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Exchange Rate Pass-Through into Import Prices of Croatia

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Abstract

The main goal of this paper is to examine the influence of macro factors and the degree of the exchange rate pass-through (ERPT) on aggregate and disaggregate import prices of the industrial sectors in the short- and long-run. The study is based on a model used by Campa and Goldberg (2002) and Campa *et al.* (2005). The ERPT is determined by applying the single equation and the cointegration approach (autoregressive distributed lag model [ARDL]), vector decomposition, and data over the period from 2002Q1 to 2016Q4. In the long-run, the ERPT is complete for the aggregate import and for the industrial sector beverages and tobacco. In the short-run, the ERPT is incomplete for the aggregate import and for majority of industrial sectors. Further, we have discovered that the degree of the ERPT is higher with heterogeneous products than with homogeneous products. Due to the inaccessibility of data for micro factors, we were not able to determine their effect on import prices. The results of our research can help economic policymakers to create adequate measures in the field of economic policies that will improve the competitiveness of the economy. Finally, this paper identified the effect of the volatility degree of the ERPT on the disaggregate import prices of industrial sectors that has not been sufficiently explored so far.

Keywords: exchange rate, industrial sectors, import prices, ARDL approach

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Introduction

In the last few decades, in the international economy and macroeconomics, the correlation between fluctuations in exchange rates and import prices remains critical (Lopez-Villavicencio & Mignon, 2017). Pass-through is defined as the percentage change in the import prices caused by a change of import prices resulting from a 1% change in the exchange rate, which is better known as the first-stage pass-through (Barhoumi, 2006; Aron *et al.*, 2014).

Earlier studies focused on the microeconomic approach, while the latter research focused on the macroeconomic approach. In microeconomic factors, we included industrial organizational models, substitution between import and domestic products, the determination of the pricing strategy of monopolistic companies at the industrial and product degree (Dornbusch, 1987; Goldberg & Knetter, 1997; Kurtović *et al.*, 2018), while macroeconomic factors included exchange rate variability, inflation, market openness, monopolistic competition, etc. (Menon, 1995; Taylor, 2000; Devereux *et al.*, 2004; María-Dolores, 2010). The degree of exchange rate pass-through (ERPT) depends on economic shocks, nominal exchange rate volatility, the importing country's shifts in demand, market structure, economic openness, market segmentation, and aggregate imports (Kurtović *et al.*, 2018). The import price ERPT elasticity ranges from 0% to 100%, depending on the exporter's pricing strategy (Brun-Aguerre *et al.*, 2012). The ERPT degree depends on the price strategy of the exporter. The ERPT will be incomplete and low, and changes in currency exchange rate will not have an impact on international prices when the prices are expressed in the local currency (LCP). On the other hand, the ERPT will be complete, and the floating currency exchange rate will have a powerful effect on macroeconomic adjustment when prices are expressed in the currency of the exporter (producer currency pricing [PCP]) (Dabusinskas, 2003).

The problem of pass-through is especially important for small open economies that are import-dependent in international exchange. In that sense, Croatia is ranked among the transition countries that have traditionally had a negative trade balance and are import-dependent. Being faced with a trade imbalance, the Croatian economy lacks competitiveness. Therefore, it is exceptionally important to measure the effect of ERPT into import prices. A low ERPT leads to low inflation. On the other hand, a low ERPT could also cause a trade imbalance when there is a requirement to change the import or export composition and impair competitiveness in the international trade exchange. A high ERPT works in the opposite direction. Finally, the evaluation of ERPT is important for restraining inflation pressures and trade imbalance caused by currency fluctuations.

The main objectives of our research are the assessment of the influence of macro factors and the degree of the ERPT on aggregate and disaggregated import prices of industrial sectors in the short- and long-run, i.e., to examine how the degree of the ERPT affects the import prices and the composition of imports by industry and whether the degree of the ERPT is higher with homogeneous products or heterogeneous products. Nevertheless, our research differs, compared with previous empirical research related to Croatia, because they mainly focus on the estimation of the exchange rate regime to degree of ERPT (Darvas, 2001; Billmeier & Bonato, 2002; Tica & Posedel, 2014).

The research is based on a model used by Campa and Coldberg (2002) and Campa *et al.* (2005), i.e., the autoregressive distributed lag model (ARDL), and variance decomposition and quarterly data over the period from 2002 to 2016. The econometric techniques we used have enabled us to measure the effects of ERPT on aggregate import prices in the short- and long-run. The majority of existing research has used Johansen's cointegration techniques and the vector autoregressive model (VAR) (Kurtović *et al.*, 2018). However, the disadvantages of these econometric techniques are explained in Methodology and Data.

In our research, due to the unavailability of data, we were not able to examine the effect of micro factors on the disaggregate import prices of the industrial sectors.

The structure of the paper is organized as follows: the next section provides an overview of the literature; then the model, econometric techniques, and used databases are presented; the last but one section presents the results of our findings; the last section provides the conclusions of this research.

Literature Review

Investigating the currency depreciation effect on US trade balance, Magee (1973) first introduced the concept of exchange-rate pass-through (ERPT). This term was originally used to estimate the effect of devaluation of domestic currency on the trade balance and the price of trade products. Later it was used to assess the relevance of the law of one price, e.g., to explain certain deviations from the law of one price and to confirm the presence of incomplete pass-through. In addition, it was used to estimate theory of purchasing-power parity and the effect of appreciation and depreciation on the (Goldberg & Knetter, 1997; Feenstra & Kendall, 1997).

Below, we further discuss the research that influenced our work. Taylor (2000), Gagnon and Ihrig (2004), and Bailli and Fuji (2004) estimated the effects of inflation and exchange rate volatility on the pass-through rate. They used yearly and quarterly data and auto-regression, panel cointegration, and dynamic panel-data models. They showed that low inflation rates and low exchange-rate volatility lead to a pass-through decline. Campa and Goldberg (2002) and Campa *et al.* (2005) estimated the transmission rate of the ERPT to the import prices of euro-zone countries. The author's used annual data and panel cointegration and VECM. In the short-run, the ERPT is higher and incomplete and differs from country to country and from industry to industry. The ERPT is higher in homogeneous than in heterogeneous industries. Marazzi *et al.* (2007) estimated the rate of the ERPT on aggregate import prices and prices of industrial products in the United States. They used data from 1970 to 1980 and panel cointegration. The degree of the ERPT has declined with aggregate import prices but has, on the other hand, increased with certain industrial products imported from Asian countries. Mumtaz *et al.* (2006) estimated the degree of the ERPT on the import prices of industrial sectors in the United Kingdom. The authors used quarterly data over the period from 1984 to 2004 and panel cointegration. They revealed a high degree of the ERPT for the food industry and the manufacturing sector, but, in spite of this, the ERPT's degree has declined over the last few years. De Bandt *et al.* (2008) and Ben Cheikh and Rault (2016, 2017) have estimated a degree of the ERPT on import prices in the euro zone. They used quarterly data and panel cointegration, GMM and GLS. The degree of the ERPT has been declined more for homogeneous products than for heterogeneous products.

Barhoumi (2006), Byrne *et al.* (2010), and Brun-Aguerre *et al.* (2012) estimated the degree of the ERPT rate at the import prices of emerging economies and developing countries. The authors used quarterly data and a nonstationary panel, a pooled mean group estimation, and error-correction models. Emerging economies and developing countries have a higher pass-through compared with that of developed countries. María-Dolores (2010) and Velickovski and Pugh (2011) estimated the ERPT's degree of import and consumer prices for new EU members, developed countries, and transition economies. The authors used cointegration analysis and error-correction terms. In most countries, a complete pass-through has not been recorded, and the pass-through degree is higher for consumer prices than import prices. Beckmann *et al.* (2014) estimated the degree of the ERPT to import prices in Germany. They found that macroeconomic factors, such as inflation and exchange rate variability, had an impact on the degree of pass-through. The short- and long-run pass-through was incomplete because of the product heterogeneousness.

Methodology and Data

Theoretical framework

Over the last three decades, a significant increase in the openness of a global economy has been recorded as well as a growing fluctuation in nominal exchange rates, which demands a better understanding of transmission of exchange rates into import prices. The effect of exchange rate variations on import prices depends on the following circumstances: a) basic economic shocks cause exchange rate variations; b) the mechanism of the model establishes a correlation among basic shocks, exchange rates and import prices; and c) time frame is important for understanding the relationship between the variables (Campa & Goldberg, 2005; Campa *et al.*, 2005).

Pioneer research was based on the partial equilibrium model. Researchers were primarily focused on the exporters/importers issue and the organisation of a single industry (Dombush, 1987; Campa *et al.*, 2005). This approach was rejected, as it failed to take into account the fact that exchange rates are affected by endogenous and exogenous variables influencing the equilibrium prices in a given industry. Accordingly, the nominal exchange rate alters the price of imported goods interacting with industrial subjects on an oligopolistic market. In our model, we use the micro assessment of exporters' behaviour as a starting point in the analysis of the effects of exchange rate variations on import prices (Campa & Goldberg, 2005; Campa *et al.*, 2005).

For the assessment of the degree of ERPT into import prices, we used the standard model initially used by Goldberg and Kantter (1997), Campa and Goldberg (2002), and Bailliu and Fujii (2004). This model enables the assessment of ERPT into import prices on the grounds of nominal effective exchange rate variation. In that sense, it is important that the model provides the necessary isolation of the effect of the nominal effective exchange rate from the effects of other variables such as changes of costs incurred by the exporter and domestic demand. Additionally, our starting point is the imperfect market, whereby the exporter is faced with the competition on the domestic market. Finally, our model enables us to assess the exporter's behaviour on the grounds of the first-stage pass-through effect. The ERPT is the linear equation

$$p_{it}^{m} = \alpha_0 + \alpha_1 mc_{it}^{x} + \alpha_2 e_{it} + \alpha_3 y_{it}^{m} + \varepsilon_t, \quad (1)$$

where p_{it}^{m} is import prices in the local currency and is a function of $\alpha_2 e_{it}$, which is the nominal effective exchange rate, mc_{it}^{x} is marginal foreign costs, y_{it}^{m} is the domestic demand, ε_t is the error disturbance term, and β_0 is a constant.

In the estimation of the ERPT on import prices, macroeconomic factors have a special impact. Therefore, in our research, we will try to assess the impact of macroeconomic factors, such as rate of inflation, trade openness, at import prices. The empirical assessment of the ERPT is based on the linear equation

$$p_{it}^{m} = \alpha_0 + \alpha_1 mc_{it}^{x} + \alpha_2 e_{it} + \alpha_3 y_{it}^{m} + \\ + \alpha_4 inf_{it}^{x} + \alpha_5 open_{it}^{x} + \varepsilon_t \quad , \tag{2}$$

where inf_{it}^{x} is the rate of inflation, $open_{it}^{x}$ is market openness.

The next step in our analysis is related to the assessment of macroeconomic factors on the import prices of sectoral industries. In that sense, we will use Eq. (2):

$$lnp_t^m;\ lnp_{jt}^m = \alpha_j + \alpha_{1,j} lnmc_{it}^x + \alpha_{2,j} lne_{it} + \alpha_{3,j} lny_{it}^m + \\ + \alpha_{4,j} lninf_{it}^x + \alpha_{5,j} open_{it}^x + \varepsilon_t x \quad , \tag{3}$$

where lnp_t^m is aggregate import price, and lnp_{jt}^m is disaggregate import price of industrial sectors in the local currency.

We shall now reflect on some of the econometric techniques we will be using in our research model. First, we will use the ADF, PP, and the KPSS tests to examine whether the variables are stationary or nonstationary. Consequently, we shall apply the cointegration approach (the ARDL model) and the EC(-1).

The ARDL model or bounds testing is used to examine whether there is a long-term relationship between the variables. Additionally, the ARDL model enables us to avoid potential endogenous problems and the inability to test our hypothesis on the grounds of assessment of variables in the long-run, characteristic of the Engle–Granger (1987) method. Moreover, the ARDL model ensures the assessment of variables in the long- and short-run (Kurtović *et al.*, 2017). It has an essential advantage over Johansen's cointegration technique, which does not assess the long-run relationship between the variables within the vector autoregressive model (VAR). As opposed to the ARDL model, the Johansen test requires that all variables are integrated of the same order and the need to define lag numbers, choose various models, and endogenous/exogenous variables and then obtain different test results from various choices (Hong & Zhang, 2016).

The ARDL model requires the following two steps (Pesaran *et al.*, 1999; Pesaran *et al.*, 2001): the first step relates to the process of determining any significant long-run relationship between the variables using the Fisher statistics; the second step relates to the long-run relationship variables and determining their value and assessment of the short-run elasticity of variables showing the error correction representation of the ARDL model. Based on Eq. (3), we will use multiple regressions and disaggregated import prices for different industrial sectors:

$$\Delta mp_t^m;\ \Delta mp_{jt}^m = \alpha_0 + \sum_{i=1}^{l} \alpha_{1,i}\, \Delta mp_{jt-1}^m + \sum_{i=0}^{l} \alpha_{2,i}\, \Delta e_{t,i} + \\ + \sum_{i=0}^{l} \alpha_{3,i}\, \Delta mc_{it}^x + \sum_{i=0}^{l} \alpha_{4,i}\, \Delta y_{it}^m + \sum_{i=0}^{l} \alpha_{5,i}\, \Delta inf_{it}^x + \\ + \sum_{i=0}^{l} \alpha_{6,i}\, \Delta open_{it}^x + \beta_{1,i} mp_{jt,i}^m + \beta_{2,i} e_{it,i} + \beta_{3,1} mc_{t-1}^{x,j} + \\ + \beta_{4,1} y_{t,i}^{x,j} + \beta_{5,i} inf_{it}^x + \beta_{6,i} open_{it}^x + \varepsilon_t \quad . \tag{4}$$

For the industrial sectors, we used quarterly disaggregated import prices data at the degree of the one-digit number of standard trade classification (SITC Revision 3) for eight industrial sectors: 0) food and live animals, chiefly for food (Standard International Trade Classification, SITC 0); 1) beverages and tobacco (SITC 1); 2) crude materials, inedible, except fuels (SITC 2); 3) mineral fuels, lubricants, and related materials (SITC 3); 4) animal and vegetable oils, fats, and waxes (SITC 4); 5) chemicals and related products (SITC 5); 6) manufactured goods classified chiefly by material (SITC 6); 7) machines and transport equipment (SITC 7); 8) miscellaneous manufactured goods (SITC 8).

Testing of a long-term relationship between the variables is done by means of bounds testing. The steps in the bounds process are based on the *F* or Wald statistics and represent the first phase of the ARDL method. The second phase relates to the *F* test of the null hypothesis of long-term variables with a time lag whose aggregate value equals zero, while in the case of the alternative hypothesis, at least one long-term variable does not equal zero (Kurtović *et al.*, 2017). This relationship is represented by the following relation: Null hypothesis or $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = 0$ and $H_0^{'} : \beta_1 = \beta_2 = \beta_3 = 0,$ i.e., the long-term relationship does not exist. Alternative hypothesis or $H_0 : \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq 0$ and $H_0 : \beta_1 \neq \beta_2 \neq \beta_3$, i.e., the long-term relationship exists (Kurtović *et al.*, 2017).

Pesaran *et al.* (2001) calculated two levels of critical value, i.e., either all variables are I(0), or all the variables are I(1). Proof of a long-term relationship between the variables is obtained if the *F*-statistic exceeds the upper critical value. In the case of a value between the critical bounds, the test is inconclusive; if it falls below the lower critical value, there is no evidence of cointegration (Belke *et al.*, 2013). The length of lags is chosen based on the Akaike information criterion (AIC) (Kurtović *et al.*, 2017).

Data

For Croatia, we used quarterly data over the period from 2002 to 2016. Our dependent variable in the model is the import price or the import unit value index (2010 = 100) - expressed in the local currency and taken from the Eurostat database (https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=teiet310&plugin=1). Import unit value index measures average changes of the value of imported goods (homogeneous and heterogeneous products). Heterogeneous products refer to manufactured goods, machinery and transport equipment, food products, beverages, tobacco products, etc., while the homogeneous products are related to mineral fuels, lubricants, raw materials, etc. The marginal costs, mc_{it}, were obtained on the basis of the calculation model Campa *et al.* (2005). Marginal foreign costs of production are calculated by eliminating the nominal effective exchange rate and labour wages or the producer price index from the relative effective exchange rate: $MC_{it}{}^{*} = REER_{it}\ x\ W_{it}\ \ NEER_{it}$, where the $NEER_{it}$ is nominal effective exchange rate, $REER_{it}$ is real effective exchange rate, and W_{it} is the domestic unit labor cost (real labour productivity per person). The nominal effective exchange rate (2010 = 100) is the weighted average of the bilateral nominal exchange rate of the euro against the basket of 37 currencies of the main trading partners; the real effective exchange rate (REER) measures the value of a particular currency against the average basket of trading currency of the leading trading partners.

Data for $REER_{it}$, $NEER_{it}$, and W_{it} were taken from the Eurostat database (https://ec.europa.eu/eurostat/web/exchange-and-interest-rates/data/main-tables; https://ec.europa.eu/eurostat/web/labour-market/labour-costs/main-tables). For inflation, we used harmonized indices of consumer prices, which measure changes in consumer prices and services needed by the household. Data for HCPI or inflation were taken from the Eurostat database (https://ec.europa.eu/eurostat/web/hicp/data/database). Openness index or trade (percentage of GDP) represents the share of exports and imports in GDP and tells us how many countries are open in international trade. This index is obtained by dividing total exports and imports into GDP. Data on the openness index or trade (percentage of GDP) were taken from the World Bank Database (World Data Indicator). Import unit value index or import prices for the sectors correspond to the one-digit-level Standard International Trade Classification (SITC 3). Data on import prices of industrial sectors were taken from the Eurostat–Comext database (http://epp.eurostat.ec.europa.eu/newxtweb/setupdimselection.do). In the end, in the absence of data on output gap, we used real GDP (gross domestic product 2010 = 100) as a domestic demand that determines the margin; thus, we took data from the Eurostat database (https://ec.europa.eu/eurostat/web/national-accounts/data/database).

Results and Discussion

Table 1 shows the correlation between our key variables over the period from 2002Q1– 2016Q4. The correlation matrix provides information about the expected signs with estimated variables. In line with expectations, a positive correlation between all variables was estimated. Namely, the correlation between aggregate import prices (MP) and the nominal effective exchange rate (NEER) is particularly important for this study. The correlation between these two variables is quite strong at 0.44%. The correlation results do not allude to any correlation with the results of the degree of the ERPT. More about degree of the ERPT to import prices will be given below.

Table 1. Correlation

	MP	NEER	Inf	Y	MC	Open
MP	1.00	0.44	0.95	0.39	0.02	0.27
NEER	0.44	1.00	0.60	0.74	0.11	0.08
Inf	0.95	0.60	1.00	0.40	0.01	0.26
Y	0.39	0.74	0.40	1.00	0.28	0.03
MC	0.02	0.11	0.01	0.28	1.00	0.04
Open	0.27	0.08	0.26	0.03	0.04	1.00

Source: Authors' calculations

Table 2. Descriptive Summary Statistics

	MP	NEER	Inf	Y	MC	Open
Mean	100.01	98.05	89.26	111.08	116.66	84.96
Median	99.15	98.15	91.15	111.94	101.65	84.95
Maximum	117.90	103.50	101.00	124.47	1041.00	96.40
Minimum	75.40	89.80	73.50	93.82	90.30	71.50
Std. Dev.	12.20	3.00	9.31	67.52	12.47	6.02
Obs.	60	60	60	60	60	60

Source: Authors' calculations

Finally, Table 2 shows a summary of statistics indicating whether the variables are mutually comparable. The variation value is satisfactory; thus, we can expect significant correlation of variables.

Table 3 presents the results for ADF, PP, and KPSS unit root tests. Most variables have unit roots, but, after the first difference is introduced, all variables become stationary at 1% or 5% of statistical significance. Consequently, we emphasize that the data series integrated at level I (0) and I (1), meaning that we can continue to use the ARDL approach.

Table 4 shows the results of *F*-statistics. The optimum number of lags was received only on the basis of Akaike information criterion (AIC) values. The optimal length is between four to five lags. The optimal length for aggregate import prices (MP) and for most industrial sectors is above the upper bounds of statistics. The optimal lag length for aggregate import prices (MP): 4, for food and live animals, chiefly for food (SITC 0); 5, beverages and tobacco (SITC 1); 5, crude materials, inedible, except fuels (SITC 2); 4, mineral fuels, lubricants, and related materials (SITC 3); 5, animal and vegetable oils, fats, and waxes (SITC 4); 4, manufactured goods classified chiefly by material (SITC 6); 4, machines and transport equipment (SITC 7); 4, miscellaneous manufactured goods (SITC 8); 4, accordingly, we reject the null hypothesis that there is no cointegration (cointegration) between variables. However, only in the case of chemicals and related products (SITC 5)

Table 3. Unit Root Test

Variable		*lnMP*	*lnNEER*	*lnMC*	*lnInf*	*lnOpen*	*lnSITC0*	*lnSITC1*
ADF	c	-2.20(0.20)	-2.64 (0.09)	-7.34(0.00)*	-1.76(0.39)	-1.42 (0.56)	-0.82(0.80)	-0.69 (0.83)
	c, t	-1.85 (0.66)	-2.58(0.28)	-7.27(0.00)*	-0.58 (0.97)	-1.76 (0.70)	-2.98(0.14)	-2.39(0.37)
	First Diff.	-5.87(0.00)* -5.87(0.00)*	-7.31(0.00)* -7.27(0.00)*		-11.06(0.00)* -6.90(0.00)*	-3.87(0.00)* -3.92(0.01)**	-7.80(0.00)* -7.74(0.00)*	-3.12(0.03)** -3.05 (0.12)
PP	c	-2.20(0.20)	-2.64(0.09)	-7.34(0.00)*	-2.02(0.27)		-0.82 (0.80)	-0.58 (0.86)
	c, t	-5.87 0.00)*	-2.61(0.27)	-7.27(0.00)*	0.11(0.99)	-1.25 (0.89)	-1.75 (0.71)	-1.34 (0.40)
	First Diff.	-5.77(0.00)* -5.74(0.00)*	-7.31(0.00)* -7.27(0.00)*		-6.37(0.00)* -6.77(0.00)*	-3.97(0.00)* -3.94 (0.01)**	-7.80(0.00)* -7.74(0.00)*	-8.75 (0.00)* -8.70(0.00)*
KPSS	c	0.53(0.46)**	0.34 (0.34)	0.32(0.34)	0.59(0.46)*	0.22(0.34)	0.91(0.71)*	0.86(0.73)*
	c, t	0.15(0.14)**	010. (0.11)	0.15(0.14)*	0.15(0.14)**	0.13(011)	0.11(0.11)	0.12(0.11)
	First Diff.		0.20(0.34) 0.20 (0.14)**	0.50 (0.46)**		0.50 (0.46)** 0.46(0.21)*	0.14(0.14)**	0.36(0.21)*

Variable		*lnSITC2*	*ln SITC3*	*ln SITC4*	*ln SITC6*	*ln SITC7*	*ln SITC8*
ADF	c	-0.62 (0.85)	-2.97 (0.04)**	-2.37 (0.15)	-2.15 (0.22)	0.06 (0.96)	-0.53 (0.87)
	c, t	-2.01 (0.58)	-3.14 (0.10)	-3.64 (0.03)**	-2.57 (0. 29)	-3.37 (0.06)	-2.35 (0.39)
	First Diff.	-3.26(0.02)** -3.22(0.09)	-5.57(0.00) *	-4.05(0.00)*	-5.11(0.00)* -5.26(0.00)*	-3.61 (0.00)* -3.62 (0.03)**	-8.62 (0.00)* -8.73 (0.00)*
PP	c	-0.61 (0.85)	-3.40(0.01)**	-2.23 (0.19)	1.78 (0.38)	0.10 (0.96)	-0.04 (0.95)
	c, t	-3.16 (0.10)	-3.43(0.05)	-2.44(0.35)	-1.62 (0.77)	-6.40 (0.00)*	-2.17 (0.49)
	First Diff.	-8.94(0.00)* -8.84 (0.00)*	-6.83 (0.00)* -7.15 (0.00)*	-3.73 (0.00)* -3.60(0.03)**	-4.79(0.00)* -4.95(0.00)*	-22.19 (0.00)*	-9.29 (0.00)* -16.63 (0.00)*
KPSS	c	0.89(0.73)*	0.93(0.73)*	0.58(0.46)*	0.84(0.73)*	0.94(0.73)*	0.82(0.83)*
	c, t	0.11(0.11)	0.11(0.11)	0.14(0.14)**	0.20(0.14)**	0.13(0.11)	0.22(0.21)*
	First Diff.	0.19(0.14)**	0.50 (0.21)*			0.16(0.14)**	

*, **, and *** show significance degrees at 1%, 5%, and 10%, respectively.

Note: c-intercept includes constant and ct-constant with trend.

Source: Authors' calculations

F-statistics are below the bounds of statistics, which means we cannot reject the null hypothesis and exclude this variable from further analysis.

Table 4. F-Test or Bounds Statistics

Variable	Lag Length	AIC	F-Statistics
SITC 0	5	-33.81, -34.68*	3.94*
SITC 1	5	-32.27, -33.29*	5.90*
SITC 2	4	-31.79, -32.69*	5.29*
SITC 3	5	-32.35, -32.51*	10.64*
SITC 4	4	-31.72, -32.23*	7.17*
SITC 5	4	-32.21, -32.89*	2.52
SITC 6	4	-32.20, -32.82*	4.33*
SITC 7	4	-32.00, -32.88*	4.27*
SITC 8	4	-33.17, -33.39*	3.74*
Total MP	4	-34.34, -36.21*	6.89*

Source: Authors' compilation

Table 5 presents the results of the ERPT degree estimates on the import prices of the industrial sectors in the short-run, which are in line with the expected sign. Short-run represents the effect of an independent variable on the dependent variable, e.g., for each independent variable, the lag is introduced for at least one or two quarters. Evaluation results show that, in the short-run, the degree of ERPT is incomplete -0.95% and negatively significant for aggregate import prices. The ERPT is incomplete and negatively significant for food and live animals, chiefly for food (SITC 0) in the amount of -0.29%, in the fifth lag. For beverages and tobacco (SITC 1), the ERPT degree ranges from -0.48% to 0.86% in the first and third lags. Also, for raw materials, the inedible, except crude materials, and inedible, except fuels (SITC 2) ERPT degree is 0.62%, in the first lag, mineral fuels, lubricants, and related materials (SITC 3) is 0.69%, at first lag, manufactured (SITC 8) is 0.35%, in the first lag and in machines and transport equipment (SITC 7), the ERPT degree ranges from -0.95% to -0.76%, in the first and fourth lags (Appendix, Figure 3).

Considering the significant values for all of the above industrial sectors, we reject the null hypothesis and complete pass-through, while the hypothesis about LCP cannot be discarded. Based on the results of the assessment, we can conclude that the ERPT degree is the highest in the short-term for beverages and tobacco of 0.86% and machines and transport equipment, which is close to one or -0.95%. In addition, the ECM (-1) has a negative significant value in all industrial sectors and the aggregate import prices. Based on the different degrees of ECM(-1) per sector, we have different correction rates in establishing long-term equilibrium after the shocks of import prices.

Table 5 also presents the results of diagnostic tests that indicate the stability and justification of the applicability of our model. The result of the Wald test shows, on the basis of *F*-statistics, that the value of the upper bounds is to confirm that there is cointegration between the variables. All other tests show that there are no functional constraints and that there is complete stability of our model. Finally, we emphasize that we have researched the heterogeneity of the exchange-rate transmission, that is, that ERPT heterogeneity exists among the industrial sectors. In addition, we conclude that the ERPT degree in the long-run is higher than in the short-run and that, in most industrial sectors, there was incomplete ERPT registered. The ERPT is higher in the case of heterogeneous products than homogeneous products. In

Table 5. Short-Run Coefficient Estimates ERPT and ECM(-1)

Variable	SITC0	SITC1	SITC2	SITC3	SITC4	SITC6	SITC7	SITC8	Total MP
D(lnMC)	0.03(5.26) 0.00*	0.01(1.06) 0.29	0.02(4.21) 0.00*	0.02(4.41) 0.00*	0.02(1.58) 0.12	0.01(1.84) 0.07	0.01(1.56) 0.12	-0.01(-0.32) 0.74	-0.01(0.30) 0.76
D(lnMC(-1))	0.06(5.57) 0.00*			-0.02(-3.92) 0.00*	0.17(6.62) 0.00*	0.01(1.53) 0.13	0.10(6.36)0.00*	0.05(5.18) 0.00*	0.06(6.95) 0.00*
D(lnMC(-2))	0.06(5.89) 0.00*				0.15(6.47) 0.00*	0.03(3.25) 0.00*	0.09(6.25)0.00*	0.05(4.74) 0.00*	0.06(7.39) 0.00*
D(lnMC(-3))	0.05(5.17) 0.00*				0.09(4.47) 0.00*	0.02(2.47) 0.01**	0.06(5.08)0.00*	0.02(3.42) 0.00*	0.03(4.39) 0.00*
D(lnMC(-4))	0.03(4.12) 0.00*					0.01(1.92) 0.06	0.04(5.40)0.00*	0.02(3.22) 0.00*	
D(lnMC(-5))	0.02(3.84) 0.00*								
D(lnY)	-0.58(-2.93) 0.00*	0.61(2.04) 0.05**	-1.35(-5.15) 0.00*	-1.17(-5.18) 0.00*	-2.38(-5.03) 0.00*	0.24(1.28) 0.20	-0.65(-3.22) 0.00*	-0.52(-2.68) 0.01**	-0.47(-2.11) *0.04
D(lnY(-1))	0.06(0.34) 0.73	0.59(1.72) 0.09	0.63(2.36) 0.02**					-0.51(-2.60) 0.01**	-0.75(-3.57) 0.00*

Table 5. Short-Run Coefficient Estimates ERPT and ECM(-1) – continuation

Variable	SITC0	SITC1	SITC2	SITC3	SITC4	SITC6	SITC7	SITC8	Total MP
D(lnY(-2))	0.08(0.47) 0.63	1.69(4.88) 0.00*						-0.43(-2.23) 0.03**	-0.63(-2.96) 0.00*
D(lnY(-3))	0.34(2.01) 0.06	1.27(3.61) 0.00*							
D(lnY(-4))	-0.58(-2.86) 0.00*	1.84(5.65) 0.00*							
D(lnY (-5))	0.84(3.30) 0.00*								
D(lnInf)	0.56(2.47) 0.02**	-0.22(-0.82) 0.41	-0.40(-1.4) 0.15	-0.76(-2.49) 0.01**	0.90(1.95) 0.06	-0.29(-1.27) 0.21	-0.85(-3.49) 0.00*	0.46(-2.53) 0.01**	0.41(2.10) 0.04**
D(lnInf(-1))	-0.88(-3.92) 0.00*		-0.42(-1.49) 0.14	-0.94(-3.71) 0.00*		-0.60(-2.32) 0.02*	0.45(1.69) 0.10		0.51 (2.50) 0.01**
D(lnInf(-2))			-0.91(-3.13) 0.00*	-1.16(-3.89) 0.00*					0.33(1.48) 0.14
D(lnInf(-3))			0.68(2.47) 0.01**						
D(lnInf(-4))									
D(lnNEER)	-0.23(-1.77) 0.091	0.27(1.24) 0.22	-0.37(-1.80) 0.08	-0.61(-2.91) 0.00*	0.15(0.41) 0.68	0.64(-3.57) 0.00*	-0.60(-3.76) 0.00*	-0.48(-3.42) 0.00*	-0.95(-5.96) 0.00*
D(lnNEER(-1))	-0.17(-1.01) 0.32	-0.48(-2.08) 0.04**	-0.62(-2.95) 0.00*	-0.69(-3.36) 0.00*			-0.95(-5.08) 0.00*	-0.35(-2.34) 0.02**	
D(lnNEER(-2))	0.31(1.75) 0.09	0.44(2.03) 0.05**					-0.02(-0.14) 0.88		
D(lnNEER(-3))	0.17(1.01) 0.32	0.86(3.88) 0.00*					-0.28(-1.56) 0.12		
D(lnNEER(-4))	0.19(1.32) 0.19						-0.76(-5.22) 0.00*		
D(lnNEER(-5))	-0.29(-2.39) 0.02**								
D(lnOpen)	-0.42(-1.93) 0.06	-0.18(-0.75) 0.45	0.91(4.71) 0.00*	0.82(4.69) 0.00*	-0.54(-1.31) 0.19	-0.10(-0.71) 0.48	-0.18(-0.85) 0.40	0.17(1.03) 0.30	0.05(0.34) 0.72
D(lnOpen(-1))	0.51(2.13) 0.04**	0.08(0.37) 0.70	-0.30(-1.72) 0.09	0.19(1.09) 0.28	-0.13(-0.38) 0.70		-1.20(-5.12) 0.00*	-0.50(-2.48) 0.01**	0.32(2.09) 0.04*
D(lnOpen(-2))	-0.73(-3.78) 0.00*	-0.87(-4.68) 0.00*	0.21(1.41) 0.16	0.16(1.05) 0.30	0.80(2.89) 0.00*		0.26(2.04) 0.05**	0.30(2.76) 0.00*	0.45(3.56) 0.00*
D(lnOpen(-3))	0.27(2.17) 0.04**	0.11(0.55) 0.58	-0.31(-1.88) 0.06	-0.29(-1.85) 0.07			0.388(3.40) 0.00*		
D(lnOpen(-4))	0.16(1.15) 0.26	0.01(0.01) 0.98	0.69(3.91) 0.00*	0.50(2.95) 0.00*					
D(lnOpen(-5))	0.31(2.44) 0.02**	0.68(3.92) 0.00*		0.47(2.64) 0.01**					
C	1.25(5.48) 0.00*	3.51(6.50) 0.00*	0.83(6.09) 0.00*	0.74(8.73) 0.00	-1.48(-6.87) 0.00*	-0.49(-5.19) 0.00*	-1.27(-5.41) 0.00*	0.24(5.20) 0.00*	-1.30(-7.64) 0.00*
ECM(-1)	-0.71(-5.44) 0.00*	-0.38(-6.49) 0.00*	-0.45(-6.08) 0.00*	-0.57(-8.67) 0.00*	-0.19(-6.87) 0.00*	-0.57(-5.27) 0.00*	-0.48(-5.49) 0.00*	-0.40(-5.07) 0.00*	-0.40(-7.65) 0.00*
Wald test	4.05 0.00*	2.25 0.00*	2.44 0.00*	7.60 0.00*	2.85 0.00*	3.66 0.00*	2.83 0.00*	3.13 0.00*	230.81 0.00*
Norm.	0.18	0.55	0.38	0.35	0.46	0.23	0.80	0.88	0.56
CUSUM	Unstable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable
CUSUMSQ	Unstable	Stable	Stable	Stable	Stable	Unstable	Stable	Stable	Stable
Adjusted R.	0.91	0.92	0.88	0.82	0.83	0.91	0.78	0.95	0.87
DW	2.07	1.86	2.04	1.72	2.00	2.023	1.61	1.90	2.03

*, **, and *** show significance degrees at 1%, 5%, and 10%, respectively. *Note*: numbers outside brackets are the standard errors and numbers in brackets are the *p*-value. *Source*: Author’s compilation.

Source: Authors’ compilation.

addition, we have investigated that a higher share of imports leads to a lower degree of the ERPT; in our case, it is evident for manufactured goods classified chiefly by material and machines and transport equipment.

Table 6 presents the results of the degree of the ERPT estimates in the long-run on the import prices of the industrial sectors, which are in line with the expected remark. The long-term effect is the sum of the coefficients of several variables. The estimation results show that, in the long-run, there is a complete ERPT for aggregate import prices -1.02% and for beverages and tobacco (SITC 1) 1.58%. In this way, we reject the null hypothesis and incomplete pass-through, while the PCP hypothesis cannot be discarded. Complete pass-through is equal to or higher than 1 or H_0: $\alpha_1 \geq 1$, while incomplete pass-through is less than 1 or H_0: $\alpha_1 \leq 1$. NEER's depreciation has led to an increase in import prices (Appendix, Figure 1). Foreign exporters use a PCP strategy that leads to complete ERPT, i.e., the prices are expressed in the manufacturer's currency. The ERPT will be complete, and the floating currency exchange rate will have a powerful effect on macroeconomic adjustment when prices are expressed in the currency of the exporter (producer currency pricing [PCP]) (Dabusinskas, 2003).

In other industrial sectors, we have revealed that a significant and incomplete ERPT, i.e., minerals, lubricants, and related materials (SITC 3), is -0.70%, Manufactured goods are classified primarily by material (SITC 6) -0.64% and machines and transport equipment (SITC 7) 0.93% lags (Appendix, Figure 2). Thus, we reject the null hypothesis and complete pass-through, while the hypothesis about local currency pricing (LCP) cannot be discarded. The ERPT will be uncomplete and low, and changes in currency exchange rate will not have an impact on international prices when the prices are expressed in the local currency (LCP) (Dabusinskas, 2003). In these industries, the Croatian economy is not competitive and not elastic enough in terms of import. In addition, foreign exporters use the LCP price strategy that affects ERPT to be low, and currency changes have no strong impact on price changes. Finally, for food and live animals, primarily for food (SITC 0), crude materials, inedible, except fuels (SITC 2), animal and vegetable oils, fats and waxes (SITC 4), and miscellaneous manufactured goods, no significant ERPT was found; therefore, we reject the null hypothesis, incomplete and complete pass-through.

Table 7 presents the results of estimating variance decomposition of the aggregate import prices (MP) to shocks in the nominal effective exchange rate (NEER) after 6.12% and 24 months. The variation of the nominal effective currency

Table 6. Long-Run Coefficient Estimates ERPT of Industrial Sectors

Variable	*D (lnMC)*	*D (lnY)*	*D (lnNEER)*	*D (lnInf)*	*D (lnOpen)*
SITC0	-0.05 (-1.10) 0.28	-0.07(-0.45) 0.65	-0.39(-1.83) 0.08	1.33(9.65) 0.00*	-0.07(-0.48) 0.63
SITC1	0.06(1.73) 0.09	-1.56(-3.78) 0.00*	1.58(3.36) 0.00*	2.06(3.90) 0.00*	-1.55(-2.11) 0.04**
SITC2	0.09(2.17) 0.03**	-0.19(-0.79) 0.43	-0.27(-0.64) 0.52	1.07(7.11) 0.00*	0.13(0.67) 0.50
SITC3	0.13(3.07) 0.00*	0.10(0.49) 0.62	-0.70(-2.30) 0.02**	1.07(10.84) 0.00*	0.04(0.41) 0.68
SITC4	-0.78(-1.74) 0.08	1.21(1.22) 0.22	0.34(0.23) 0.81	0.67(0.23) 0.17	-0.02(-0.06) 0.95
SITC6	0.02(0.90) 0.36	0.47(3.78) 0.00*	-0.64(-2.75) 0.00*	0.93(21.09) 0.00*	-0.07(-1.30) 0.20
SITC7	-0.18(-2.94) 0.00*	-0.23(-1.67) 0.10	0.93(3.07) 0.00*	0.95(11.26) 0.00*	0.39(3.13) 0.00*
SITC8	-0.13(-2.19) 0.03**	0.08(0.47) 0.63	0.09(0.37) 0.71	0.15(1.33) 0.19	0.61(4.32) 0.00*
Total MP	-0.16(-2.32) 0.02**	0.80(4.13) 0.00*	-1.02(-3.21) 0.00**	0.85(5.80) 0.00*	0.30(2.16) 0.03*

*, **, and *** show significance levels at 1%, 5%, and 10%, respectively.

Note: Numbers inside brackets are the standard errors; numbers in outside brackets are the coefficients and the *p*-value.

Source: Authors' compilation

exchange rate variation is growing in the short-term from 8.15% to 9.19%, which means that NEER explains shocks in import prices at 9.19% in the short-term.

Table 7. Variance Decomposition of Import Prices

Period	lnMP	ln NEER	lnY	lnMC	lnInf	lnOpen
6	71.02	8.15	8.01	5.93	6.35	0.51
12	68.89	9.19	8.37	5.03	7.31	1.18
24	63.09	8.84	13.44	5.04	7.60	1.96

Source: Authors' compilation

In the long-run (24 months), the variation of the nominal effective exchange-rate decomposition varies to 8.84%. On the other hand, the variation of domestic demand decomposition grows in short- and long-run. In the long-run, the decomposition variant amounts to 13.44% and mostly explains shocks at import prices. Finally, the variation of inflation decomposition in the long run or in 24 months at 7.60% explains shocks at import prices (Appendix, Figure 4).

Conclusion

This paper examines the influence of macro factors and the degree of the exchange-rate pass-through (ERPT) on aggregate and disaggregated import prices of industrial sectors, in the short- and long-run, in Croatia over the period from 2002 to 2016.

We have estimated the degree of the ERPT to aggregate and disaggregated import prices of the industrial sectors. In a short-run, the degree of the ERPT is incomplete at -0.95% and negatively significant for aggregate import prices and for food and live animals, chiefly for food mineral fuels, lubricants, and related materials, manufactured goods classified chiefly by material, machines and transport equipment, and miscellaneous manufactured goods. On the other hand, in the long-run, degree of ERPT is a complete for aggregate import prices at -1.02% and beverages and tobacco at 1.58%, while mineral fuels, lubricantsm, and related materials, chemicals and related products, and machines and transport equipment have incomplete pass-through. Therefore, we have examined that, in the long-term, foreign exporters use the PCP price-setting strategy, while using an LPC short-run pricing strategy. The latter strategy has little impact on changing prices in the international market.

The estimation results show ERPT heterogeneity, which is the result of the heterogeneity transmission of the exchange rate. The ERPT degree is higher in the long- than in the short-run for the majority of the industrial sectors. The ERPT is higher in the case of heterogeneous products than homogeneous products. In addition, we have investigated that a higher share of imports leads to a lower degree of the ERPT; in our case, it is evident for manufactured goods classified chiefly by material and machines and transport equipment. On the other hand, we have succeeded in confirming the conventional statement that product imports composition will change, meaning that product imports from sectors with lower ERPT will increase, and that imports of products from the sectors with higher pass-through will decrease. In our case, imports of raw materials and chemical and related products were increased, while imports of machinery and transport equipment decreased.

Finally, the results of the research emphasize the importance of macroeconomic factors, such as currency exchange rate and inflation, and degree of the ERPT, i.e., to import prices. Also, the industrial compositions of trade influence the degree of the ERPT, i.e., at the import prices of the industrial sectors. In this respect, the results of our research can be helpful to economic policymakers.

In our research, due to unavailability of data, we were not able to examine the effect of micro factors on the disaggregated import prices of industrial sectors. In addition, due to the limited scope of work, we were not able to present results of the structural breakpoint and robustness checks.

Our future research will focus on comparison of a degree of the ERPT to the import, consumer, and producer prices in Croatia. Accordingly, we will include additional micro- and macroeconomic factors in our analysis.

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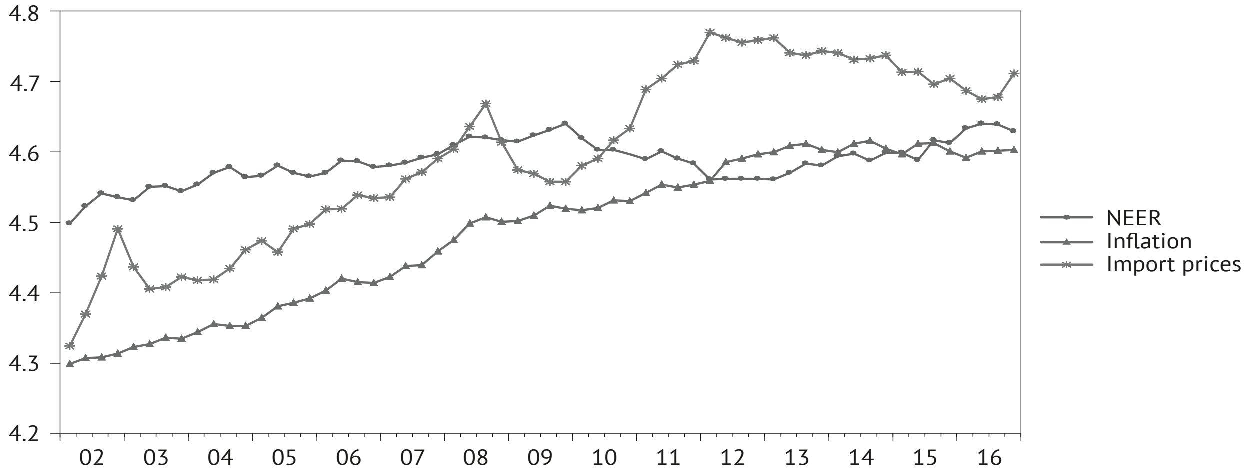
Appendix

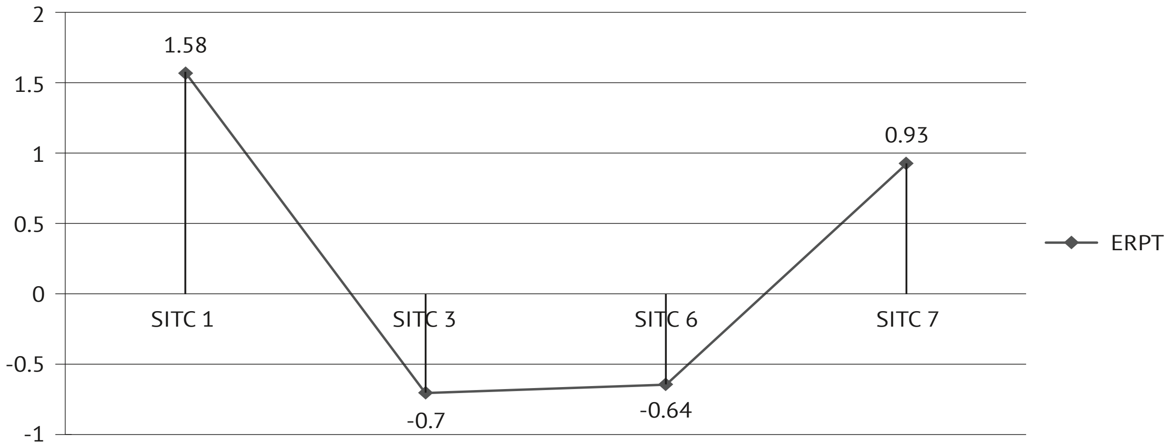
Figure 1. Movement of NEER, Inflation, and Import Prices for Croatia, from 2002 to 2016



Notes: Figure 1 is based on the Eurostat database

Source: Authors' compilation

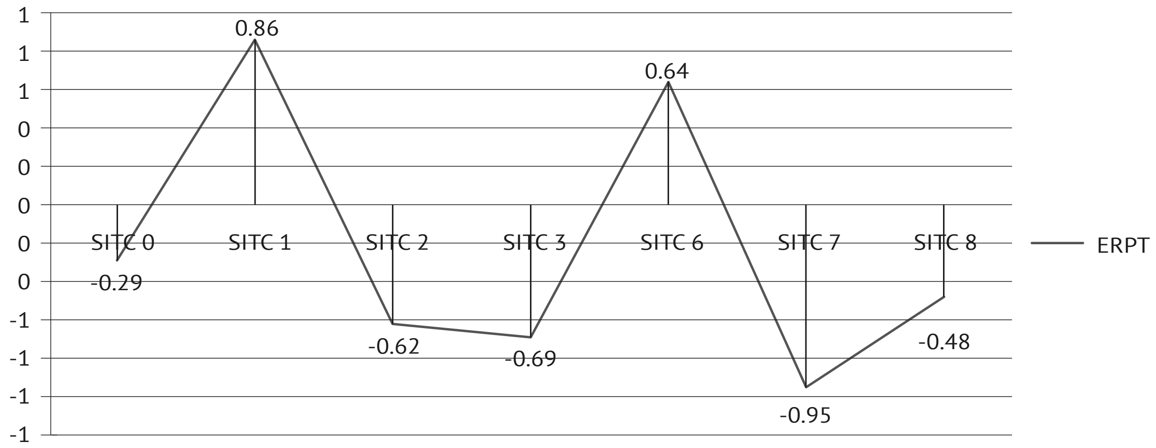
Figure 2. Complete and Partial ERTP in the Long-Term, Significant by Sectors



Notes: Figure 2 is based on results

Source: Authors' compilation

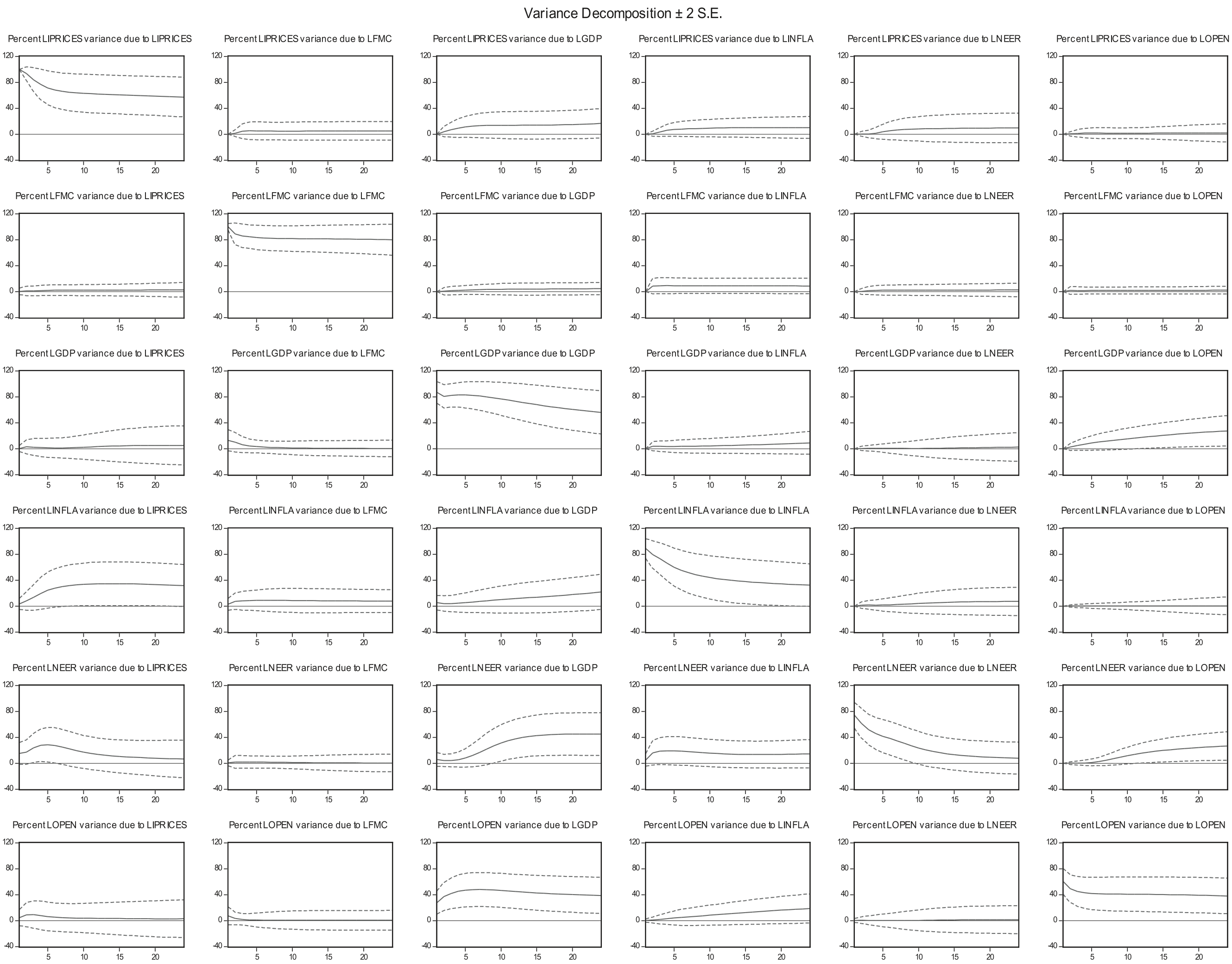
Figure 3. Complete and Partial ERTP in a Short-Term, Significant by Sectors



Notes: Figure 3 is based on results

Source: Authors' compilation

Figure 4. Variance Decomposition of Import Price for 24 months



Source: Author's compilation

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Učinek prehajanja deviznega tečaja v hrvaške uvozne cene

Izvleček

Ključni cilj tega članka je testirati kratkoročni in dolgoročni vpliv makro dejavnikov in stopnjo učinka prehajanja deviznega tečaja (ERPT) v agregatne in neagregatne uvozne cene industrijskih sektorjev. Študija temelji na modelu Campe in Goldberga (2002) ter Campe in drugih (2005). Učinek prehajanja deviznega tečaja smo določili z uporabo ene enačbe in kointegracijskega pristopa (ARDL), vektorske razčlenitve ter podatkov iz obdobja od 2002Q1 do 2016Q4. Dolgoročno je ERPT popoln za agregatni uvoz in industrijski sektor pijač in tobaka. Kratkoročno je ERPT nepopoln za agregatni uvoz in večino industrijskih sektorjev. Nadalje smo ugotovili, da je stopnja ERPT-ja višja pri heterogenih proizvodih kot pri homogenih proizvodih. Zaradi nedostopnosti podatkov za mikro dejavnike nismo mogli določiti njihovega učinka na uvozne cene. Rezultati naše raziskave lahko pripomorejo k oblikovanju primernih ukrepov ekonomskih politik, ki bodo izboljšali konkurenčnost gospodarstva. Nazadnje je članek identificiral vpliv stopnje volatilnosti ERPT-ja na neagregatne uvozne cene industrijskih sektorjev, ki do zdaj še ni bil zadosti raziskan.

Ključne besede: devizni tečaj, industrijski sektorji, uvozne cene, pristop ARDL