quarrying of energy producing materials**	0.027	0.021	0.019	0.014	**0.020**	**-0.013**
CB	**Mining and quarrying, except of energy producing materials**	0.005	0.004	0.003	0.003	**0.004**	**-0.002**
DA	**Manufacture of food products, beverages and tobacco**	0.134	0.118	0.099	0.094	***0.115***	*-0.041*
DB	**Manufacture of textiles and textile products**	0.051	0.049	0.054	0.060	***0.053***	*0.009*
DC	**Manufacture of leather and leather products**	0.016	0.015	0.015	0.016	**0.015**	**0.0**
DD	Manufacture of wood and wood products	0.015	0.018	0.022	0.023	0.019	0.008
DE	Manufacture of pulp, paper and paper products; publishing and printing	0.041	0.037	0.037	0.033	0.037	-0.007
DF	**Manufacture of coke, refined petroleum products and nuclear fuel**	0.085	0.044	0.065	0.052	***0.062***	***-0.033***
DG	Manufacture of chemicals, chemical products and man-made fibres	0.107	0.100	0.109	0.103	0.106	-0.004
DH	Manufacture of rubber and plastic products	0.040	0.040	0.045	0.047	0.043	0.007
DI	**Manufacture of other non-metallic mineral products**	0.028	0.027	0.025	0.025	***0.026***	***-0.003***
DJ	**Manufacture of basic metals and fabricated metal products**	0.080	0.093	0.090	0.099	**0.088**	**0.019**
DK	Manufacture of machinery and equipment n.e.c.	0.093	0.116	0.107	0.123	0.106	0.030
DL	Manufacture of electrical and optical equipment	0.133	0.140	0.146	0.117	0.135	-0.016
DM	Manufacture of transport equipment	0.073	0.114	0.097	0.128	0.102	0.055
DN	**Manufacturing n.e.c.**	0.028	0.025	0.026	0.023	**0.026**	**-0.005**
	TOTAL	0.998	0.998	0.997	0.996		

Source: Author’s calculations.
Notes: categories of goods for which significant exchange rate pass-through was estimated and which are summarised in Table A.3 are shown in bold.

Table A.2. Unit root tests, aggregate prices

Variable	Lag	ADF (test)	ADF (trend)	PP (test)	PP (trend)	Lag	ADF (test)	ADF (const)	PP (test)	PP (const)	Lag	ADF (test)	PP (const)
ER	3	-2.67 p= 0.25	-2.49	-8.49 p= 0.55	-1.96	3	-0.96 p= 0.77	-1.13	-1.74 p= 0.81	-0.69	3	0.72 p= 0.87	0.43 p= 0.79
D(ER)						2	-2.90 p= 0.05	-1.00	-26.78 p= 0.0	-0.79	**2**	**-2.72 p=0.006**	**-26.09 p= 0.0**
P*	5	*-3.29 p= 0.07*	*3.20*	-13.84 p=0.23	2.32	5	-0.66 p= 0.86	1.10	-2.29 p= 0.75	3.90	5	1.51 p= 0.97	0.67 p=0.85
D(P*)						2	**-2.71 p= 0.07**	**1.83**	**-12.18 p=0.08**	**2.16**	2	-1.92 p= 0.05	-9.80 p= 0.03
IUV	4	-2.20 p=0.49	1.93	-9.89 p=0.44	1.49	2	-1.00 p=0.75	1.29	-2.99 p=0.66	2.68	2	0.63 p=0.85	0.70 p=0.85
D(IUV)						5	-2.06 p=0.26	1.17	-21.31 p=0.008	1.48	3	**-2.36 p= 0.018**	**-21.34 p=0.001**
PPI	3	-2.49 p=0.33	1.77	-3.72 p= 0.90	0.300	3	-1.91 p=0.33	2.01	-2.97 p=0.66	7.06	3	0.14 p=0.73	0.63 p=0.84
D(PPI)						2	-1.72 p=0.42	0.33	**-21.62 p=0.008**	**2.21**	2	**-2.10 p=0.03**	-15.99 p=0.006
PPI_D	3	-2.67 p=0.24	1.78	-4.51 p=0.85	0.17	3	-2.16 p=0.22	2.24	-3.78 p=0.56	6.45	3	0.01 p=0.69	0.38 p=0.78
D(PPI_D)						2	-1.69 p=0.44	0.38	-13.56 p=0.057	1.24	2	**-1.87 p=0.058**	**-10.68 p=0.02**
CPI	5	-2.00 p=0.60	1.29	-4.39 p=0.86	2.06	3	*-2.64 p=0.085*	*2.89*	-2.92 p=0.67	14.20	5	1.09 p=0.93	0.77 p=0.87
D(CPI)						5	-2.82 p=0.05	1.31	-3.49 p=0.60	0.85	5	**-2.82 p=0.005**	**-2.79 p=0.25**
CPI_T	5	-2.07 p=0.56	1.66	-4.10 p=0.88	1.02	5	-1.35 p=0.61	1.52	-3.03 p=0.65	8.33	5	0.88 p=0.90	0.72 0.86
D(CPI_T)						5	-2.71 p=0.07	1.02	-7.32 p=0.26	1.37	5	**-2.86 p=0.004**	**-4.64 p=0.14**

Notes: ADF and PP refer to Augmented Dickey-Fuller and Phillips-Perron unit root tests, respectively. Reported are test statistics (t-statistics for deterministic variables). Lag length was selected by the rule min(j+2, maxlag), where j is the lag length minimizing Akaike information criterion and maxlag is the maximum lag length assumed (see TSP manual). Operator D(.) denotes first differencing. The three vertical sections of the table refer to the model that includes both trend and constant, only constant, and no constant, respectively.

Table A.3. Import unit values, summary of single equation and SUR estimates

	B	CA	CB	DA	DB	DC	DF	DI	DJ	DN
Share, %	0.2	2.2	0.4	11.9	5.2	1.6	6.6	2.6	8.6	2.6
Single equation										
ERPT Jointly zero Chi-sq	4.41 p= 0.35	52.7 p=0.0	0.76 p=0.68	5.93 p=0.05	7.84 p=0.10	8.91 p=0.01	15.37 p=0.0	6.67 p=0.04	12.2 p=0.0	6.88 p=0.14
SHORT RUN	.282 .168	.102 .056	.164 .710	1.56** .640	.306 .304	2.60** 1.24	.343** .134	.914** .358	.285 .177	-3.69** 1.50
SHORT RUN=1	-.72*** .17	-.90*** .06	-.84 .71	.56 .64	-.69** .30	1.60 1.24	-.66*** .13	-.08 .36	-.71*** .18	- 4.69*** 1.50
LONG RUN Chi-sq(1)	.48 .44 p=0.27	.26 .02 p=0.0	-.28 .59 p=0.64	2.16 1.23 p=0.08	1.15 1.14 p=0.31	3.10 1.05 p=0.0	-.17 .24 p=0.49	.52 .28 p=0.07	.46 .13 p=0.0	-.54 1.21 p=0.66
LONG RUN =1	-.52 .44	-.74*** .02	-1.28** .59	1.16 1.23	.15 1.14	2.10** 1.05	-1.17*** .24	-.48* .28	-.54*** .13	-1.54 1.21
SUR										
ERPT Jointly zero Chi-sq(4)	21.0 p=0.0	56.0 p=0.0	16.2 p=0.0	5.7 p=0.22	20.9 p=0.0	40.4 p=0.0	49.2 p=0.0	34.0 p=0.0	15.4 p=0.0	11.3 p= 0.02
SHORT RUN	.390*** .098	.222*** .045	.948** .378	.100 .617	.439** .222	3.15*** .804	.775*** .145	1.31*** .300	.260** .109	- 3.66*** 1.35
SHORT RUN=1	-.61*** .10	-.78*** .045	-.05 .38	-.90 .62	-.56** .22	2.15*** .80	-.23 .14	.31 .30	-.74*** .11	- 4.66*** 1.35
LONG RUN Chi-sq(1)	.28 .12 p=0.02	.254 .032 p=0.0	.18 .46 p=0.70	2.02 1.18 p=0.09	.84 .38 p=0.03	.34 1.2 p=0.78	1.08 .42 p= 0.01	1.10 .151 p=0.0	.54 .17 p=0.0	-.50 1.47 p= 0.73
LONG RUN=1	-.71*** .12	-.75*** .03	-.82* .46	1.01 1.18	-.16 .38	-.67 1.20	.08 .42	.10 .15	-.45*** .17	-1.50 1.47

Notes: ERPT jointly zero reports the result of testing that all pass-through coefficients are jointly zero.
SHORT RUN refers to the short run pass-through elasticity, here defined as the contemporaneous pass-through.
SHORT RUN=1 reports the result of testing that the short run pass-through coefficient is equal to one.
LONG RUN refers to the long run pass-through elasticity, defined as B(1)/1-A(1), see equation 2 in the text.
LONG RUN=1 reports the result of testing that the long run pass-through elasticity is equal to one.
Reported are coefficient estimates and their standard errors; p refers to p-values; *** indicates significance at 1%, ** indicates significance at 5%, * indicates significance at 1%.

Table A.4. Producer prices, summary of single equation and SUR estimates

	dPPI_DA Food prod.	dPPI_DB Textile prod.	dPPI_DG Chemical prod	dPPI_DK Machinery & equip.	dPPI_DN Furniture & other
Share, %	28.5	9.4	8	2	5.3
Single equation					
ERPT Jointly zero ChiSq	16.8 p=0.001	9.8 p=0.007	12.7 p=0.005	7.4 p=0.12	12.5 p=0.05
SHORT RUN	-.166 .358	.084 .147	.403 .331	1.40** .553	.472 .278
SHORT RUN=1	-1.17*** .36	-.92*** .15	-.60** .33	.40 .55	-.53* .28
LONG RUN	.019 1.55	.803** .346	1.73*** .503	.38 3.7	.72 .76
LONG RUN=0 Chi-sq	0.0001 p=0.99	5.40 p=0.02	11.9 p=0.0	0.01 p=0.92	0.90 p=0.34
LONG RUN=1	-.98 1.55	-.20 .35	.73 .50	-.62 3.67	-.28 .76
Rsq-adj	.55	.63	.32	.21	.51
NOBS	33	32	33	33	30
SUR					
ERPT Jointly zero ChiSq	11.4 p=0.04	54.3 p=0.0	17.7 p=0.003	26.4 p=0.0	28.0 p=0.0
SHORT RUN	.069 .241	.549*** .127	.371 .260	2.59*** .569	.571** .232
SORT RUN=1	-.93*** .24	-.45*** .13	-.63** .26	1.59*** .57	-.43 .23
LONG RUN Chi-sq(1)	1.37* .840 p=0.10	2.50*** .597 p=0.0	1.00* .519 p=0.05	3.30** 1.58 p=0.04	1.05* .54 p=0.05
LONG RUN=1	.37 .84	1.50** .60	0.001 .52	2.30 1.58	.05 .54
Rsq	.69	.81	.61	.53	.62
NOBS	27	27	31	27	31

Notes: ERPT jointly zero reports the result of testing that all pass-through coefficients are jointly zero.
SHORT RUN refers to the short run pass-through elasticity, here defined as the contemporaneous pass-through.
LONG RUN refers to the long run pass-through elasticity, defined as B(1)/1-A(1), see equation 2 in the text.
LONG RUN=1 reports the result of testing that the long run pass-through elasticity is equal to one.
Reported are coefficient estimates and their standard errors; p refers to p-values; *** indicates significance at 1%, ** indicates significance at 5%, * indicates significance at 1%.

Table A.5. Producer prices, summary of SUR estimates, controlling for GDP growth

	dPPI_DA Food prod.	dPPI_DB Textile prod.	dPPI_DG Chemical prod	dPPI_DK Machinery & equip.	dPPI_DN Furniture & other
Share, %	28.5	9.4	8	2	5.3
SUR (as before)					
ERPT Jointly zero ChiSq	11.4 p=0.04	54.3 p=0.0	17.7 p=0.003	26.4 p=0.0	28.0 p=0.0
SHORT RUN	.069 .241	.549*** .127	.371 .260	2.59*** .569	.571** .232
SHORT RUN=1	-.93*** .24	-.45*** .13	-.63** .26	1.59*** .57	-.43 .23
LONG RUN Chi-sq(1)	1.37* .840 p=0.10	2.50*** .597 p=0.0	1.00* .519 p=0.05	3.30** 1.58 p=0.04	1.05* .54 p=0.05
LONG RUN=1	.37 .84	1.50** .60	0.001 .52	2.30 1.58	.05 .54
Rsq	.69	.81	.61	.53	.62
NOBS	27	27	31	27	31
SUR, controlling for GDP growth					
ERPT Jointly zero ChiSq	9.3 p=0.10	145.5 p=0.0	36.3 p=0.0	25.9 p=0.0	34.3 p=0.0
SHORT RUN	.035 .232	.713*** .092	.414* .237	2.45*** .641	.899*** .259
SHORT RUN=1	-.97*** .23	-.287*** .093	-.586** .237	1.45** .641	-.101 .259
LONG RUN Chi-sq(1)	1.56 1.67 p=0.35	4.18*** .724 p=0.0	1.57** .704 p=0.03	2.50 2.38 p=0.29	.54 .57 p=0.34
LONG RUN=1	.56 1.7	3.2*** .72	.570 .704	1.50 2.38	-.463 .568
Rsq	.72	.91	.73	.53	.66
NOBS	27	27	31	27	31
GDP jointly zero, Chi(3)	3.27 p=0.35	41.5 p=0.0	17.7 p=0.0	1.34 p=0.72	6.06 p=0.11

Notes: ERPT jointly zero reports the result of testing that all pass-through coefficients are jointly zero.
SHORT RUN refers to the short run pass-through elasticity, here defined as the contemporaneous pass-through.
LONG RUN refers to long the run pass-through elasticity, defined as B(1)/1-A(1), see equation 2 in the text.
LONG RUN=1 reports the result of testing that the long run pass-through elasticity is equal to one.
Reported are coefficient estimates and their standard errors; p refers to p-values; *** indicates significance at 1%, ** indicates significance at 5%, * indicates significance at 1%.

Table A.6. Exchange rate pass-through to aggregate import and producer prices, OLS estimates

	DIUV	dIUV	DIUV	dPPI	dPPI	dPPI	dPPI_D	dPPI_D	dPPI_D
dP(-1)	-.141 .223	-.198 .242	-.210 .265	.158 .154	.101 .153	.086 .162	.189 .166	.170 .180	.148 .180
dP(-2)	-.289 .248	-.269 .270	-.355 .296	-.072 .150	-.042 .145	-.018 .154	-.151 .165	-.141 .179	-.125 .179
dP(-3)	-.403* .214	-.306 .241	-.388 .247	.216* .116	.154 .115	.170 .124	.155 .123	.131 .143	.123 .139
dP(-4)	-.401* .203	-.511* .259	-.478 .274						
DER	.012 .198	.067 .226	.105 .273	.076 .079	.100 .077	.114 .099	.138* .073	.149* .083	.195* .099
DER(-1)	.019 .190	-.065 .237	-.007 .266	.183** .079	.085 .083	.126 .092	.189** .074	.152 .089	.189* .092
dER(-2)	.452* .205	.503* .240	.489 .275	.074 .086	.058 .085	.075 .099	.064 .080	.063 .093	.088 .103
dER(-3)	-.062 .206	-.164 .234	-.086 .260	.021 .084	-.011 .084	.023 .094	.020 .079	.019 .090	.040 .093
dER(-4)	.684** .239	.636** .259	.631* .278						
dP*	1.25 .912	1.10 1.08	1.30 1.14	.474* .259	.240 .267	.471 .284	.478* .238	.407 .288	.522* .279
dP*(-1)	-.046 .852	-.167 .912	.040 .962	-.326 .295	-.135 .320	-.192 .351	-.270 .285	-.231 .362	-.131 .367
dP*(-2)	.676 .815	.796 .891	.806 .961	-.077 .297	-.303 .311	-.304 .327	-.003 .279	-.055 .355	-.149 .328
dP*(-3)	.597 .911	.514 1.11	.622 1.24	.433** .203	.608*** .201	.617** .237	.441** .197	.504** .229	.525** .235
dP*(-4)	-.057 .736	-.220 .909	-.049 .953						
		GROWTH	GAP		GROWTH	GAP		GROWTH	GAP
GDP		.155 .368	.170 .368		.273** .109	.207* .116		.116 .116	.097 .111
GDP(-1)		-.134 .313	-.127 .445		-.027 .109	-.201 .137		-.047 .116	-.095 .135
GDP(-2)		.380 .291	.207 .342		-.060 .100	-.025 .133		-.020 .104	.013 .131
GDP(-3)					.029 .090	.107 .126		-.008 .093	.100 .126
NOBS	24	24	24	32	32	32	32	32	32
F-test (reduction)	0.70 p=0.42	-	-	1.38 p=.29	0.30 p= .90	0.70 p=.63	1.46 p=.26	0.71 p=.63	1.10 p=.41
ERPT Jointly zero, ChiSq	10.0 p=0.08	8.75 p=0.12	7.1 p=0.22	10.8 p=0.03	4.64 p= 0.33	3.6 p=0.46	16.7 p=0.0	10.2 p=0.04	8.4 0.08
SHORT RUN =1	- .99*** .20	-.93*** .23	-.89*** .27	-.92*** .08	-.90*** .08	-.89*** .10	-.86*** .07	-.85*** .08	-.80*** .10
LONG RUN	.49** .22	.43* .25	.47 .31	.51** .21	.29 .20	.44 .30	.51*** .15	.46** .20	.60** .27
ERPT jointly zero, Chi-sq(1)	5.26 p=0.02	2.89 p=0.09	2.23 p=0.13	5.63 p=0.02	2.20 p=0.14	2.2 p=0.14	10.25 p= 0.0	5.34 p=0.02	5.10 p=0.02
LONG RUN=1	-.51** .22	-.57** .25	-.53* .31	-.49** .21	-.71*** .20	-.56* .30	-.49*** .16	-.54*** .20	-.40 .27
P* jointly zero Chi(5)	18.9 p=0.0	9.8 p=0.08	14.1 p=0.02	14.6 p=0.0	15.6 p=0.0	13.8 p=0.01	19.9 p=0.0	16.4 p=0.0	17.4 p=0.0
GDP jointly zero, Chi(3)	-	1.92 p=0.59	0.96 p=0.82	-	7.1 p=0.13	4.3 p=0.37	-	1.07 p=0.90	1.42 p=0.84
LM-acorr	ok	no[1]	no[1]	ok[2]	ok	ok	ok	ok	ok
Rsq-adj	.42	.34	.26	.69	.71	.69	.69	.72	.73

Notes: All notes for Table A.4 apply here.
1 – LM test indicates autocorrelation in residuals at 1% (3rd order).
2 – LM test indicates autocorrelation in residuals at 10% (5th order).
Reduction test in the case of PPI is from the most general model: ARDL(4,4) with a constant.

Table A.7. Exchange rate pass-through to aggregate CPI, OLS estimates

	dCPI	dCPI	dCPI_T	dCPI_T	dCPI_T
dP(-1)	.303* .157	.188 .153	.511*** .174	.459** .162	.538*** .164
dP(-2)	.092 .167	.111 .145	-.272 .198	-.174 .187	-.272 .192
dP(-3)	-.123 .178	-.092 .156	.060 .146	.021 .133	.116 .135
dP(-4)	-.430** .178	-.352** .155			
dP(-5)	.569*** .131	.551*** .114			
dER	.047 .059	.101 .062	.067 .068	.137* .078	.079 .065
DER(-1)	-.047 .068	-.041 .062	-.004 .075	.011 .075	.024 .069
DER(-2)	.055 .064	.077 .060	-.094 .075	-.068 .074	-.051 .068
DER(-3)	-.094 .056	-.066 .052	.041 .065	.034 .065	.063 .062
DP*	.136 .209	.385* .184	.422* .217	.594*** .199	.366** .159
dP*(-1)	-.252 .277	-.130 .262	-.713** .309	-.625** .284	-.493** .226
dP*(-2)	-.309 .253	-.363 .215	.095 .331	-.096 .266	.053 .250
dP*(-3)	.661*** .178	.710*** .157	.645*** .214	.747*** .191	.577*** .183
	GROWTH	GAP	GROWTH	GAP	
GDP	.077 .090	.184** .075	.112 .098	.176* .089	
GDP(-1)	-.078 .086	-.119 .086	.019 .091	-.126 .105	
GDP(-2)	.203** .082	.242** .088	.093 .078	.133 .095	
GDP(-3)	.126 .074	-.069 .086	-.035 .082	-.027 .100	
NOBS	31	31	33	33	33
F-test (reduction)	2.03 p=.17	0.85 p= .52	2.21 p=0.13	3.0 p=0.06	1.95 p=.15
ERPT jointly zero, ChiSq	3.47 p=0.48	5.28 p=0.26	2.85 p=0.58	4.65 p= 0.32	3.18 p=0.53
SHORT RUN=1	-.95*** .06	-.90*** .06	-.93*** .07	-0.86*** .08	-0.92*** 0.7
LONG RUN Chi-sq(1)	-.07 .18 p=0.72	.12 .22 p=0.59	.02 .18 p=0.93	.16 .24 p=0.49	.19 .17 p=0.28
LONG RUN=1	-1.07** .18	-.88*** .22	-.98*** .18	-.84*** .24	-.81*** .17
P* jointly zero Chi(4)	18.6 p=0.0	29.6 p=0.0	37.0 p=0.0	46.8 p=0.0	
GDP jointly zero Chi(4)	13.7 p=0.01	21.6 p=0.0	3.95 p=0.41	7.1 p=0.13	
LM-acorr	ok	no[1]	ok	ok	ok
Rsq-adj	.90	.92	.82	.84	.82

Notes: All notes for Table A.4 apply here.

1 – LM test indicates autocorrelation in residuals at 5% (5th order) and 1% (6th order).

2 – LM test indicates autocorrelation in residuals at 10% (5th order).

F test for reduction refers to the restrictions imposed when reducing the model from the most general model assumed initially: ARDL(5,4) with a constant.

Table A.8. Exchange rate pass-through to selected CPI components, OLS estimates

	Food	Food	Clothing & footwear	Clothing & footwear	Clothing & footwear	Household goods	Household goods	Transport & commun.	Transport & commun.	Transport & commun.
	.013** .005	.013*** .004				.0037** .0015	.0019 .0014			
dP(-1)	.027 .154	.103 .142	.419** .172	.452** .160	.490*** .162	-.092 .197	.102 .200	.129 .208	.165 .184	.207 .179
dP(-2)	-.049 .164	-.081 .144	.485** .175	.462*** .160	.462*** .156	.341** .154	.326 .171	-.050 .224	.159 .200	.176 .188
dP(-3)	-.335** .121	-.296** .116				.477** .179	.272 .175	.482** .207	.503** .210	.425** .180
dER	.215* .102	.234** .082	.009 .068	.011 .057	.029 .056	.024 .045	.049 .041	.639** .235	.488* .245	.340* .186
dER(-1)	.084 .106	.145 .092	.018 .067	-.001 .060	.032 .059	.073 .048	.053 .043	-.182 .226	-.271 .234	-.221 .205
dER(-2)	-.039 .105	-.021 .091	.046 .061	.055 .050	.051 .049	.052 .042	.039 .038	.346 .236	.074 .209	.009 .180
dER(-3)	.059 .090	.075 .075				.089** .041	.060 .039	-.301 .195	-.515** .186	-.378** .163
dP*	-.252 .389	-.212 .303	-.224 .213	-.264 .181		-.090 .143	.065 .144	1.50** .688		
dP*(-1)	-1.08** .413	-.908** .373	.125 .259	.108 .245		-.154 .164	-.069 .171	-.296 1.01		
dP*(-2)	-.420 .374	-.364 .362	.098 .148	.122 .139		-.057 .128	-.182 .134	.102 .720		
dP*(-3)	1.62*** .286	1.44*** .257				.017 .092	.127 .082	-.007 .416		
GDP gap	.153 .122		-.031 .076			-.076 .056		.138 .236	.074 .245	
GDP gap (-1)	-.219 .139		.102 .099			-.030 .059		-.093 .307	-.003 .329	
GDP gap (-2)	.068 .145		-.041 .090			-.010 .061		.493 .303	.343 .322	
GDP gap (-3)	-.051 .137					-.032 .058		.122 .286	-.152 .271	
NOBS	30	30	31	31	31	31	31	31	31	31
F-test (reduct.)	0.68 p=0.65	.70 p=0.70	1.3 p= .33	1.1 p=0.42	1.3 p=0.37	2.2 p=.14	2.5 p=.08	1.4 p=.29	1.8 p=.20	1.6 p=.22
ERPT jointly zero, ChiSq	5.81 p=0.21	16.0 p=0.0	0.74 p=0.86	1.4 p=0.70	2.3 p=0.51	6.2 p= 0.18	7.5 p=0.12	9.3 p=0.05	13.1 p=0.01	10.9 p=0.03
SHORT RUN=1	-.78*** .10	-.77*** .08	-.99*** .07	-.99*** .06	-.97*** .06	-.98*** .04	-.95*** .04	-.36 .24	-.51** .24	-.65*** .19
LONG RUN Chi-sq(1)	.23 .16 p=0.14	.34 .10 p=0.0	.75 1.31 p=0.57	.76 1.23 p=0.54	2.30 3.24 p=0.48	.87* .46 p=0.06	.67** .31 p=0.03	1.14 1.08 p=0.29	-1.29 2.09 p=0.54	-1.30 1.38 p=0.35
LONG RUN=1	-.77*** .15	-.66*** .10	-.25 1.31	-.24 1.23	1.30 3.24	-.13 .46	-.33 .31	.14 1.08	-2.29 2.09	-2.30* 1.38
P* jointly zero, Chi(4)	54.1 p=0.0	57.8 p=0.0	3.5 p=0.32	4.7 p=0.19	-	10.6 p=0.03	6.1 p=0.19	7.8 p=0.10	-	-
GDP jointly zero, Chi(4)	3.3 p=0.51	-	1.5 p=0.69	-	-	8.7 p=0.07	-	9.0 p=0.06	3.7 p=0.45	-
LM-acorr	ok	ok	~ok[1]	~ok[2]	ok	ok	ok	~ok[3]	ok	ok
Rsq-adj	.85	.85	.74	0.76	.73	.87	.83	.57	.47	.48

Notes: All notes for Table A.4 apply here.

Reduction test refers to restrictions imposed when going from the most general model AR(5,4) with a constant.

1 – LM indicates 2nd order autocorrelation at 10%.

2 – LM indicates 2nd and 3rd order autocorrelation at 10%.

3 – LM indicates 5th order autocorrelation at 10%

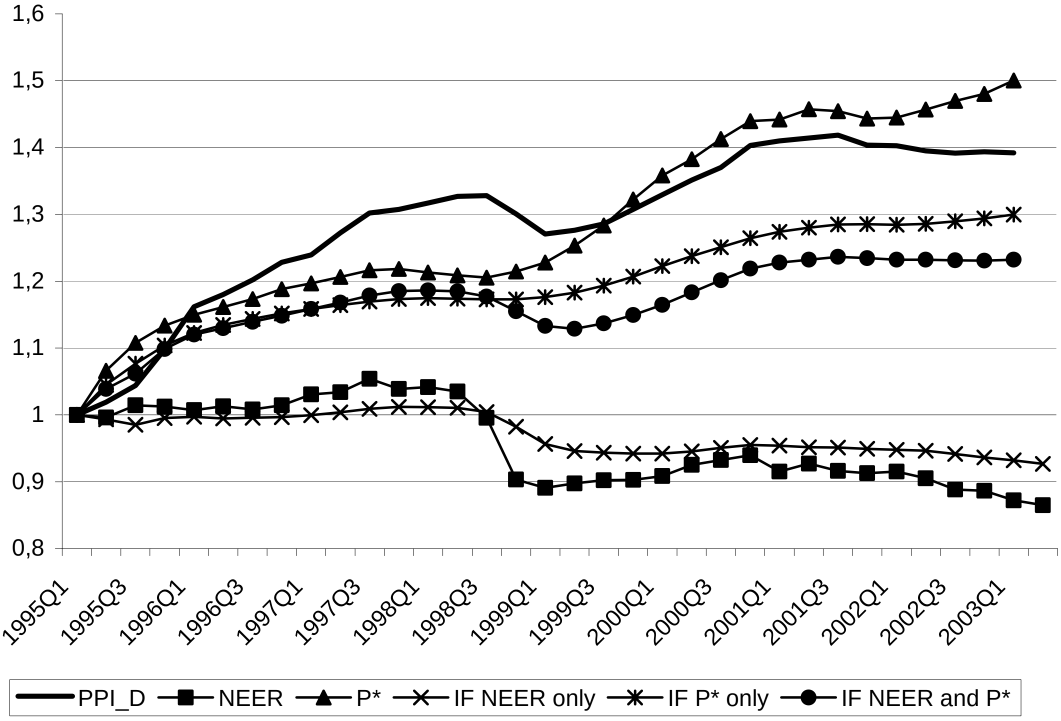

Figure A.1. Contribution of NEER and foreign prices to PPI in manufacturing
Notes: PPI_D is the producer price index in the manufacturing sector; NEER – nominal effective exchange rate; P* – foreign effective producer price index.
IF NEER only, IF P* only, and IF NEER and P* mean that only historical NEER, only historical P* or both were used to simulate PPI_D, respectively. See text for explanation

Appendix B

Table B.1. Main partners by NACE import category, normal imports

Group	TOTAL	FI	DE	RU	SE	IT	NL	DK	FR	JP	US	LV	LT	GB	PL
	0.810	0.268	0.155	0.130	0.100	0.051	0.037	0.035	0.034	0.034	0.033	0.032	0.031	0.033	0.027
A		UZ	NL	RU	FI	TJ	KZ	LV	FI	IT	LT	TM	UA		
Agriculture	0.038		0.199	0.211	0.097	0.090	0.064	0.098	0.095	0.053	0.046	0.046	0.038		
B		**RU**	**NO**	**FI**	**SE**	**GB**	**LV**	**DK**	**UA**	**NL**	**DE**	**LT**	**US**		
Fishing	0.002	0.494	0.174	0.173	0.071	0.023	0.011	0.007	0.026	0.010	0.006	0.0	0.005		
CA		**RU**	**FI**	**LV**	**NL**	**KZ**	**DE**	**BE**	**DK**	**SE**	**BY**	**IE**	**PL**		
Mining: energy materials	0.022	0.997	0.001	0.001	0.0	0.001	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
CB		**FI**	**BY**	**RU**	**UA**	**DE**	**SE**	**DK**	**LV**	**NL**	**FI**	**LT**	**IT**		
Mining: non-energy mat.	0.004	0.338	0.110	0.280	0.088	0.057	0.034	0.024	0.022	0.013	0.011	0.012	0.010		
DA		**FI**	**DE**	**DK**	**SE**	**NL**	**LT**	**PL**	**LV**	**US**	**FR**	**BE**	**HU**		
Food	0.119	0.243	0.147	0.085	0.080	0.093	0.061	0.055	0.059	0.055	0.046	0.045	0.031		
DB		**FI**	**IT**	**DE**	**CN**	**SE**	**BE**	**GB**	**FR**	**LT**	**RU**	**DK**	**PK**		
Textiles	0.052	0.233	0.121	0.115	0.083	0.087	0.080	0.054	0.047	0.048	0.069	0.040	0.022		
DC		**IT**	**FI**	**CN**	**DE**	**SE**	**NL**	**PT**	**VN**	**FI**	**LV**	**GB**	**DK**		
Leather	0.016	0.255	0.262	0.117	0.069	0.100	0.064	0.031	0.020	0.021	0.018	0.032	0.012		
DD		RU	FI	LV	SE	DE	DK	LT	US	PL	BY	AT	FR		
Wood pr.	0.018	0.396	0.299	0.077	0.084	0.064	0.020	0.014	0.009	0.014	0.009	0.007	0.005		
DE		FI	DE	SE	RU	LV	PL	GB	IT	LT	CH	NL	DK		
Paper pr.	0.038	0.477	0.105	0.106	0.086	0.046	0.043	0.033	0.025	0.024	0.022	0.016	0.016		
DF		**RU**	**FI**	**LT**	**SE**	**BY**	**DE**	**LV**	**NL**	**DK**	**NO**	**BE**	**UA**		
Petroleum	0.066	0.483	0.295	0.084	0.027	0.049	0.017	0.016	0.009	0.007	0.007	0.004	0.002		
DG		FI	DE	RU	SE	FR	GB	LV	NL	BE	PL	DK	CH		
Chemical pr.	0.106	0.227	0.185	0.153	0.089	0.051	0.054	0.049	0.050	0.039	0.035	0.039	0.030		
DH		FI	DE	SE	IT	BE	PL	LT	GB	NL	LV	DK	RU		
Rubber, plastic	0.043	0.350	0.161	0.151	0.061	0.045	0.039	0.030	0.039	0.033	0.027	0.033	0.032		
DI		**FI**	**IT**	**DE**	**SE**	**RU**	**CZ**	**PL**	**LT**	**FR**	**BE**	**LV**	**NO**		
Other non-metal	0.026	0.411	0.109	0.084	0.067	0.078	0.058	0.038	0.040	0.034	0.029	0.026	0.026		
DJ		**FI**	**RU**	**DE**	**SE**	**UA**	**IT**	**LV**	**DK**	**PL**	**GB**	**CN**	**LT**		
Basic metals	0.087	0.423	0.189	0.114	0.091	0.036	0.033	0.031	0.023	0.016	0.020	0.009	0.015		
DK		FI	DE	SE	IT	DK	FR	GB	US	NL	JP	RU	CH		
Machinery & equip.	0.104	0.328	0.196	0.130	0.108	0.053	0.034	0.031	0.031	0.025	0.024	0.023	0.019		
DL		FI	DE	SE	US	JP	GB	CN	NL	TW	DK	FR	KR		
Electrical equip.	0.135	0.334	0.155	0.123	0.091	0.078	0.060	0.030	0.039		0.032	0.030	0.028		
DM		DE	SE	JP	FI	FR	US	RU	UA	GB	NL	KR	BE		
Transport equip.	0.097	0.325	0.150	0.165	0.121	0.055	0.030	0.041	0.020	0.022	0.027	0.024	0.019		
DN		**FI**	**IT**	**DE**	**CN**	**SE**	**PL**	**NL**	**DK**	**GB**	**US**	**FR**	**AT**		
Manuf. furniture	0.026	0.398	0.136	0.104	0.062	0.079	0.046	0.037	0.037	0.030	0.032	0.020	0.017		

Source: Author’s calculations.
Notes: Entries in bold denote categories of imports for which the exchange rate pass-through is significant.

Table B.2. Cointegration tests

Engle-Granger					
	NEER	EFP	TestStat	P-value	Lag
IUV	0.409	0.601	-2.44	0.72	2
PPI	0.673	0.121	-2.37	0.75	2
PPI_D	0.683	0.326	-2.45	0.72	2
CPI	0.544	0.143	-1.24	0.98	3
CPI_T	0.592	0.101	-1.66	0.95	3

Lag	Johansen (trace)				
4	H0:r=0	24.82 p=0.37	IUV	NEER	EFP
	H0:r<=1	6.53 p=0.75	1	0.130	0.60
	H0:r<=2	0.14 p=0.59			
			PPI	NEER	EFP
5	H0:r=0	30.95 p=0.11	1	1.22	2.01
	H0:r<=1	17.40 p=0.06			
	H0:r<=2	6.94 p=0.01			
			PPI_D	NEER	EFP
5	H0:r=0	28.32 p=0.19	1	0.79	1.48
	H0:r<=1	13.00 p=0.23			
	H0:r<=2	5.94 p=0.013			
			CPI	NEER	EFP
5	H0:r=0	33.76 p=0.06	1	2.11	-0.28
	H0:r<=1	15.90 p=0.10			
	H0:r<=2	7.74 p=0.004			
			CPI_T	NEER	EFP
5	H0:r=0	39.72 p=0.01	1	0.25	0.30
	H0:r<=1	21.61 p=0.02	1	4.91	2.44
	H0:r<=2	10.77 p=0.001	1	17.04	0.12

Table B.3.1. Import unit values, single equation estimation

	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN
dP(-1)	.138 .239	-.074 207	-.429** .191	-.338 .202	-.445** .179	.005 .192	-.649*** .131	-.828*** .204	-.584*** .195	-.548*** .184	-.168 .121	-.176 .218	-.359 .226	-.839*** .227
dP(-2)		.233 .213		-.044 .180	-.130 .191	.246* .138	-.058 .152	-.301 .196						-.394 .232
dP(-3)		.108 .201			-.383** .162		.129 .126							-.111 .150
dER	**1.56**** **.640**	.306 .304	**2.60**** **1.24**	-.092 .201	.018 .341	**.343**** **.134**	.025 .209	-.113 .677	**.914**** **.358**	**.285** **.177**	.118 1.16	-.044 1.67	-.027 .386	-3.69** 1.50
dER(-1)	.299 .724	-.201 .312	1.82 1.19	.024 .224	-.442 .378	-.587*** .173	.041 .235	-.116 .726	-.091 .389	.431** .187	-.369 1.15	-.498 1.48	-.328 .389	-.010 1.51
dER(-2)		-.097 .310		.407* .193	.462 .391	.117 .194	.282 .224	1.27* .696						.87 1.58
dER(-3)		.832** .329			-.667 .442		.238 .231							1.56 1.65
dP*	-.332 .898	1.06 .756	-2.09 2.56	-.428 1.06	-.437 .881	.463*** .081	-.052 .917	1.95* .960	-.706 .497	.324 .714	.588 1.53	.568 3.92	.158 1.11	3.36 2.06
dP*(-1)	.642 .863	-.502 .859	.70 2.4	.164 1.34	.367 .928	.248** .105	3.54*** 1.00	.591 1.27	.903* .512	.622 .719	.534 1.51	1.22 3.48	2.14 1.27	2.53 2.85
dP*(-2)		-.303 .900		.625 .984	1.58 .980	-.009 .118	-1.06 1.15	-1.22 1.09						-4.93 3.07
dP*(-3)		.535 .795			.954 .883		.413 1.02							7.02*** 2.13
NOBS	27	24	26	25	25	26	25	26	27	26	27	26	27	24
F-test	2.42	1.76	2.52	1.15	1.48	1.23	0.62	1.46	2.29	2.66*	0.95	1.33	2.02	0.14
ERPT (jointly zero, ChiSq)	**5.93** **p=0.05**	7.84 p=0.10	**8.91** **p=0.01**	5.67 p=0.13	3.75 p=0.44	**15.37** **p=0.002**	3.87 p=0.42	3.41 p=0.33	**6.67** **p=0.04**	**12.2** **p=0.0**	0.11 p=0.95	0.11 p=0.94	0.75 p=0.69	6.88 p=0.14
SHORT RUN=1	**.56** **.64**	-.69** .30	**1.60** **1.24**	-1.09*** .20	-.98*** .34	**-.66***** **.13**	-.98*** .21	-1.11 .68	**-.08** **.36**	**-.71***** **.18**	-.88 1.16	-1.04 1.67	-1.03*** .39	-4.69*** 1.50
LONG RUN	**2.16** **1.23**	1.15 1.14	**3.10** **1.05**	.25 .23	-.32 .32	**-.17** **.24**	.37 .25	.49 .47	**.52** **.28**	**.46** **.13**	-.21 1.30	-.46 1.90	-.26 .36	-.54 1.21
LONG RUN=0 Chi-sq(1)	**3.05** **p=0.08**	1.01 p=0.31	**8.66** **p=0.003**	1.12 p=0.29	0.99 p=0.32	**0.48** **p=0.49**	2.15 p=0.14	1.06 p=0.30	**3.35** **p=0.07**	**12.5** **p=0.0**	0.03 p=0.87	0.06 p=0.81	0.51 p=0.47	0.20 p=0.66
LONG RUN=1	**1.16** **1.23**	.15 1.14	**2.10**** **1.05**	-.75*** .23	-1.32*** .32	**-1.17***** **.24**	-.63*** .25	-.51 .47	**-.48*** **.28**	**-.54***** **.13**	-1.21 1.30	-1.46 1.90	-1.26*** .36	-1.54 1.21
LM-autocorr	ok	ok	ok	ok	ok	ok	ok	no[1]	ok	ok	no[2]	ok	no[3]	ok
Rsq-adj	.19	.19	.24	.10	.40	.82	.68	.40	.34	.38	-.04!	-.13!	.03	.74

Notes: Notes for Table A.4 apply here.

1 – LM test: residual autocorrelation at 1% (5^{th} order). 2 – LM test: residual autocorrelation at 10% (1^{st} order). 3 – LM test: residual autocorrelation at 10% (4^{th} order), and 5% (5^{th} order).

DC: Constant was included into estimation: estimate = 0.20, standard error = 0.12

DK: autocorrelation in residuals at 10%, lag-1, appeared after enlarging the sample from 25 to 27 observations. Sample 25 was used when selecting the best model. Since the model produces a very bad fit no matter what number of lags is used, ARDL(1,1) was selected despite the indication of autocorrelation.

Entries in bold denote categories of goods that feature significant exchange rate pass-through. These categories are selected for Table A.3.

Table B.3.2. Import unit values, single equation (continued)

	A	B	CA	CB
DP(-1)	-.330 .250	-.716** .247	-1.07*** .201	-.309* .159
DP(-2)		.338 .275	-1.38*** .265	
DP(-3)		.332 .248	-.757 .249	
			-.450 .194	
dER	.084 .328	.282 .168	**.102** **.056**	.164 .710
DER(-1)	.066 .303	.148 .241	.339*** .064	-.529 .605
DER(-2)		-.040 .175	.343*** .068	
DER(-3)		.113 .167	.294*** .071	
			.315*** .078	
dP*	.130 .896	.133 .864	.261*** .073	-1.67 2.53
dP*(-1)	.555 .869	.864 .883	.124 .073	1.59 2.08
dP*(-2)		-2.41** .863	.077 .076	
dP*(-3)		1.75** .757	-.075 .076	
			-.214** .072	
NOBS	24	25	24	25
F-test	0.90	0.84	-	0.89
ERPT jointly zero, ChiSq	0.19 p=0.91	4.41 p= 0.35	**52.7** **p=0.0**	0.76 p=0.68
SHORT RUN=1	-.92*** .32	-.72*** .17	**-.90***** **.06**	-.84 .71
LONG RUN	.11 .27	.48 .44	**.26** **.02**	-.28 .59
LONG RUN=0 Chi-sq	0.18 p=0.67	1.21 p=0.27	**202.8** **p=0.0**	0.22 p=0.64
LONG RUN=1	-.89*** .27	-.52 .44	**-.74***** **.02**	-1.28** .59
LM-acorr	no[4]	No[5]	ok	ok
Rsq-adj	-.03!	.60	.81	.11

Notes: 4 – LM test: residual autocorrelation at 5% (4th order).
5 – Ljung-Box Q statistics indicates autocorrelation at 5%, (up to lag-3).
CA: Constant was included into estimation: estimate = 0.105***,
standard error = 0.017

Table B.3.3. Import unit values, SUR estimates

	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN
Const	-.010** .005	.016*** .005	.032*** .009						.021*** .005				.024*** .009	
dP(-1)	-.365** .187	-.139 .165	- .462*** .146	-.332* .180	-.601*** .142	-.130 .184	- .660*** .208	-.836*** .155	-.659*** .155	-.318* .181	-.137 .198	-.132 .180	- .533*** .201	- .854*** .180
dP(-2)	-.100 .168	-.023 .148	.041 .165	.065 .174	-.297** .119	.240* .124	-.093 .151	-.441** .190	-.151 .199	-.106 .154	-.511** .203	-.374** .162	-.119 .203	-.210 .2702
dP(-3)	.030 .186	-.109 .143	-.007 .137	-.080 .150	-.479*** .115	.197* .115	.144 .104	-.160 .173	-.596*** .200	-.140 .147	-.532** .254	-.156 .146	.237 .187	.072 .2148
dP(-4)	.035 .183	-.214 .134	- .349*** .112	-.263** .133	-.177 .111	-.005 .086	.042 .087	-.390*** .134	-1.01*** .162	-.070 .120	-.460*** .114	-.036 .129	- .748*** .201	.120 .144
dER	.100 .617	__.439**__ __.222__	__3.15***__ __.804__	-.065 .151	.108 .236	__.775***__ __.145__	-.009 .170	-.044 .477	__1.31***__ __.300__	__.260**__ __.109__	-1.91 1.34	__-.613__ __1.23__	-.245 .276	__-__ __3.66***__ __1.35__
dER(-1)	.570 .593	-.132 .210	1.50* .829	-.024 .183	-.329 .243	.243 .212	.014 .177	.147 .495	.347 .300	.230* .123	-1.55 1.02	1.37 1.06	.358 .298	.782 1.24
dER(-2)	1.55** .660	.011 .209	.146 1.16	.307* .171	.292 .256	.127 .173	.302* .169	.535 .517	1.38*** .292	.122 .115	-.566 .917	.599 1.32	.264 .306	.945 1.39
dER(-3)	.599 .590	.927*** .220	- 4.21*** 1.17	.163 .179	-.698** .292	- .393*** .151	.196 .183	-.032 .526	.729*** .261	.283** .120	-.977 .818	-3.81*** 1.33	.300 .302	.997 1.24
dP*	.256 .866	.583 .528	-4.11** 1.74	-.282 .940	-.830 .562	2.80*** .714	.164 .718	1.17 .742	-.890** .366	1.01* .535	1.62 1.43	1.02 2.82	-1.72 1.14	3.71** 1.61
dP*(-1)	-.757 .760	-.698 .572	2.72 2.22	-.076 1.03	.612 .590	2.23*** .819	3.39*** .757	.986 .864	.415 .378	-.733 .528	-.508 1.42	-1.25 2.99	.045 1.19	2.56 2.18
dP*(-2)	-.290 .717	-.457 .592	.160 2.02	.567 1.02	1.91*** .628	-2.19** 1.01	-1.16 1.10	.227 .914	-1.01*** .385	.139 .476	3.30** 1.41	7.44*** 2.80	1.43 1.22	-4.58* 2.68
dP*(-3)	2.35*** .77	.380 .550	2.20 1.55	.248 .801	1.35** .635	-1.85** .923	.544 .832	-.686 .749	.033 .336	.894* .504	.056 1.06	-.434 2.20	-.076 .955	5.54*** 2.04
NOBS	23	23	23	23	23	23	23	23	23	23	23	23	23	23
ERPT Jointly zero, Chi(4)	5.7 p=0.22	__20.9__ __p=0.0__	__40.4__ __p=0.0__	6.4 p= 0.17	7.16 p= 0.13	__49.2__ __p=0.0__	5.68 0.22	1.50 p= 0.83	__34.0__ __p=0.0__	__15.4__ __p=0.0__ __04__	5.2 p= 0.27	__13.0__ __p= 0.01__	3.83 p= 0.43	__11.3__ __p= 0.02__
SHORT RUN=1	-.90 .62	__-.56**__ __.22__	__2.15***__ __.80__	- 1.06*** .15	-.89*** .24	__-.23__ __.14__	- 1.01*** .17	-1.04** .48	__.31__ __.30__	__-__ __.74***__ __.11__	-2.91** 1.34	__-1.61__ __1.23__	- 1.25*** .27	__-__ __4.66***__ __1.35__
LONG RUN	2.02 1.18	__.84__ __.38__	__.34__ __1.2__	.24 .23	-.25 .17	__1.08__ __.42__	.321 .199	.21 .29	__1.10__ __.151__	__.54__ __.17__	-1.89 .674	__-1.44__ __1.84__	.31 .32	__-.50__ __1.47__
LONG RUN=0 Chi(1)	2.91 p=0.09	__4.97__ __p= 0.03__	__0.07__ __p=0.78__	1.1 p= 0.30	2.1 p= 0.15	__6.6__ __p= 0.01__	2.60 p= 0.11	0.54 p= 0.46	__53.4__ __p=0.0__	__10.1__ __p=0.0__ __02__	7.9 p= 0.0	__0.62__ __p= 0.43__	0.96 0.33	__0.11__ __p= 0.73__
LONG RUN=1	1.01 1.18	__-.16__ __.38__	__-.67__ __1.20__	-.76*** .23	-1.25*** .17	__.08__ __.42__	-.68*** .20	-.79*** .29	__.10__ __.15__	__-__ __.45***__ __.17__	-2.89*** .67	__-2.44__ __1.84__	-.69** .32	__-1.50__ __1.47__
Rsq	.69	.61	.73	.49	.70	.89	.76	.74	.74	.68	.47	.44	.58	.85

Notes: Notes for Table A.4 apply here.
Group DA, DC, DH, DJ: Test that lag-4 is jointly zero: CHISQ(4)= 17.0, p=0.0. Test that ERPT and EFP Lag-3 are jointly zero: CHISQ(8)=36.1, p=0.0.
Group DB, DG, DI, DM: Test that lag-4 is jointly zero: CHISQ(4)= 54.8, p=0.0. Test that ERPT and EFP Lag-3 are jointly zero: CHISQ(8)= 33.7, p=0.0.
Group DD, DK, DN: Test that lag-4 is jointly zero: CHISQ(3)= 20.2, p=0.0. Test that ERPT and EFP Lag-3 are jointly zero: CHISQ(6)= 9.78, p= 0.13.
Group DE, DL, DF, CA: A-4: Test that lag-4 is jointly zero: CHISQ(4)= 4.13, p= 0.39. Test that ERPT and EFP Lag-3 are jointly zero: CHISQ(6)= 54.1, p= 0.0.
Entries in bold denote categories of goods that feature significant exchange rate pass-through. These categories are selected for Table A.3.

Table B.3.4. Import unit values, SUR estimates (continued)

	A	B	CA	CB
Const		.039** .016	.055*** .010	.073** .032
dP(-1)	-.540*** .179	-.920*** .152	-.915*** .167	-.072 .171
dP(-2)	-.169 .173	-.080 .182	-.525*** .170	-.169 .137
dP(-3)	-.361* .210	-.200 .207	-.096 .158	-.140 .167
dP(-4)	-.568*** .177	-.326** .158	-.219 .163	-.213** .097
DER	-.246 .231	**.390*** .098**	**.222*** .045**	**.948** .378**
DER(-1)	.151 .255	.132 .153	.195*** .044	-1.24*** .459
DER(-2)	-.089 .290	-.036 .123	.1363** .055	1.41*** .426
DER(-3)	.414* .225	.223** .100	.147*** .056	-.828** .358
dP*	-.788 .802	-.227 .528	.029 .072	-1.20 1.56
dP*(-1)	.436 .908	.507 .495	.100 .068	3.86*** 1.32
dP*(-2)	1.00 .753	-2.52*** .536	-.047 .066	-3.78*** 1.30
dP*(-3)	.757 .618	1.34** .632	-.147*** .057	.466 1.16
NOBS	21	21	23	21
ERPT Jointly zero Chi(4)	5.3 p=0.25	**21.0 p=0.0**	**56.0 p=0.0**	**16.2 p=0.0**
SHORT RUN=1	-1.25*** .23	**-.61*** .10**	**-.78*** .045**	**-.05 .38**
LONG RUN	.09 .16	**.28 .12**	**.254 .032**	**.18 .46**
LONG RUN=0 Chi(1)	0.28 p=0.60	**5.4 p=0.02**	**62.4 p=0.0**	**0.15 p=0.70**
LONG RUN=1	-.91*** .16	**-.71*** .12**	**-.75*** .03**	**-.82* .46**
Rsq	.56	.87	.73	.78

Notes: Group A, B, CB: Test that lag-4 is jointly zero: CHISQ(3)= 18.0, p=0.0;
Test that ERPT and EFP Lag-3 are jointly zero: CHISQ(6)=19.7, p=0.003.

Table B.4.1. Pass-through to Estonian PPI and its components, single equation estimation

	dPPI_DA Food	dPPI_DB Textiles	dPPI_DC Leather	dPPI_DD Wood pr.	dPPI_DG Chem. p.	dPPI_DI Non-metal prod.	dPPI_DK Machinery & equip.	dPPI_DN Furniture & other	dPPI Total industry	dPPI_D Manufact.
Const			.012* .006	.005 .003				.011* .006		
DP(-1)	.739*** .162	.405** .149	.513 .299	.858*** .213	-.020 .175	.412* .208	.100 .201	.105 .214	.158 .154	.189 .166
DP(-2)	-.189 .162		.032 .226	-.219 .228	.030 .163	-.051 .200	.199 .215	-.192 .166	-.072 .150	-.151 .165
DP(-3)			.020 .250	-.041 .207			.423* .205	.078 .147	.2164* .116	.155 .123
DP(-4)			-.010 .292	-.409* .208				-.355** .151		
DP(-5)				.204 .186				.524*** .158		
DER	**-.166 .358**	**.084 .147**	-.343 .501	-.057 .043	**.403 .331**	-.306 .209	1.40** .553	**.472 .278**	.076 .079	.138* .073
dER(-1)	.939** .372694	.394** .143	1.24* .575	.059 .042	.835** .357	-.042 .208	-.414 .632	.037 .319	.183** .079	.189** .074
dER(-2)	-.764** .358		.800* .442	-.114** .045	.477 .339	.059 .193	-.346 .587	.811** .320	.074 .086	.064 .080
dER(-3)			-.432 .630	.075 .044			-.534 .591	-.289 .312	.021 .084	.020 .079
dER(-4)			-1.24** .555	-.076* .037				-.259 .324		
dER(-5)				-.003 .030				-.170 .306		
dP*	.742 .503	.808*** .286	-1.36 1.41	-.475* .231	1.09 .905	-.094 .346	-.203 .990	-2.07** .732	.474* .259	.478* .238
DP*(-1)	-1.61** .656	-.080 .291	-2.21* 1.08	.089 .265	2.07* 1.09	-.031 .418	.683 1.23	-.077 .664	-.326 .295	-.270 .285
DP*(-2)	1.66*** .533		1.46 1.56	.081 .246	-1.66** .702	.564* .307	.287 1.21	-.011 .569	-.077 .297	-.003 .279
DP*(-3)			3.83*** 1.17	.536** .235			-.429 .889	1.85** .638	.433** .203	.441** .197
DP*(-4)			-3.30* 1.57	-.810*** .212				-.557 .536		
DP*(-5)				.350*** .097				-1.15* .569		
NOBS	33	32	27	30	33	33	33	30		
F-test (reduct.)	1.22 p=.36	1.31 p=.32	4.77 p=.03	- -	0.52 p=.84	0.39 p=.93	1.21 p=.36	- -	1.38 p=.29	1.46 p=.26
ERPT jointly zero, ChiSq	**16.8 p=0.001**	**9.8 p=0.007**	9.7 p=0.09	11.2 p=0.08	**12.7 p=0.005**	2.3 p=0.52	7.4 p=0.12	**12.5 p=0.05**	10.8 p=0.03	16.7 p=0.002
SHORT RUN=1	**-1.17*** .36**	**-.92*** .15**	-1.34*** .50	-1.06*** .04	**-.60** .33**	-1.31*** .21	.40 .55	**-.53* .28**		
LONG RUN	**.019 1.55**	**.803 .346**	.073 2.38	-.191 .194	**1.73 .503**	-.45 .48	.38 3.7	**.72 .76**	.51	.51
LONG RUN=0 Chi-sq(1)	**0.0001 p=0.99**	**5.40 p=0.02**	0.001 p=0.98	0.97 p=0.32	**11.9 p=0.001**	0.88 p=0.35	0.01 p=0.92	**0.90 p=0.34**	5.63 p=0.017	10.25 p=0.001
LONG RUN=1	**-.98 1.55**	**-.20 .35**	-.93 2.4	-1.19*** .19	**.73 .50**	-1.45*** .48	-.62 3.67	**-.28 .76**		
LM-auto	ok	ok	ok	ok	ok	ok	ok	no	ok	ok
Rsq-adj	.55	.63	.17	.62	.32	.28	.21	.51	.69	.76

Notes: Notes for Table A.4 apply here.

1 – LM test: residual autocorrelation at 1% (5^{th} order); 2 – LM test: residual autocorrelation at 10% (5^{th} order).

The most general model here is ARDL(5,5) with constant. F-test (reduction) reports the test of restrictions imposed to obtain the final specification. DC: reduction from ARDL(5) model is not supported by the F-test at 5% significance but ARDL(5,5) featured autocorrelation in residuals.

Entries in bold denote categories of goods that feature significant exchange rate pass-through. These categories are selected for Table A.4.

Table B.4.2. Pass-through to PPI components, SUR estimates

	DA Food	DB Textiles	DC Leather	DD Wood pr.	DG Chemical pr.	DI Non-metal mineral pr.	DK Machinery & equip.	DN Furniture & other
Const	.0005 .0021	.008** .003	.013*** .004	.0058** .0027	.015* .009	.004 .005	.011 .007	.008** .003
dP(-1)	.425*** .135	.293 .190	.523*** .198	.504*** .181	.127 .157	.380** .178	-.220 .168	.095 .126
dP(-2)	-.349** .152	-.113 .194	.010 .149	.070 .197	.082 .157	-.229 .177	.065 .151	.055 .117
dP(-3)	.242* .144	-.222 .171	.010 .165	-.131 .193	.068 .124	.343* .184	.362** .153	.218* .117
dP(-4)	-.184* .100	.301* .156	-.017 .193	-.051 .164	-.406*** .138	-.204 .174	.227 .167	-.247** .122
dER	**.069** **.241**	**.549*** **.127**	**-.336** **.333**	-.018 .038	**.371** **.260**	-.312 .285	**2.59***** **.569**	**.571**** **.232**
dER(-1)	.827 .270	.495*** .160	1.22*** .382	.063 .038	.844*** .285	.069** .282	-.128 .514	-.127 .206
dER(-2)	.057*** .270	.283 .209	.795*** .294	-.047 .041	-.086 .317	-.506** .257	.717 .518	.847*** .202
dER(-3)	.277 .282	.117 .253	-.434 .417	.011 .033	.297 .311	.606 .290	-.832* .438	-.368 .230
dER(-4)	-.043 .230	.410** .183	-1.22*** .368	.014 .030	-.296 .278	.192 .254	-.477 .468	-.002 .221
dP*	.344 .398	.107 .462	-1.31 .931	-.217 .205	-.869 1.37	.143 .468	-2.54** 1.10	-1.45*** .513
dP*(-1)	-.820** .346	.874** .402	-2.22*** .722	.088 .235	3.30*** 1.00	.228 .388	1.74* .989	.736 .460
dP*(-2)	.838** .401	-.176 .410	1.44 1.03	.131 .224	-2.73*** .918	.430 .387	-.344 .951	-.606 .450
dP*(-3)	-.254 .436	-1.07** .450	3.83*** .776	.095 .199	1.32 .937	-.412 .419	.634 .916	1.35*** .389
dP*(-4)	.159 .379	.176 .247	-3.21*** 1.04	-.174** .086	-.370 .597	-.034 .321	-1.17 .849	-1.08*** .402
NOBS	27	27	27	31	31	27	27	31
ERPT jointly zero, ChiSq	**11.4** **p=0.04**	**54.3** **p=0.0**	**21.3** **p=0.0**	4.1 p=0.53	**17.7** **p=0.003**	9.9 p=0.077	**26.4** **p=0.0**	**28.0** **p=0.0**
SHORT RUN=1	**-.93***** **.24**	**-.45***** **.13**	**-1.34***** **.33**	- 1.02*** .04	**-.63**** **.26**	-1.31*** .28	**1.59***** **.57**	**-.43** **.23**
LONG RUN	**1.37** **.840**	**2.50** **.597**	**.066** **1.48**	.036 .140	**1.00** **.519**	.067 .906	**3.30** **1.58**	**1.05** **.54**
LONG RUN=0 Chi-sq(1)	**2.66** **p=0.10**	**17.5** **p=0.0**	**0.002** **p=0.96**	0.07 p=0.80	**3.7** **p=0.053**	0.006 p=0.94	**4.3** **p=0.04**	**3.8** **p=0.05**
LONG RUN=1	**.37** **.84**	**1.50**** **.60**	**-.93** **1.48**	-.96*** .14	**0.001** **.52**	-.93 .91	**2.30** **1.58**	**.05** **.54**
Weight	28.5	9.4	1.2	6.6	8.0	3.8	2.0	5.3
Rsq	.69	.81	.61	.58	.61	.45	.53	.62

Notes: Notes for Table A.4 apply here.

SUR estimation has been carried out in the following groups: DA, DB, DC, DI and DD, DG, DK, DN. The choice was based on the degree of simple correlation between the left hand side variables – cross-group inflation rates.

Entries in bold denote categories of goods that feature significant exchange rate pass-through. These categories are selected for Table A.4.