THE EXCHANGE RATE AS A DETERMINANT OF THE DEVELOPMENT OF FOREIGN TRADE IN THE AGRI-FOOD INDUSTRY IN THE VISEGRAD REGION

JANA ŠIMÁKOVÁ

ABSTRACT

The majority of empirical studies assume the symmetric effects of exchange rate development on the trade balance. However, we follow more recent studies to show that there are distinctions to be made between the directions of changes inthe exchange rate. In this study, we assume that the effects can be asymmetrical in certain branches of the agri-food industry. This paper aims to evaluate the asymmetric effects of the exchange rate on foreign trade in the agri-food sector in the Visegrad region. For this purpose, we employ a non-linear auto-regressive distributed lag approach to incorporate the assumed asymmetries of exchange rate changes in a model of the J-curve pattern in the case of Czechia, Hungary, and Poland.The dataset on the SITC two-digit level covers the period between 2000 and 2018. The paper shows that there is a clear difference in the effects of appreciation and depreciation. The difference is not only in the direction, but also in the intensity, of the effects of exchange rate changes on the trade balances of food and live animals, dairy products and birds' eggs, and animal oils and fats in Czechia; meat and preparations in Hungary; sugar, sugar preparations and honey and beverages in Poland.

KEY WORDS

Agri-food sector, asymmetric effects, exchange rate, foreign trade, J-curve

DOI: 10.23762/FSO_VOL9_NO2_1

JANA ŠIMÁKOVÁ
e-mail: simakova@opf.slu.cz

Silesian University in Opava, School of Business Administration in Karviná, Czech Republic

Introduction

The Visegrad Four (V4) region is a group of statesin the Central European Region that make strategic efforts to collaborate in several areas of common interest, especially within the process of European integration. They tend to adopt common positions even in some areasof agri-food policy, for instance in the application of the EU Common Agricultural Policy. All V4 countries – Czechia, Hungary, Poland, and Slovakia – became members of the European Union (EU) in 2004. This step was another important milestone in their economic transformation, including the transformation in the processes of agri-food industries. As Szabo et al. (2018) state, transformation in the agriculture and food industry had an effect on its material and production base, ownership relations, the concentration of production, establishing new companies with more effective organisational structures, the inflow of foreign capital, the refocusing of product specification, and a decline in the number of employees. The

Paper received: 20 March 2021 • Paper revised: 28 May 2021 • Paper accepted: 11 June 2021

V4 -except for Poland -previouslyhad large and strongly concentrated companies in the agri-food sector. Most of these businesses have been dismantled and the previously homogeneous agricultural production sector has become fragmented (Szabo et al., 2018). According to European Commission data, approximately 90% of food and beveragecompanies in Europe are currently small and medium-sized enterprises (SMEs).

V4 membership in the EU on one hand represents the opening of the new agri-food market, and on the other hand, increased competition. Kiss (2011) confirmed,by means of the analysis of data gathered between 2003 and 2006, that the agricultural exports of the V4 to the old EU member countries almost doubled within that timeframe. At the same time, agricultural imports also increased by 2.1 times. Furthermore, Szabo et al., (2018) showed that even though EU agricultural production increased by 10.2% between 2010 and 2013, Poland's agriculture grew by 81.3%. The equivalent increase in Czechia was 38.3% and in Slovakia 26.9% respectively. According to arecent survey by the Visegrad Group (2018), the V4 - with a 5.7% current share of the total GDP of the EU - own 14% of the total EU agricultural area and 10% of EU forests. With these resources, the V4 produce 9.6% of the total agri-food production of the EU. The V4 countries take an important position in EU foreign trade of agri-food goods, with a 9.7% share of EU agri-food imports and a 10.1% share of EU agri-food exports. In general, these countries performed competitively after accession to the EU (Łukiewska, 2019; Szczepaniak, 2019).

According to Svatoš and Smutka (2012), agri-food trade in the V4 countries is significantly concentrated, both in the structure of the commodities traded as well as the structure of the trading partners. 80% of V4 agri-food foreign trade is undertaken within the EU, while foreign trade with one another is also important. The majority of mutual V4 foreign trade is conducted by Czechia and Slovakia. Poland and Hungary represent the most competitive countries operating in the V4 region. As Svatoš and Smutka (2012) state, the agri-food foreign trade of Czechia, Hungary, and Slovakia does not have any comparative advantages compared to the EU market as a whole. However, they can achieve comparative advantages on the bilateral level with individual EU member countries.

The overall competitiveness of agri-food foreign trade can be affected by numerous microeconomic and macroeconomic factors alike, such as economic development, interest rates, inflation or the labour market. One of the most crucial such factorsis the exchange rate. The majority of empirical studies assume that exchange rate developments tend to have symmetric effects on the trade balance of the respective country. However, we follow more recent studies to show that distinctions should be made between the directions of changes inthe exchange rate (e.g. Bahmani-Oskooee and Kanitpong, 2019; Bahmani-Oskooee and Fariditavana, 2020; Šimáková, 2018). In this study, we assume that the effects maybe asymmetrical in certain branches of the agri-food industry. This recent approach reflects the findings that the price elasticity of the traded goods is crucial in estimating the relationship between exchange rates and international trade, and simultaneously, the companies and consumers involved tend to have different reactions to the depreciation and appreciation of the currency. The behaviour of producers may be diverse in terms of the speed and means of managing the changing cash flows related to exchange rate development.

Hence, this paper aims to evaluate the asymmetric effects of the exchange rate on foreign trade in the agri-food sector in the Visegrad region. For this purpose, we employ the auto-regressive distributed lag (ARDL) approach. The dataset will cover the period between 2000 and 2018; as the Euro area (EA) covers the majority of total trade of each country, we will focus only on the impact of the development of the value of the respective home currency against the Euro. Since Slovakia is already a member of the EA, we will focus on the agri-food industry in Czechia, Hungary, and Poland.

To this end, the next section reviews the relevant literature concerning the researched area and provides a theoretical background and existing findings in the agri-food sector in the V4 region. The subsequent section introduces the methods, the empirical model used in empirical estimation, and data description. The following sections present and discuss the empirical results of the J-curvemodel employed inthe research. Finally, the last section includesconcluding remarks pertaining to theagri-food foreign trade in Czechia, Hungary, and Poland.

1. Literature review

The literature review is structured in accordance with the purpose of our research to evaluate the asymmetric effects of the exchange rate on foreign trade in the agri-food sector in the Visegrad region. First, the theoretical background of the approach to research and its development is specified. Second, the specifics for the agri-food sector derived from existing studies are described.

1.1. Theoretical background

The economic theory concerning the effects of the exchange rate on trade balance generally assumes that on one hand, the depreciation of the domestic currency represents the driving force of exports from the home country, while on the other hand, it represents a disadvantage for imports from abroad. Therefore, this circumstance should lead to the improvement of the country's trade balance. However, empirical testing shows that these theoretical assumptions cannot be applied in allcases. One mayisolate several methodological milestones in testing this relationship: (1) distinguishing between short-term and long-term effects; (2) distinguishing between trading partners; (3) distinguishing between goodstraded; (4) distinguishing between the effects of depreciation and appreciation.

The idea of distinguishing between short-term and long-term effects comes from Magee (1973), who described the development of the trade balance after the depreciation of the domestic currency with the letter J. The logic of this phenomenon is derived from the initial short-term effect when the negative price effect of the exchange rate effect is dominantand followed by apositive long-term effect when the volume effect prevails. The turning point in statistical testing was due to Rose and Yellen (1989), according to whom the J-curve is a combination of the negative short-term coefficients of estimation, followed by the positive ones. However, the first such studies (e.g. Bahmani-Oskooee, 1986; Mahdavi and Sohrabian, 1993) suffered from aggregation bias, as they used both the aggregate export and import data and the effective exchange rate, which can lead to ambiguous results when a domestic currency appreciates against one currency and simultaneously depreciates against another currency. Hence, Bahmani-Oskooee and Brooks (1999), Bahmani-Oskooee and Ratha (2004), and many others began to apply bilateral exchange rates and the bilateral trade balances of the respective

countries. Bahmani-Oskooee and Hegerty (2011) and Bahmani-Oskooee et al., (2016) developed an approach based on the disaggregation of trade balance data atthe product level. As Bahmani-Oskooee and Hegerty (2011) explain, the significant currency effect on some commodities can be compensated for by insignificant currency effects on others, thereby resulting in an insignificant impact of the exchange rate on the trade balance as a whole.

Recent studies (e.g. Bahmani-Oskooee and Kanitpong, 2019; Bahmani-Oskooee and Fariditavana, 2020; Šimáková, 2018) argue that previous studies may still suffer from statistical bias as they assume the symmetrical effects of the exchange rate on the trade balance. The symmetricity means that they do not distinguish between the effects of depreciation and appreciation. One may refer to the work of Bahmani-Oskooee and Baek (2016), who argue that traders can react differently when a currency depreciates than when it appreciates. Even producers tend to react more quickly to depreciation to satisfy the increased demand for exports. Contrary, producers do not react so quickly to appreciation. Studies concerning the most recent approach to exchange rate effects on international trade employing the nonlinear ARDL approach are usually devoted to bilateral trade disaggregated to the industry level.

However, the insights of industry are very limited in this case, as they are predominantly focused only on the mutual trade flows between the two countries. Although the results of these studies are beneficial for the development of economic theory and the implications of economic policy, this approach limits the foundation of its basis – the basis of the J-curve pattern. Said pattern is based on the elasticity approach derived from the Marshall-Lerner condition, which is not usually fulfilled in the short run, but only in the long run. This condition states that the sum of export and import demand elasticity has to be at least 1, at which point currency depreciation is followed by animprovement in the trade balance. As currency depreciation means a reduction in the price of exports, the demand for them will increase. At the same time, the price of imports will rise and their quantity will decrease. Therefore, as we assume that elasticity is based more on the specific product than on the country specifics of the trading partner, it is necessary to focus on one product category in order to isolate the unbiased effects of the exchange rate.

1.2. Review of studies on the agri-food sector

This paper is concerned with the agri-food sector. The majority of the previously published studies concerning agricultural foreign trade were devoted to the effect of the exchange rate on agricultural export and import volume (e.g. Bradshaw and Orden, 1990; Gardner, 1981), although we can find some studies on the J-curve phenomenon as well. For example, in his study of Turkey, Yazici (2006) indicates that the agricultural trade balance initially improved after the depreciation of Turkish lira, then worsened, and then improved again. Turkish agricultural trade remained free of the J-curve effect. Godwin (2009) empirically confirmed that the J-curve didnot even exist in the Nigerian agri-food sector. The pattern of the effects of currency on the trade balance resembleda horizontal S in this case. Yazdani and Shajari (2009) published a study ofthe agri-food sector in Iran, whereby the ARDL approach confirmed that real depreciation of the Iranian rial had a positive impact on the agri-food trade balance. The agri-food sector in the USA was researched by Baek et al., (2009) and Gong and Kinnucan (2015), both with the

application of the dynamic ARDL approach and the error correction model. Said studies have not confirmed the J-curve effect, but they have confirmed the crucial role of the exchange rate in agri-food foreign trade development, as the depreciation of the domestic currency is positively linked to the U.S. agri-food sector trade balance.

V4 agri-food foreign trade and the respective J-curve have been estimated in a very limited number of studies. Some consequences for the agri-food sector can be found in papers concerning overall foreign trade disaggregated at the product level. For instance, Šimáková and Stavárek (2015) verified the positive effects of the depreciation of the Czech koruna on agri-food foreign trade in Czechia. However, agri-food trade remains free of the J-curve effect. Šimáková (2014) confirmed the same conclusions in the case of Poland. Acomprehensive study ofV4 agri-food foreign trade was performed by Šimáková (2017), proving that foreign trade in food, live animals, beverages, and tobacco commodities has a long-term relationship with exchange rate development. However, the effects of depreciation are inconsistent. Although the majority of particular trade balances were positively affected by currency depreciation, the J-curve for Czechia was estimated only in the foreign trade of food and live animals with Italy and Poland. This leads to the need for research into theopen question on the ambiguous effects of exchange rates on the agri-food sector in V4 countries. Therefore, compared to other papers, this paper not only tests the latest available disaggregated foreign tradedata, but also follows the main criticism of possible biases in estimation and assumes the asymmetrical effects of depreciation and appreciation. As a result, this study can fill the gap in the empirical estimation of the foreign trade of the V4 countries.

2. Methodology and data description

2.1. Methodology

To estimate the effects of the exchange rate on the agri-food trade balances in selected V4 countries, we follow Bahmani-Oskooee and Fariditavana (2016) in basing the model of the J-curve on the bilateral reduced form of the trade balance model for the long term (Equation (1)). The trade balance is the dependent variable of domestic income (a proxy for import demand), foreign income (a proxy for export demand), and the exchange rate.

$$\ln TB_{p,t} = \alpha + \beta \ln Y_{d,t} + \gamma \ln Y_{f,t} + \lambda \ln ER_{f,t} + \varepsilon_t \quad (1)$$

In Equation (1), TB_p stands for a measure of the trade balance in period t expressed as the ratio of the export volume of the selected domestic country *d* to foreign country f over its import volume from country f in a selected product category p. Y_d is a measure of domestic income, and Y_f is a measure of foreign income, both measured in GDP and set in index form to make them unit-free. We suppose that growth in foreign income should lead to a higher demand for exports from domestic country *d*. Therefore, an estimate of γ is assumed to be positive. On the other hand, growth in domestic income Y_d should lead to a higher demand for imports from abroad. Hence, an estimate of β is assumed to be negative. ER_f is the bilateral exchange rate quoted in a direct manner; consequently, an increase thereinl eads to the depreciation of the domestic currency, which should lead to increased exports and decreased imports

represented by the positive parameter $\lambda.\varepsilon_t$ stands for an error term.

Following Bahmani-Oskooee et al. (2016), we incorporate the dynamic adjustments into Equation (1) through a modification to the error-correction model (Equation (2)), where differentiated short-term variables and static long-term variables are in the same model. The J-curve pattern is confirmed if the estimated short-term coefficient π is negative and the normalised long-term coefficient θ is positive.

$$\Delta \ln TB_{p,t} = \alpha + \sum_{j=1}^{n1} \beta_j \Delta \ln TB_{p,t-j} + \sum_{j=0}^{n2} \chi_j \Delta \ln Y_{d,t-j} + \sum_{j=0}^{n3} \delta_j \Delta \ln Y_{f,t-j} + \sum_{j=0}^{n4} \pi_j \Delta \ln ER_{t-j} + \theta_1 \ln TB_{p,t-1} + \\ + \theta_2 \ln Y_{d,t-1} + \theta_3 \ln Y_{f,t-1} + \theta_4 \ln ER_{t-1} + \varepsilon_t \quad (2)$$

Assumed asymmetries of exchange rate changes are incorporated into the model by applying the nonlinear *ARDL* approach (as in Bahmani-Oskooee et al., 2016). The initial step to test the potential asymmetric effects of exchange rate changes is to calculate a time series, representing the appreciation (*POS*) and depreciation (*NEG*) of the home currency as expressed in Equations (3) and (4).

$$POS_t = \sum_{j=1}^{t} \Delta \ln ER_j^+ = \sum_{j=1}^{t} \max(\Delta \ln ER_j, 0) \quad (3)$$

$$NEG_t = \sum_{j=1}^{t} \Delta \ln ER_j^- = \sum_{j=1}^{t} \min(\Delta \ln ER_j, 0) \quad (4)$$

The nonlinear ARDL model is as follows (Equation (5)):

$$\Delta \ln TB_{p,t} = \alpha + \sum_{j=1}^{n1} \beta_j \Delta \ln TB_{p,t-j} + \sum_{j=0}^{n2} \chi_j \Delta \ln Y_{d,t-j} + \sum_{j=0}^{n3} \delta_j \Delta \ln Y_{f,t-j} + \sum_{j=0}^{n4} \pi_j^+ \Delta \ln POS_{t-j} + \\ + \sum_{j=0}^{n5} \pi_j^- \Delta \ln NEG_{t-j} + \theta_1 \ln TB_{p,t-1} + \theta_2 \ln Y_{d,t-1} + \theta_3 \ln Y_{f,t-1} + \theta_4^+ \ln POS_{t-1} + \theta_5^- \ln NEG_{t-1} + \varepsilon_t \quad (5)$$

We assume adjustment asymmetry if the number of lags in the variable *POS* is different from the number of lags in the variable *NEG*. Furthermore, if the sign and/or size of coefficients estimated for *POS* and *NEG* are different, short-term asymmetric effects will be proven.

2.2. Data description

Data used for the estimation of the relationship between exchange rates and agri-food trade balance are at a quarterly frequency and cover the period from Q12000 to Q42018. All data series are obtained from the Eurostat statistical database. Because the EA covers the majority of total trade of each Visegrad country, we focus only on the impact of the development of the value of the respective home currency against the Euro. Since Slovakia is already a member of the EA, we will focus on the agri-food industry in Czechia, Hungary, and Poland.

Data for domestic income are represented by the GDP of Czechia, Hungary, and Poland, dependingon the estimated agri-food trade balance. The income of the foreign partner is represented by the GDP of the entire Eurozone. GDPs for respective individual countries and the Eurozone are weighted to current prices and in real terms. Exchange rates are also given

in real terms. They are quoted in a direct manner, which means that an increase represents a depreciation of the domestic currency against the Euro and a decrease represents an appreciation of domestic currency (CZK, HUF, and PLN) against the Euro. Therefore, we apply the exchange rates of CZK/EUR for all partial trade balances of Czechia, HUF/EUR for all partial trade balances of Hungary, and PLN/EUR for all partial trade balances of Poland, respectively. Estimated product categories representing the agri-food foreign trade in selected countries with the EA are based on the Standard International Trade Classification (SITC) one- and two-digit level as stated in Table 1.

Table 1. Agri-Food Products Tested According to SITC 1-and 2-Digit Classification

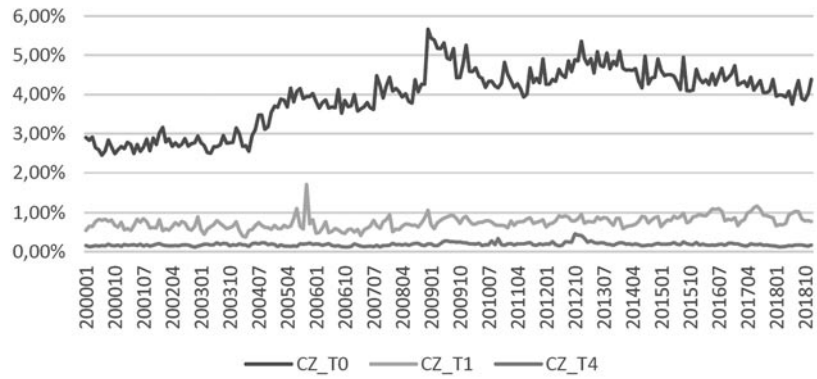
T0		Food and live animals
	T00	Live animals chiefly for food
	T01	Meat and preparations
	T02	Dairy products and birds' eggs
	T03	Fish, crustaceans and mollusks, and preparations thereof
	T04	Cereals and cereal preparations
	T05	Vegetables and fruit
	T06	Sugar, sugar preparations and honey
	T07	Coffee, tea, cocoa, spices, and manufactures thereof
	T08	Feeding stuff for animals (not including unmilled cereals)
	T09	Miscellaneous edible products and preparations
T1		Beverages and tobacco
	T11	Beverages
	T12	Tobacco and tobacco manufactures
T4		Animal and vegetable oils, fats and waxes
	T41	Animal oils and fats
	T42	Fixed vegetable oils and fats
	T43	Animal and vegetable oils and fats, processed, and waxes

Source: Own elaboration based on Eurostat data.

The importance of individual SITC one digit agri-food categories, measured as a ratio of particular trade flows to the total foreign trade of Czechia (CZ), Hungary (HU), and Poland (PL), can be seen in Figures 1, 2, and 3.

The product category of food and live animals accounts for the highest share of agri-food in Czech foreign trade (see Figure 1). The average share of these products is 3.94% for the entire period, while the value of this share was 4.38% in the last observed period. The highest share of this product category was detected after the global financial crisis when the total volume of Czechforeign trade decreased. The agricultural sector is generally considered to bean anticyclical sector ofthe economy; therefore, the volume of agri-food foreign trade was not as significantly affected by the financial crisis. This led to a higher share of food and live animals in total foreign trade. The shares of the foreign trade of beverages and tobacco in total foreign trade are less than 1%. The average share of beverages and tobacco products for the period as a whole is 0.75%, while the share in the last observed period was 0.78%. The share of animal and vegetable oils, fats, and waxes is very low, culminating in avalue of 0.19% over time.

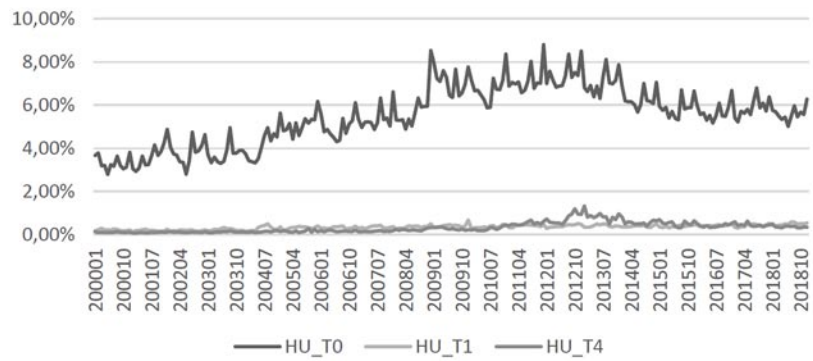
Figure 1. Shares of Agri-Food Products in the Total Foreign Trade of Czechia



Source: Own elaboration based on Eurostat data.

The shares of respective partial agri-food trade balances of Hungary can be seen in Figure 2. As in the case of Czechia, the highest share of agri-food in foreign trade is represented by the product category of food and live animals. However, the average share of these products is 5.51% for the entire period, while the value of this share was 6.27% in the last observed period. The importance of this product category is higher by two percentage points in comparison to Czechia. The major shift in this product category can be observed after the global financial crisis even in this case, but the duration of this share was more long-term-oriented. Furthermore, one can see that internationally traded products in this product group are seasonal. The average share of beverages and tobacco products amounts to 0.35% for the entire period, while the share in the last observed period was 0.54%. The share of animal and vegetable oils, fats, and waxes isslightly higher than that of Czechia, culminating in a value of 0.33% over time.

Figure 2. Shares of Agri-Food Products in the Total Foreign Trade of Hungary

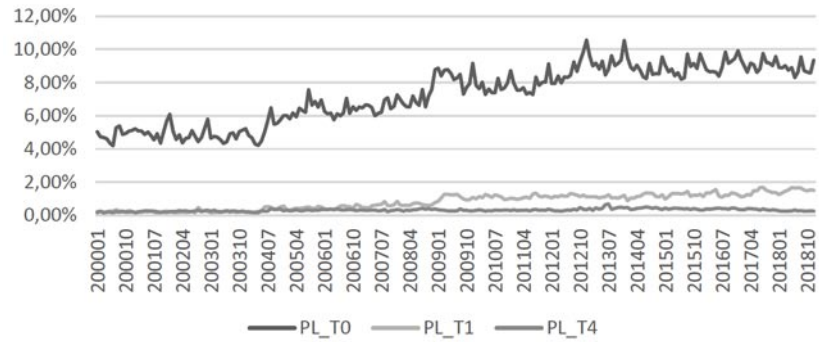


Source: Own elaboration based on Eurostat data.

In the context of the V4 economies, agri-food production is most important in the case of Poland. As can be seen in Figure 3, the product category of food and live animals returns figures twice as high as those of Czechia and higher by almost two

percentage points in comparison to Hungary. An interesting fact is that theshare of this category intotal foreign trade doubled in the testing period, and this trend is still present in this economy. Positively increasing trends can be seen also in the time series data of foreign trade in beverages and tobacco. The average share of this product category is 0.83%, while the most recent data shows a share of up to more than 1.5%. The share of the animal and vegetable oils, fats, and waxes category is comparable to that of Hungary, culminating in avalue of 0.32% over time.

Figure 3.Shares of Agri-Food Products in the Total Foreign Trade of Poland



Source: Own elaboration based on Eurostat data.

3. Research results

3.1. Results of long-term estimation

To estimate the long-term relationship between exchange rates and respective agri-food trade balances, we apply the non-linear ARDL approach to Equation (5). This approach can be employed for both the stationary data series on their levels and the stationary first-differenced (I(1)) variables. This assumption is generally held by all macroeconomic variables and by data series in this paper as well. We estimate the model using bilateral data between the selected V4 countries and the Eurozone as such trade covers the majority of all international trading flows in the V4 countries. By applying Akaike's information criterion, a maximum of four lags are selected on the I(1) variables. The results for long-term relationships from each model are reported in Table 2. If no long-term relationship is proved in the specific agri-food trade balance, we do not report the results. We also state the adjusted R2 coefficient of determination of the models, referred to as Adj. R2 in Table 2.

Table 2. Results of long-term estimation

	Czechia						Hungary						Poland					
	C	lnY_{CZ}	lnY_{EA}	POS	NEG	$Adj.R^2$	C	lnY_{HU}	lnY_{EA}	POS	NEG	$Adj.R^2$	C	lnY_{PL}	lnY_{EA}	POS	NEG	$Adj.R^2$
T0	11.90	1.25	6.37**	0.15***	-0.34*	0.58	10.22	-2.36*	2.29**	0.49	-0.14**	0.54	5.12*	-5.02	0.41*	0.23	-0.11*	0.52
T00	8.14	-6.71**	5.20*	1.16*	1.02*	0.32	-2.16	2.51*	7.15	0.93	-0.22	0.56	4.81	-2.13**	5.10**	0.14*	2.13	0.38
T01	2.09*	3.67	4.16*	-0.74	-0.67**	0.61	-1.27*	10.21	3.27*	0.25*	-0.43**	0.69	-1.12	-1.05*	9.14*	-0.06**	-1.16	0.53
T02	9.67	-9.07	-2.34	0.17**	-0.53*	0.57	9.15	-2.35*	1.17**	0.02**	1.03	0.47	-2.94	4.05	-0.16*	0.67	-0.13**	0.84
T03	-	-	-	-	-	-	7.33*	-9.10*	-2.43	-0.36	0.07	0.46	3.66*	5.10	6.31	1.16*	0.63	0.74
T04	5.91*	0.59**	4.25	0.64	-0.08	0.48	-3.41	-2.01**	5.89	-0.07	0.24	0.70	-	-	-	-	-	-
T05	13.88	-3.08	8.62*	0.23	0.04**	0.39	6.34	-5.96**	-8.22	-0.12	-0.19*	0.64	2.71**	-9.52	2.63**	0.94	0.09	0.29
T06	-6.21	-8.43**	-1.64	0.15	-0.73	0.45	4.55**	9.03	5.61	0.67*	-2.04	0.33	-4.67	1.15	9.88*	0.82**	-0.17**	0.27
T07	-	-	-	-	-	-	-	-	-	-	-	-	-3.47	0.54	0.19	-1.13	0.00	0.60
T08	6.29**	-4.19	5.12**	0.25*	0.36	0.52	3.16	2.34	2.95**	1.01*	-0.98	0.53	-1.88**	-4.16**	10.01	0.05*	-1.08	0.14
T09	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T1	-	-	-	-	-	-	-1.27*	-3.27*	8.83	-0.05	-0.54	0.41	-	-	-	-	-	-
T11	-10.80	5.56*	9.81	0.10	0.52	0.35	-5.26	-0.91**	2.67	0.94	0.01**	0.44	3.40	-5.26	-6.12	0.00**	-0.99*	0.80
T12	11.17	-7.15*	-4.80	-0.19**	-1.01	0.43	6.45	-8.26	5.15*	0.31	-0.34	0.39	3.58*	-8.11	11.13	0.01*	-0.34	0.43
T4	-	-	-	-	-	-	-	-	-	-	-	-	-2.17	11.20	3.23**	-0.22	-0.45	0.37
T41	6.38	-1.44	6.92	0.91*	-0.20**	0.51	2.94	-5.19*	-3.03**	0.20*	0.68	0.52	9.16*	-5.23	-2.57*	5.79	0.74	0.33
T42	-	-	-	-	-	-	3.16**	0.58	2.25*	-0.04*	0.00	0.59	-	-	-	-	-	-
T43	1.55**	0.95*	3.41	-0.62	2.11	0.46	-	-	-	-	-	-	-10.11	-7.19*	7.91*	0.18	0.02	0.17

Source: Own elaboration.

Note: * indicates a significant statistic at the 10% level, ** indicates a significant statistic at the 5% level, *** indicates a significant statistic at the 1% level

In the case of Czechia, there is no long-term relationship between domestic GDP, GDP in the Eurozone, and changes in exchange rates in the case of the trade balance of T03 Fish, crustaceans and mollusks, and preparations thereof; T07 Coffee, tea, cocoa, spices, and manufactures thereof; T1 Beverages and tobacco; T4 Animal and vegetable oils, fats and waxes; and T42 Fixed vegetable oils and fats. For Hungary, there is no proof of long-term relationships in the case of T07 Coffee, tea, cocoa, spices, and manufactures thereof; T1 Beverages and tobacco; and T43 Animal and vegetable oils and fats, processed, and waxes. In Poland, there is no long-term relationship for the trade balances of T04 Cereals and cereal preparations; T1 Beverages and tobacco; and T42 Fixed vegetable oils and fats. Even though some one-digit SITC product trade balances remained free of long-term equilibrium, after disaggregating data on the two-digit SITC level, this is proven in the case of T11 Beverages and T12 Tobacco and tobacco manufactures in Czechia and Poland, and in the case of T41 Animal oils and fats and T42 Fixed vegetable oils and fats in Hungary.

This study employed the bilateral exchange rate quoted in a direct manner; an increase therein leads to a depreciation of the domestic currency. We separately accumulated all positive (domestic currency depreciation) and negative changes (domestic currency appreciation), so as to compare both the direction and the magnitude of the effects of exchange rates on particular agri-food trade balances. From the perspective of the effects of positive changes, one may observe that those statistically significant coefficients reflect the growth of the majority of agri-food trade balances following depreciation of the domestic currency. Depreciation, in this case, leads to increased exports and decreased imports represented by positive parameters. The only exceptions are T12 Tobacco and tobacco manufactures in Czechia, T42 Fixed vegetable oils and fats in Hungary, and T01 Meat and preparations in Poland. Almost all statistically significant coefficients indicate a worsening inparticular trade balances after appreciation. Only T00 Live animals chiefly for food in Czechia and T11 Beverages do not hold to the stated expectations.

Comparing the effects of positive and negative exchange rate changes on the respective product-level trade balances brings crucial results. Differences not only in the direction, but also in the intensity, of the effects of exchange rate changes can be observed in the trade balances for T0 Food and live animals, T02 Dairy products and birds' eggs, and T41 Animal oils and fats in Czechia; T01 Meat and preparations in Hungary; and T06 Sugar, sugar preparations and honey and T11 Beverages in Poland, respectively. These results confirm assumptions pertaining to the different reaction of agri-food market participants to currency appreciation and depreciation.

3.2. Results of short-term estimation

The estimated short-term effects of exchange rate changes can be found in Table 3. As can be seen, the statistical significance of the short-term coefficient for positive and negative changes in tested exchange rates is very limited. Nevertheless, several important patterns concerning the J-curve issue may be observed.

As explained in Section 2, the J-curve pattern is confirmed for a particular trade balance if the estimated short-term coefficients of depreciation are negative (Table 3) and the normalised long-term coefficient is positive (Table 2). This pattern can be observed in four cases. The short-term worsening of the trade balance followed

by its long-term growth after depreciation of the domestic currency against the euro can be seen in the caseof T0 Food and live animals in Czechia, T00 Live animals chiefly for food in Czechia and Poland, and T03 Fish, crustaceans and mollusks, and preparations thereof in Poland. Hungary remained free of any form of J-curve pattern for every trade balance tested.

The proven J-curves follow the short-term worsening of the respective product-level trade balances as a consequence of the dominance of the price effect over the volume effect. After producers and consumers adapt to the new level of the depreciated home currency, the trade balance begins to improve as a consequence of the domination of the volume effect over the price effect. These results indicate the changing elasticity of the respective agri-food products. Their elasticity is lower in the short term but tends to rise from a long-term perspective.

Table 3. Results of Short-Term Estimation for Exchange Rates

Czechia	ΔPOS_t	ΔPOS_{t-1}	ΔPOS_{t-2}	ΔPOS_{t-3}	ΔNEG_t	ΔNEG_{t-1}	ΔNEG_{t-2}	ΔNEG_{t-3}
T0	0.02	-0.14*	-0.16**	-0.03**	-0.35	0.01*	-	-
T00	0.06	-0.38	-0.09*	-	0.00	0.19	-	-
T01	0.04	-	-	-	0.07	0.11	-0.05	-
T02	-0.06	0.01	-	-	0.00	-	-	-
T03	-	-	-	-	-	-	-	-
T04	0.19	0.20*	-0.62	-	0.24	0.08	-	-
T05	-0.02	-0.41	0.16	-	0.16	-	-	-
T06	-0.54	0.09	-	-	0.01*	-0.03*	-	-
T07	-	-	-	-	-	-	-	-
T08	0.13*	0.07	-	-	0.15	-	-	-
T09	-	-	-	-	-	-	-	-
T1	-	-	-	-	-	-	-	-
T11	-0.28		-	-	0.06	0.14	-	-
T12	0.33	-0.05	-	-	0.11	-0.00	-0.06	-
T4	-	-	-	-	-	-	-	-
T41	-0.10	-0.08	-	-	0.32	-	-	-
T42	0.29	0.16	-0.22	-	0.46	-0.13	-	-
T43	0.03	0.04	-	-	-0.01*	0.70	-	-
Hungary	ΔPOS_t	ΔPOS_{t-1}	ΔPOS_{t-2}	ΔPOS_{t-3}	ΔNEG_t	ΔNEG_{t-1}	ΔNEG_{t-2}	ΔNEG_{t-3}
T0	0.16	0.01**	-0.03	-	0.01	0.06**	0.12*	-
T00	-0.06	-0.07	0.07	-	0.03*	0.13*	-0.10	0.04
T01	0.00	-	-	-	-0.21	-	-	-
T02	-0.06	-0.01	-	-	0.81*	-	-	-
T03	0.28	-	-	-	0.36*	0.07	-	-
T04	0.37	-	-	-	-0.15	0.03	-	-
T05	-0.69	-0.08*	0.03*	0.09	-0.09	0.08	-	-
T06	-0.04	0.01	-	-	0.07	0.06	-	-
T07	-	-	-	-	-	-	-	-
T08	0.08	-	-	-	0.00	0.18	0.33	-
T09	-	-	-	-	-	-	-	-
T1	0.17	-0.02	0.11	-	-0.09	0.21	-0.00*	-0.02
T11	-0.11*	0.46	-	-	0.26	0.13*	-	-

T12	-0.31	-0.57	-	-	0.11	0.03	-	-
T4	-	-	-	-	-	-	-	-
T41	0.22	0.09	-	-	0.00	-	-	-
T42	-0.03*	-	-	-	-0.13**	0.04	0.12	-
T43	-	-	-	-	-	-	-	-
Poland	ΔPOS_t	ΔPOS_{t-1}	ΔPOS_{t-2}	ΔPOS_{t-3}	ΔNEG_t	ΔNEG_{t-1}	ΔNEG_{t-2}	ΔNEG_{t-3}
T0	0.11	0.23	-0.16	-	0.15	-0.32	-	-
T00	-0.12*	-0.07	-	-	0.21	-	-	-
T01	-0.64	0.08	-0.13	-	0.17	-	-	
T02	0.37	0.24	-	-	-0.01	0.05*	0.07	-
T03	-0.17**	0.01*	-	-	0.07*	-0.02*	-	-
T04	-	-	-	-	-	-	-	-
T05	-0.33	-0.08**	-0.21*	-	0.14	-0.19	-	-
T06	-0.19	-	-	-	0.08	0.07	0.08*	-
T07	0.03	0.09	-0.25	-	0.04	-	-	-
T08	0.02	-0.14	-0.31	-	-0.03	0.00	0.04	-
T09	-	-	-	-	-	-	-	-
T1	-	-	-	-	-	-	-	-
T11	-0.10	-0.36	-0.12	-	0.21	-	-	-
T12	0.18	-0.41	-0.07	-	0.05	-0.08	-	-
T4	0.04	-	-	-	0.15*	-0.16**	0.04	-
T41	-0.03*	-0.03	-	-	0.06	0.13	0.01	-
T42	-	-	-	-	-	-	-	-
T43	0.00	-0.13	0.17	-	-0.03	-	-	-

Note: * indicates a significant statistic at the 1% level, ** indicates a significant statistic at the 5% level, *** indicates a significant statistic at the 10% level

Source: Own elaboration.

4. Discussion

The estimated models show the long-term co-movements between the majority of tested agri-food trade balances, GDPs and bilateral exchange rates. The results showed that even though some one-digit SITC product trade balances remained free of long-term equilibrium, after disaggregating data on the two-digit SITC level, this is proven in the case of more product categories. Furthermore, none of the tested V4 countries offered proof of any long-term relationship in the case of the product category of miscellaneous edible products and preparations. We assume that data inconsistency and different elasticities of traded products maybe the cause of these results. This points to the importance of disaggregating data to consistent product categories which tend to have similar price elasticities.

The comparison of variables employed in the model shows that the sizes of the coefficients of exchange rates are lower than the coefficients of GDPs, but they do matter in the development of agri-food international trade. From the perspective of the long-term effects of exchange rates, one may observe that those statistically significant coefficients reflect the growth of the majority of agri-food trade balances following the depreciation of the domestic currency. Depreciation, in this case, leads to increased exports and decreased imports. The product categories in which the depreciation of local currencies causes the worsening of respective trade balances are

highly isolated. This phenomenon can occur in trade affected by the use ofhedging instruments or trade which is highly import-intensive. The estimated coefficients of the appreciation of local currency against the Euro predominantly corresponds with theoretical assumptions. Almost all statistically significant coefficients indicate a worsening of particular trade balances after appreciation.

The main contribution of these results is made through the comparison of the magnitude of the effects of depreciation and appreciation. As Bahmani-Oskooee and Baek (2016) argue, this can be explained by the different reactions of traders, producers, and consumers to appreciation and depreciation. Producers tend to react quicker and more enthusiastically to the depreciation of the domestic currency, taking the opportunity to increase exports with more favourable prices for business partners or end consumers. On the other hand, the reaction to domestic currency appreciation is slower, which is usually affected by existing contracts and the time needed for consumers and business partners to find cheaper substitutes on the market.

The results of this study even show the importance of distinguishing the time perspective. Especially in the short term, when international trade is affected by existing business contracts, it is important to consider proper hedging strategies. Exchange rate risk hedging should be applied especially in the agri-food business, with the estimated negative effects of changes to the exchange rate. Effective hedging can decrease the negative aspects of currency development in this case. This is important primarily from the perspective of SMEs. Their hedging instruments for decreasing exchange rate risk are very limited, and the estimated relationships are critical in terms of their international trade efforts.

Hence, this study systematically contributes to research into the relationship between exchange rates and V4 agri-food foreign trade. We confirmed that, in comparison to previously published studies on the V4 countries, which remained free of the J-curve effect (e.g. Šimáková and Stavárek, 2015; Šimáková, 2014) or found limited examples of this phenomenon (e.g. Šimáková, 2017), disaggregating data on the bilateral level and adjusting the methodology with the assumption of asymmetrical exchange rate effects can lead to less biased results.

Conclusions

This paper aimed to evaluate the asymmetric effects of the exchange rate on foreign trade in the agri-food sector in V4 countries. For this purpose, we employed the non-linear ARDL approach to incorporate the assumed asymmetries of exchange rate changes into the model of the J-curve pattern. The dataset covered the period between 2000 and 2018 and, because the Euro area covers the majority of total trade of each country, the paper was focused only on the impact of the development of the value of the respective domesticcurrency against the Euro in Czechia, Hungary, and Poland. The estimated models show the long-term co-movements between the majority of tested agri-food trade balances and the variables incorporated in the testing. Furthermore, the results showed that, despite the fact that some one-digit SITC product trade balances remained free of long-term equilibrium, after disaggregating data on the two-digit SITC level this was proven in the case of T11 Beverages and T12 Tobacco and tobacco manufactures in Czechia and Poland, and for the case of T41 Animal oils and fats and T42 Fixed vegetable oils and fats in Hungary. The domestic income growth of the tested economies predominantly tends to worsen

the agri-food trade balances, as it has a tendency to increase the level of imports from the Eurozone. On the other hand, an increase in the GDP of the Eurozone is generally followed by an improvement inthe tested agri-food trade balances, as it is considered the driving force of V4 exports.

The results of the paper confirmed that the depreciation of the domestic currencies of the V4 countries against the Euro leads to an improvement in the tested agri-food trade balances. The only exceptions are T12 Tobacco and tobacco manufactures in Czechia, T42 Fixed vegetable oils and fats in Hungary, and T01 Meat and preparations in Poland. The estimated coefficients of appreciation of the local currency against the Euro predominantly correspond to theoretical assumptions as well. Almost all statistically significant coefficients indicate a worsening in theparticular trade balances after appreciation. Only T00 Live animals chiefly for food in Czechia and T11 Beverages do not hold to the stated expectations. However, the main contribution of these results is through the comparison of the magnitude of the effects of depreciation and appreciation. The difference not only in the direction, but also in the intensity, of effects of exchange rate changes can be observed in the trade balances of the following categories: T0 Food and live animals, T02 Dairy products and birds' eggs, and T41 Animal oils and fats in Czechia; T01 Meat and preparations in Hungary; T06 Sugar, sugar preparations and honey and T11 Beverages in Poland, respectively.

Furthermore, this paper proved the short-term worsening of the trade balance followed by its long-term growth after the depreciation of the domestic currency against the euro, known as the J-curve pattern, in the trade of T0 Food and live animals in Czechia, T00 Live animals chiefly for food in Czechia and Poland, and T03 Fish, crustaceans and mollusks, and preparations thereof in Poland. Hungary remained free of any form of J-curve pattern forevery trade balancetested.

This paper contributes to the empirical economics of the agri-food sector in that the effects of exchange rates have to be considered by applying appropriate methodological approaches, distinguishing between traded goods and trading partner countries. Furthermore, this paper supports the assumption that there is insufficient information in the aggregate trade data to enable the full comprehension thereof. As proven in this paper, exchange rate changes can have asymmetric effects on the trade balance as a consequence of differing reactions of traders and consumersto appreciation and depreciation. The results of this study are important primarily from the perspective of SMEs. Their hedging instruments to bring down exchange rate risk are very limited, and the estimated relationships are critical in terms of their international trade efforts.

Acknowledgement

This contribution was supported by the Internal Grant System of Silesian University in Opava [project IGS/19/2019]. Suchsupport is gratefully acknowledged.

References

Baek, J., Koo, W.W., Mulik, K. (2009), Exchange Rate Dynamics and the Bilateral Trade Balance: The Case of U.S. Agriculture, Agricultural and Resource Economics Review, 38(2), 213-228. https://doi.org/10.1017/S106828050000321X

Bahmani-Oskooee, M. (1986), Determinants of international trade flows: The case of developing countries, Journal of Development Economics, 20(1), 107-123. https://doi.org/10.1016/0304-3878(86)90007-6

Bahmani-Oskooee, M., Baek, J. (2016), Do exchange rate changes have symmetric

or asymmetric effects on the trade balance? Evidence from U.S. – Korea commodity trade, Journal of Asian Economics, 45,15-30. https://doi.org/10.1016/j.asieco.2016.06.001

Bahmani-Oskooee, M., Brooks, T. (1999), Cointegration Approach to Estimating Bilateral Trade Elasticities between U.S. and Her Trading Partners, International Economic Journal, 13, 119-128. https://doi.org/10.1080/10168739900000048

Bahmani-Oskooee, M., Fariditavana, H. (2016), Nonlinear ARDL Approach and the J-Curve Phenomenon, Open Economies Review, 27, 51-70. https://doi.org/10.1007/s11079-015-9369-5

Bahmani-Oskooee, M., Fariditavana, H. (2020), Asymmetric cointegration and the J-curve: new evidence from commodity trade between the U.S. and Canada, International Economics and Economic Policy, 17, 427-482. https://doi.org/10.1007/s10368-019-00447-0

Bahmani-Oskooee, M., Halicioglu, F., Hegerty, S.W. (2016), Mexican bilateral trade and the J-curve: An application of the nonlinear ARDL model, Economic Analysis and Policy, 50, 23-40. https://doi.org/10.1016/j.eap.2016.02.003

Bahmani-Oskooee, M., Hegerty, S. (2011), The J-curve and NAFTA: Evidence from Commodity Trade between the U.S. and Mexico. Applied Economics, 43, 1579--1593. https://doi.org/10.1080/00036840802360328

Bahmani-Oskooee, M., Kanitpong, T. (2019), Thailand-China commodity trade and exchange rate uncertainty: Asymmetric evidence from 45 industries, The Journal of Economic Asymmetries, 20, 1-17. https://doi.org/10.1016/j.jeca.2019.e00130

Bahmani-Oskooee, M., Ratha, A. (2004), The J-Curve: A Literature Review, Applied Economics, 36, 1377-1398. https://doi.org/10.1080/0003684042000201794

Bradshaw, G.W., Orden. D. (1990), Granger Causality from the Exchange Rate to Agricultural Prices and Export Sales, Western Journal of Agricultural Economics, 15(1), 100-110. https://www.jstor.org/stable/40988057

Gardner, B.L. (1981), The Governing of Agriculture. Lawrence: Regents Press of Kansas.

Godwin, D.O. (2009), Is There a J-curve in Nigerian Agricultural Sector? Agricultura tropica et subtropica, 42(1), 10-14.

Gong, L., Kinnucan, H. (2015), Effects of Recession and Dollar Weakening on the U.S. Agricultural Trade Balance, Atlanta: Southern Agricultural Economics Association.

Kiss, J. (2011), Some impacts of the EU accession on the new member states' agriculture, Eastern Journal of European Studies, 2(2), 49-60.

Łukiewska, K. (2019), Changes in the competitive position of the food industry in the European Union member states, Forum Scientiae Oeconomia, 7(2), 71--87. https://doi.org/10.23762/FSO_VOL7_NO2_5

Magee, S.P. (1973), Currency Contracts, Pass Through and Devaluation, Washington, D.C.: Brooking Papers on Economic Activity.

Mahdavi, S., Sohrabian, A. (1993), The Exchange Value of the Dollar and the US Trade Balance: An Empirical Investigation Based on Cointegration and Granger Causality Tests, The Quarterly Review of Economics and Finance, 33(4), 343-358. https://doi.org/10.1016/1062-9769(93)90003-3

Rose, A.K., Yellen, J.L. (1989), Is there a J-curve? Journal of Monetary Economics, 24,53-68. https://doi.org/10.1016/0304-3932(89)90016-0

Svatoš, M., Smutka, L. (2012), Development of Agricultural Trade and Competitiveness of the Commodity Structures of Individual Countries of the Visegrad Group. Agricultural Economics, 58(5),222–238. https://doi.org/10.17221/51/2011-AGRICECON

Szabo L., Grznár, M., Zelina, M. (2018), Agricultural performance in the V4 countries and its position in the European Union, Agricultural Economics – Czech

Republic, 64, 337-346. https://doi.org/10.17221/397/2016-AGRICECON

Szczepaniak, I. (2019), Changes in comparative advantages of the Polish food sector in world trade, Equilibrium. Quarterly Journal of Economics and Economic Policy,14(3), 463-480.https://doi.org/10.24136/eq.2019.022

Šimáková, J. (2014), Relationship between the Poland´s Trade Flows at the Commodity Level and the Zloty Exchange Rate',in: 8thInternational Scientific Conference "Business and Management 2014", Vilnius: Vilnius Gediminas Technical University, 305-312.

Šimáková, J. (2017), Assessing exchange rate sensitivity of bilateral agricultural trade for the Visegrad countries, Outlook on Agriculture, 46(3), 195-202. https://doi.org/10.1177/0030727017726207

Šimáková, J. (2018), Asymmetric effects of exchange rate changes on the foreign trade of Czechia, Eastern European Economics, 56(5), 422-437. https://doi.org/10.1080/00128775.2018.1487767

Šimáková, J., Stavárek, D. (2015), The Effect of the Exchange Rate on Industry-Level Trade Flows in Czechia, E+M Ekonomie a Management, 18, 150-165. http://dx.doi.org/10.15240/tul/001/2015-4-011

Visegrad Group (2018), Main Indicators of the Visegrád Group Countries, retrieved from:http://www.ksh.hu/docs/eng/xftp/idoszaki/ev4_fobbadatok.pdf (accessed 3 April 2020).

Yazdani, S., Shajari, S. (2009), The Impact of Macroeconomic Indicators on Agricultural Trade Balance of Iran, American Journal of Applied Sciences, 6(8), 1473-1477. https://doi.org/10.3844/ajassp.2009.1473.1477,

Yazici, M. (2006), Is There a J-Curve Effect Observable in Turkish Agricultural sector?, Journal of Central European Agriculture, 7(2), 319-322.

Jana Šimáková is a Doctor of Finance, and works as an Assistant Professor at the Department of Finance and Accounting at the School of Business Administration, Silesian University in Opava. Her professional and research orientation covers the areas of exchange rates, international trade, and international financial management. She regularly lectures on issues of international finance and monetary policy at foreign universities. She serves as a Chair of the Academic Senate. She is a member of the faculty Commission for Economic Affairs. She serves as a member of the control and advisory body in the multifunctional coworking centre for business support – Business Gate.ORCID no. https://orcid.org/0000-0002-4194-9971