Time-Varying Elasticities of Import Demand: the Cases of Czech Republic and Hungary

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Abstract

This paper aims to examine price and income elasticity of import demand in Czech Republic and Hungary while allowing parameters of import demand to vary over time. Research sample consists of quarterly time series data the first quarter of 1996 to the third quarter of 2018. The results were obtained following state space model with time-varying parameters approach. The results revealed import demand elastic to changes in income in both countries while the elasticity was found to be higher in Hungary comparing to Czech Republic. Elasticity of import demand to changes relative prices were found in Hungary while in case of Czech Republic the price elasticity estimates indicated convergence of prices. Based on the empirical results from this research, the paper brings country-specific policy implications.

Keywords

Import demand, income, relative prices, Kalman filter

JEL code

C13, C51, F17, F2

INTRODUCTION

Understanding elasticity of substitution between domestic and foreign goods is one of the most important issues for any economy. Underlying literature assumes imperfect substitutes between domestic and foreign goods and empirical findings mostly imply higher income elasticity comparing to price elasticity of import demand. Following Crucini and Davis (2016) due to capital reallocation, the demand would be shifted towards lower prices only in a long run. Crucini and Davis (2016) pointed out that domestic and foreign goods are poor substitutes in a short run, while in the long run the substitutability increases. Hungary and Czech Republic are selected due to dynamic path from centrally planned economies to European Union (EU) member countries. Following Gagyi (2016), Hungary restructured its economy from import substitution to export-led specialization in Hungarian economy through reforms directed

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to attract foreign direct investment. Konopczak (2013) examined Balassa-Samuelson effect in the Czech Republic, Slovakia, Poland and Hungary and pointed out that the catching-up driven inflationary pressure is a non-negligible issue in the context of the CEE countries. Therefore, the goal of the paper is to estimate long-term import demand elasticity for these two countries. The aim of the paper is to illustrate role of prices in import demand and its potential variation over the last two decades while taking into account effect out of joining EU. Consequently, the research hypothesis of the paper assumes convergence of prices in Hungary and Czech Republic towards prices in members of European Monetary Union (EMU).

The rests of this paper is organized as follows: Section 1 briefly summarizes theoretical foundation and existing literature related to the topic under consideration. Section 2 presents the research data and methodology, while Section 3 provides research results and discussion and final section provides an overview of the main findings of the research.

1 THEORETICAL FOUNDATION AND BRIEF LITERATURE OVERVIEW

Following baseline theory of imperfect substitutes, function of a country's import demand is illustrated in Formula (1):

$$M = f(Y_d,\ P_d, P_M). \tag{1}$$

Import demand of country (M) is expected to be elastic domestic income (Y_d), domestic prices of imperfect substitutes at home market (P_d) and price of imported goods (P_M). The elasticity of import demand to increase in domestic income and domestic prices of imperfect substitutes are expected to be positive while the effect of increase in price of imported goods is expected to be negative. Grounded on theory of imperfect substitutes and a form of baseline model in Formula (1), on-going empirical literature brings various evidences from all over the globe. As introductory stated, the literature was directed towards long-term or towards short-term elasticity of substitution. This paper directs its attention towards long-term effects to capture long-run effects of prices and contributes with robust and accurate estimates regarding convergence of prices in two considered cases towards the prices in EMU countries.

Bayat et al. (2015) examined causality and dynamics between crude oil prices and exchange rates in Czech Republic, Poland and Hungary, the results indicated that oil price fluctuations affected real exchange rates in the long run in Poland and Czech Republic while oil price fluctuations did not affect exchange rate in any period in Hungary. Martinez-Zarzoso and Ramos (2008) pointed out that with the higher integration of economies, the volume of trade between them was increasing and role of exchange rates as one of the determinants was decreasing. Stanislava et al. (2017) used time series data from 1994 to 2014 and found the price of substitutes and past consumption as significant determinants of beer consumption while income elasticity was insignificant. Gürtler (2019) examined J-curve pattern in the Czech economy using quarterly data for the period 2000–2014. The results point out that the real effective exchange rate has a strongly negative effect on trade balance in the short run while in the long run the effects were positive and in line with the J-curve. Mirdala et al. (2018) followed panel data approach on a sample of 21 EU member countries and quarterly time series over the period 1999Q1–2016Q4 to examine determinants of imports and exports demand. The results pointed out a dominant role of domestic demand in determining import dynamics. Leško and Muchová (2019) followed convergence quadrants diagram and analysed different phases of non-price convergence within Central and Eastern Europe (CEE). The results indicated that most of the countries from CEE region grew at a higher rate than the one consistent with the BOP equilibrium. Furthermore, the research results pointed out that the convergence of the countries in CEE region was unsustainable considering the lower ratio of income elasticities and increasing external debt. Bilas et al. (2018) found similar development pattern in net exports of Czech Republic, Slovakia, Slovenia, Hungary. Halpern et al. (2015) pointed

out that importing all input varieties in Hungary would increase a firm's revenue productivity by 22% and main reason was imperfect substitution between foreign and domestic inputs. Imbs and Mejean (2017) followed multi-sector model developed from Arkolakis et al. (2012) and estimated aggregate elasticity of trade for 28 countries. The lowest values of trade elasticity were found for small open specialized economies and the difference in trade elasticity was explained with specialization of consumption, specialization of production or with international differences in sector-level trade elasticity. Erdey and Pöstényi (2017) between examined International trade of Hungary over the period 1993–2014 and found that International trade of Hungary was in line with Linder hypothesis. International trade of Hungary was more prominent with countries having similar factor endowments differentiated products are used as key drivers of international trade in Hungary. Recent paper from Leibovici et al. (2019) points out that trade is time-intensive and variation in the rate of import substitution across time affects how trade volumes respond to changes in output and prices. Hałka and Leszczyńska-Paczesna (2019) analysed price convergence in in European Union countries over the period 1999–2016 and reported lower dispersion of prices in 2016 comparing to 1999. Furthermore, the research revealed catching-up of countries with price level below the average that is more prominent up until 2008. As illustrated earlier within this section, contemporary literature struggle to explain convergence of prices within EU and recent paper from Çulha et al. (2019) and Leibovici et al. (2019) indicated time-varying nature of import demand substitution. Therefore, the baseline model in Formula (1) and state space model with time-varying parameters make an appropriate analytical framework to examine elasticity of import substitution and price convergence. Mirdala (2016) pointed out increased responsiveness of real exchange rates in EMU non-member states to demand and supply shocks due to the effects of the crisis period. Furthermore, real exchange rates in EMU member states from EU-11 group became more responsive to nominal shocks. This paper contributes to the debate while bringing time-varying estimates of import substitution for Hungary and Czech Republic.

2 RESEARCH DATA AND METHODOLOGY

The research data sample consists of quarterly time series data over the period 1996Q1–2018Q3. The data on imports and gross domestic product at constant prices were retrieved from National Bureaus of statistics of Hungary and Czech Republic, respectively. The data on real effective exchange rate against 19 European Monetary Union (EMU) countries were retrieved from Eurostat database – all of the variables under consideration were X-13 ARIMA seasonally adjusted and are transformed to (natural) logarithm so as to the estimated coefficients can be interpreted as elasticities. The observed series are illustrated in the Appendix in Figure A1 and Figure A2 while descriptive statistics of the series are provided in Table A1 and Table A2. As already stated, the methodological approach in this paper employs a state space model with time-varying parameters instead of the commonly used time series approaches. Modelling the import demand elasticity within TVP framework allows us the insights into evolution of the relationship with the time. Bošnjak (2019) used state space model with time-varying parameters to examine current account determinants in cases of Serbia and Romania. Recent paper from Çulha et al. (2019) employed state space model with time varying parameters to examine the case of import demand in Turkey. Following Harvey (1991), a general form of the state space model is presented in Formula (2) and transition Formula (3):

$$Y_t = X_t' \beta_t + \varepsilon t, \qquad \varepsilon_t \sim IIDN(0, \sigma^2), \tag{2}$$

$$\beta_t = \theta + \Gamma\beta_{t-1} + \nu_t, \qquad \nu_t \sim IIDN(0, Q), E(\varepsilon_t \nu_t) = 0, \tag{3}$$

where:

Y_t – 1×1 vector presenting observed dependent variable,

X_t – k × 1 vector presenting observed explanatory variables,
β_t – k × 1 vector presenting unobserved variables,
Γ – k × k matrix of constant parameters,
ε_t – error term in observation Formula (2),
ν_t – error term in transition Formula (2) and
Q – the diagonal variance-covariance matrix.

Kalman (1960) provided the algorithm to obtain filtered and smoothed estimates of unobserved time-varying coefficients (β_t) recursively. The prediction equation is given in the Formula (4) and the covariance matrix is given in Formula (5):

$$\hat{\beta}_{t|t-1} = \Gamma\, \hat{\beta}_{t-1}, \tag{4}$$

$$P_{t|t-1} = \Gamma\, P_{t-1}\, \Gamma' + Q_t\,. \tag{5}$$

Eventually, the estimates were updated recursively following Formulas (6) and (7):

$$\hat{\beta}_t = \beta_{t|t-1} + P_{t|t-1}\, X(Y_t - X'^{\hat{\beta}_{t|t-1}})(XP_{t|t-1}\, X + H_t), \tag{6}$$

$$P_t = P_{t|t-1} - P_{t|t-1}\, X' XP'_{t|t-1} / X'P_{t|t-1}\, X + H_t\,. \tag{7}$$

A time-varying parameters (TVP) model within state-space model consists of an observation or measurement equation and a transition or state equation. Thus, the import demand equation in cases of Hungary and of Czech Republic can be specified in logarithmic form given by Formulas (7) to (11):

$$\ln(M_t) = \alpha_t + \beta_{1,t} \ln(Y_t) + \beta_{2,t} \ln(\mathrm{REER}_t) + \beta_{3,t}\, \mathrm{EU} + \varepsilon_t, \quad \varepsilon_t \sim IIDN(0, \sigma^2), \tag{8}$$

$$\alpha_t = \alpha_{t-1} + \nu_{0,t}, \quad \nu_{0,t} \sim IIDN(0, \sigma_{v0}^2), \tag{9}$$

$$\beta_{1,t} = \beta_{1,t-1} + \nu_{1,t}, \quad \nu_{1,t} \sim IIDN(0,\sigma_{v1}^2), \tag{10}$$

$$\beta_{2,t} = \beta_{2,t-1} + \nu_{2,t}, \quad \nu_{2,t} \sim IIDN(0,\sigma_{v2}^2), \tag{11}$$

$$\beta_{3,t} = \beta_{3,t-1} + \nu_{3,t}, \quad \nu_{3,t} \sim IIDN(0,\sigma_{v3}^2), \tag{12}$$

where the observation equation is given by Formula (7) and state equations by Formulas (8), (9), (10) and (11). State equations illustrate that the new state value is modelled as a linear combination of the former state value and an error process. The observation equation presents the relationship between observed variables and unobserved transition or state variables. Dependent variable $\ln(M_t)$ is observed and presents imports (M_t) in (natural) logarithmic form, while explanatory variables are GDP (Y_t) in (natural) logarithmic form, real effective exchange rate (REER_t) in (natural) logarithmic form and dummy variable (EU) that indicate EU membership. The explanatory variables establish the relationship between the observable dependent variable and the unobservable time-varying coefficients. The terms α_t, $\beta_{1,t}$, $\beta_{2,t}$ and $\beta_{3,t}$ are unobserved time-varying coefficients to be estimated. ε_t and $\nu_{0,t}$ represent the error term in the measurement and state equations, respectively. The model in Formulas (7), (8), (9), (10) and (11) presents state space form with initial conditions. The estimates of the state-space were obtained using the Kalman filter while the estimates of the parameters in the equations were obtained by maximizing the Likelihood-function. Kalman filter is a recursive procedure that needs to set plausible initial values.

To do so, the parameters of the model was first estimated by means of OLS and these parameters and fitted values of the state variables obtained from the OLS estimation was specified as initial values. Eventually, the paper follows methodology presented in this section and brings the results for Hungary and Czech Republic. These two countries are EU member countries. TVP approach allows the insight into time variation. Therefore, it is expected to illustrate potential convergence of prices within EU and effects of EU membership.

3 RESEARCH RESULTS AND DISCUSSIONS

Following presented methodology and research data, the results for case of Hungary are summarized in Table 1.

Table 1 Time varying determinants of import demand: the case of Hungary

	Final state	Root MSE	z-statistic	p-value
α (Constant)	–6.902	1.522	–4.534	<0.010
ln(*Y*) (Income)	1.347	0.100	13.452	<0.010
ln(*REER*) (Real effective exchange rate)	0.240	0.101	2.369	<0.010
EU (EU membership – dummy variable)	0.063	0.028	2.213	0.013
Log likelihood: –224.793		AIC: –449.568		
Diagnostic tests:				
Ljung- Box Test statistic: 23.049		p-value: 0.027		
Jarque Bera Test statistic: 0.683		p-value: 0.710		
ARCH Test statistic: 21.285		p-value: 0.046		

Source: Own estimates

The results in Table 1 point significant and relatively income elasticity of import demand or marginal propensity to importing Hungary. Furthermore, income elasticity of demand in Hungary have not varied of time as illustrated in Figure A4 in the Appendix. Depreciation of real effective exchange rate were found to positively affect imports in Hungary. The reasonable explanation can be that real depreciation of real effective exchange rate in Hungary did not redirected demand in Hungary towards home products. Furthermore, an increase in prices of imported goods increase in volume of import demand while the quantities of imports holding constant. The time variation of the effects are illustrated in Figure A5. Eventually, the effects of joining European Union on imports in Hungary were positive. Therefore, after joining EU imports in Hungary has increased significantly and time variation of the effect is illustrated in Figure A6. The estimates for the case of Czech Republic is summarized in Table 2.

Following the estimates in Table 2, imports in Czech Republic has been elastic to changes in income and time invariant as illustrated in Figure 8. However, the import elasticity of demand is lower in Czech Republic comparing to Hungary. The effects of prices in Czech Republic was insignificant at the final state. Figure A9 illustrates that there was negative elasticity in the past that has approached to zero over time. Therefore, In case of Czech Republic, the depreciation in real exchange rate was negatively correlated with imports demand and by the time, the effect out of real exchange rate has vanished. Eventually,

Table 2 Time varying determinants of import demand: the case of Czech Republic

	Final state	Root MSE	z-statistic	p-value
α (Constant)	0.297	2.212	0.134	0.446
ln(*Y*) (Income)	0.963	0.172	5.597	<0.010
ln(*REER*) (Real effective exchange rate)	–0.066	0.142	–0.463	0.321
EU (EU membership – dummy variable)	0.210	0.030	6.940	<0.010
Log likelihood: –242.221		AIC: –466.443		
Diagnostic tests:				
Ljung- Box Test statistic: 23.265		p-value: 0.025		
Jarque Bera Test statistic: 0.000		p-value: 0.999		
ARCH Test statistic: 12.926		p-value: 0.374		

Source: Own estimates

due to price convergence the effect of exchange rate at the end of the observed period was not distinguishable from zero. With joining EU imports in Czech Republic has increased significantly and more than in case of Hungary. Time varying effects of joining EU is illustrated in Figure A10.

Conclusively, the obtained estimates illustrate long-run elasticity of import demand in two considered cases. There was higher income elasticity of import demand in case of Hungary comparing to Czech Republic. Following Kolozsi et al. (2018) there was highly expansionary fiscal policy in Hungary what might explain high import elasticity of demand at least partially. Furthermore, there was a higher long run increase of import in Czech Republic comparing to Hungary as a results of EU membership. However, the effects from real effective exchanger rate on imports were different in these two cases. Exchange rate of national currency against euro has been a nominal anchor of monetary policy in both of the considered countries. At the beginning of transition process, Hungary had adopted crawling peg regime and Czech Republic had adopted a pegged regime with horizontal bands. In case of Hungary, we found positive and significant long-term effects from real exchange rate depreciation to increase in imports. This finding is not in line with theoretical assumptions since the depreciation of real exchange rate should redirect import demand towards domestic substitutes. Therefore, the domestic goods in Hungary might not be substitutes for the imported goods. Furthermore, Hungarian industry is import dependent industry. In case of Czech Republic, the results indicate long-term convergence of prices. At the beginning of the observation period, there was a negative effect from real exchange rate depreciation to imports in Czech Republic. By the time, the long run effect has disappeared and eventually at final state, the effect from real effective exchange rate on imports in Czech Republic was not distinguishable from zero. Hence, there was convergence of prices in Czech Republic towards EMU member countries. Lízal and Schwarz (2017) presented the evidence of the functioning of foreign exchange interventions and the exchange rate pass-through to consumer prices in Czech Republic. Nucu and Anton (2018) pointed out monetary policy in the EMU have prominent effects on monetary conditions in CEE countries.

CONCLUDING REMARKS

There are several conclusions that can be drawn out of the research presented in this paper. Firstly, Robust and accurate estimates from state space model with time varying parameters contributes to the existing

body of literature and policy makers in Hungary and Czech Republic while considering the effects of joining EMU. Secondly, long-term import demand in case of Hungary was elastic to change in income and prices while joining the EU increased the level of imports. The elasticity from real effective exchange rate to imports in Case of Hungary was positive. The positive price elasticity indicates that domestic goods were poor substitute of imported goods in Hungary. In case of Czech Republic, there was income elasticity of import demand as well but lower comparing to Hungary. The positive effect from joining EU on import in Czech Republic was more prominent comparing to Hungary. Furthermore, price elasticity of demand in Czech Republic was theoretically consistent. At the beginning of the observation period, there was negative elasticity from real effective exchange rate to imports. Hence, the foreign goods were substituted with domestic good with lower prices. By the time the effects from real effective exchange rate to import has vanished and eventually cannot be distinguished from zero. The results indicate long-term convergence of prices in Czech Republic towards the prices in EMU countries. Eventually, the main research hypothesis that assumes convergence of prices towards EMU countries is supported in case of Czech Republic while not in case of Hungary. Despite many similarities between two considered countries, there were evident differences in import demand and elasticity of substitution between domestic and foreign goods. Further research need to be directed towards structure of imports and its consumption.

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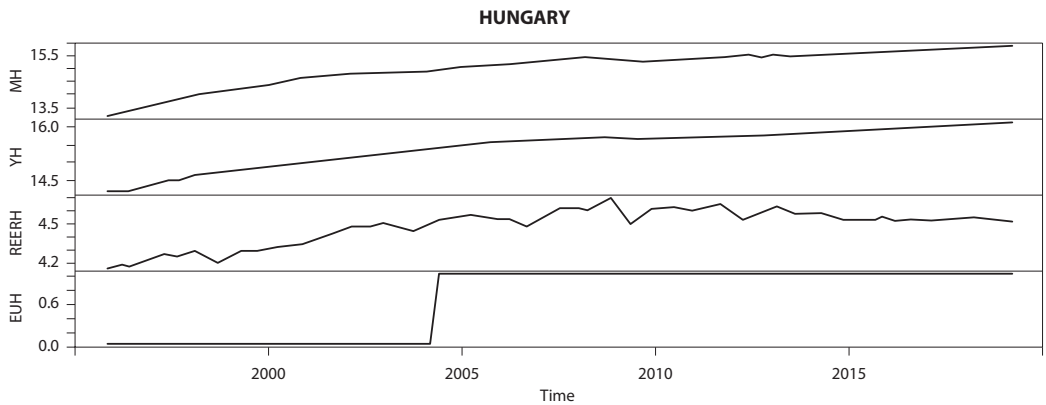
APPENDIX

Table A1 Descriptive statistics of the variables: the case of Hungary

	MH	YH	REERH
Min.	13.18	14.15	4.154
1st Q	14.74	15.09	4.422
Median	15.33	15.62	4.520
Mean	15.08	15.43	4.476
3rd Q	15.55	15.77	4.570
Max.	15.94	16.14	4.690

Source: Own estimates

Figure A1 Development of the observed series: the case of Hungary



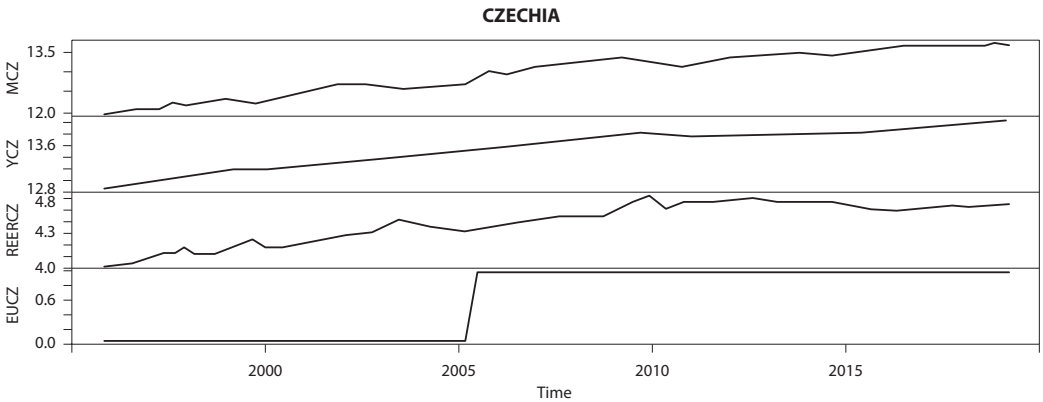
Source: Own estimates

Table A2 Descriptive statistics of the variables: the case of Czech Republic

	MCZ	YCZ	REERCZ
Min.	11.98	12.84	4.024
1st Q	12.63	13.32	4.270
Median	13.17	13.67	4.463
Mean	13.01	13.58	4.413
3rd Q	13.45	13.83	4.566
Max.	13.74	14.06	4.647

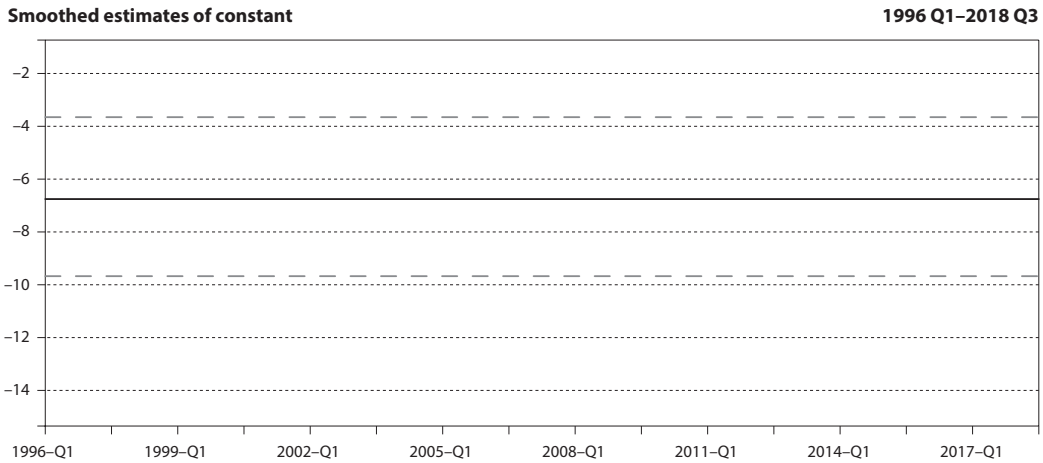
Source: Own estimates

Figure A2 Development of the observed series: the case of Czech Republic



Source: Own estimates

Figure A3 TV estimates of constant term: the case of Hungary



Source: Own estimates

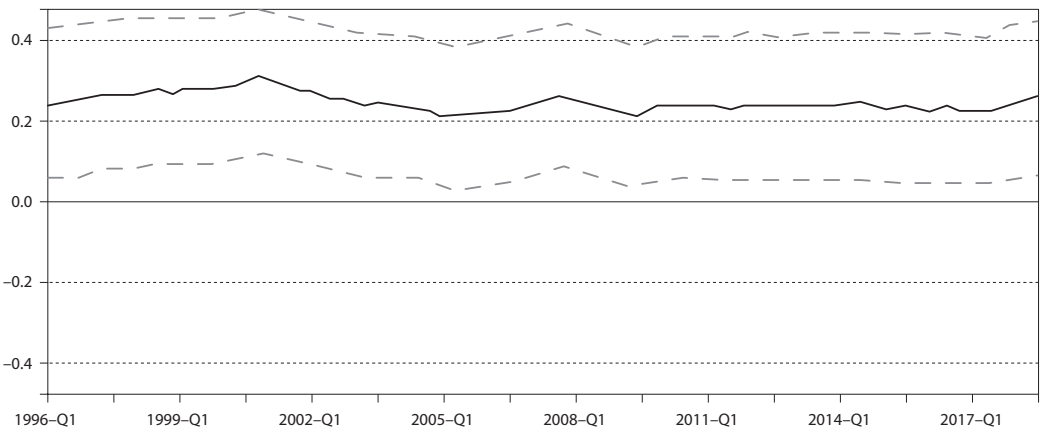
Figure A4 TV estimates of income elasticity: the case of Hungary

Smoothed estimates – income elasticity **1996 Q1–2018 Q3**

Source: Own estimates

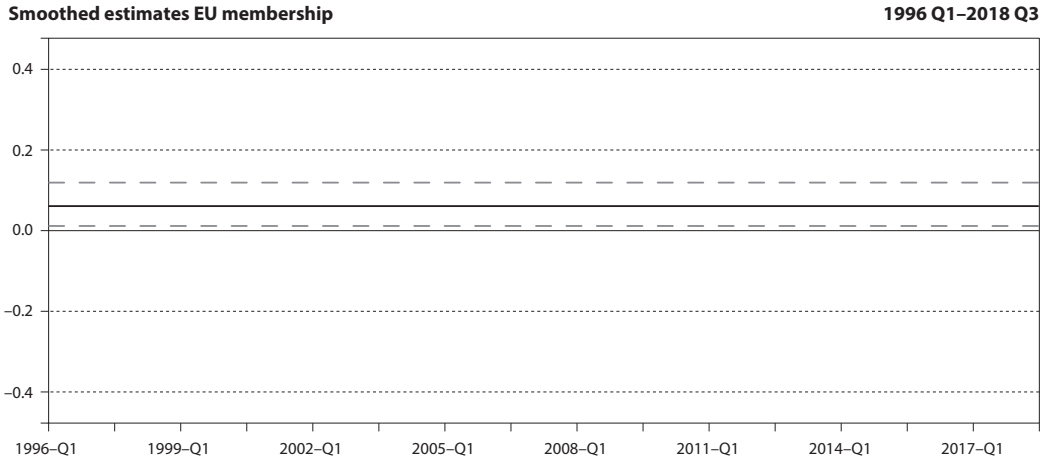
Figure A5 TV estimates of price elasticity: the case of Hungary

Smoothed estimates REER elasticity **1996 Q1–2018 Q3**



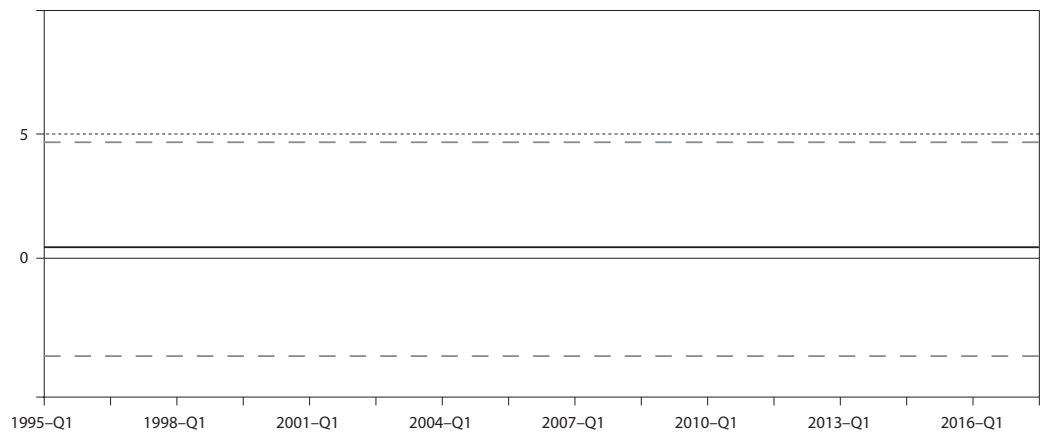
Source: Own estimates

Figure A6 TV estimates of EU membership effects: the case of Hungary



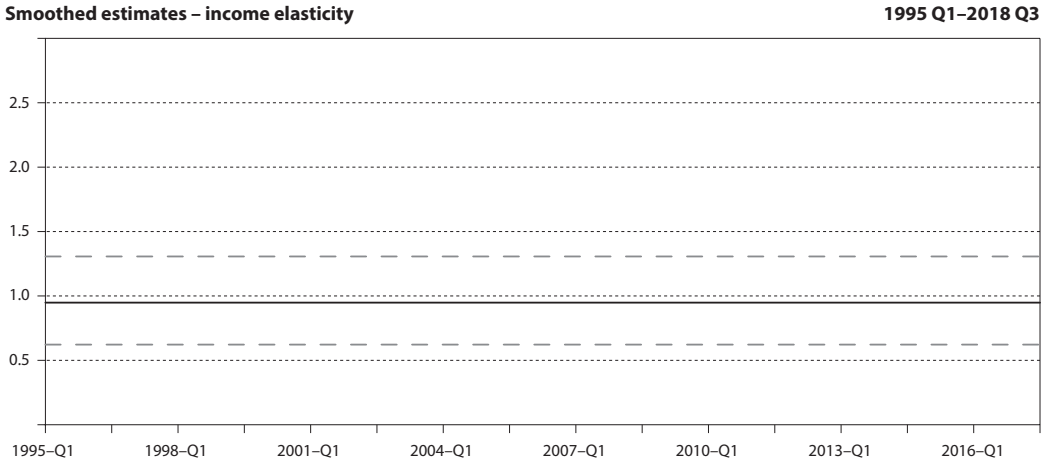
Source: Own estimates

Figure A7 TV estimates of constant term: the case of Czech Republic



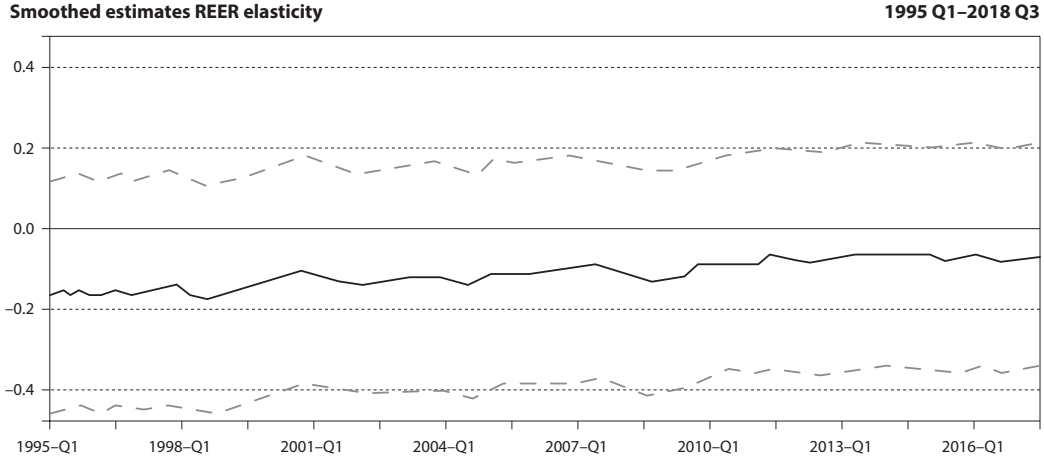
Source: Own estimates

Figure A8 TV estimates of income elasticity: the case of Czech Republic



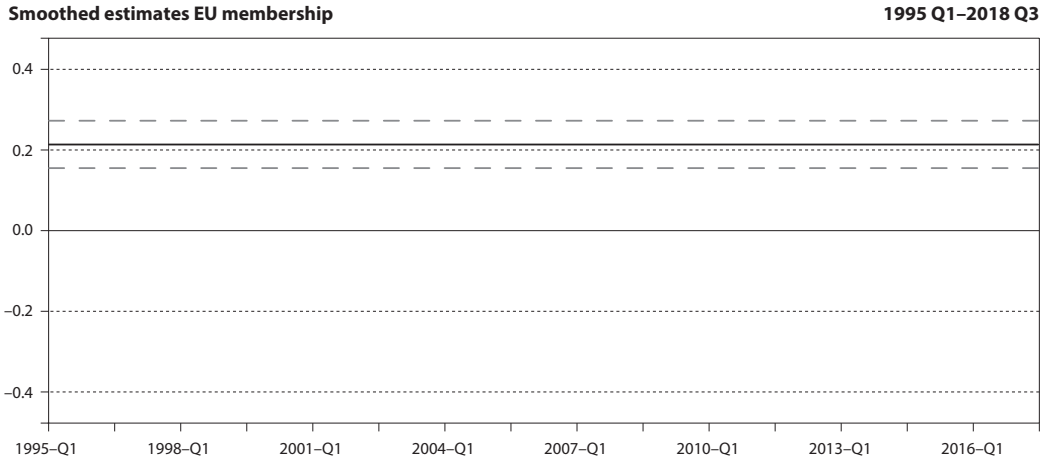
Source: Own estimates

Figure A9 TV estimates of price: the case of Czech Republic



Source: Own estimates

Figure A10 TV estimates of EU membership effects: the case of Czech Republic



Source: Own estimates