INFORMATION SYSTEMS IN MANAGEMENT

Information Systems in Management (2014) Vol. 3 (3) 201−211

MODELLING OF AGRICULTURAL IMPORT DEMAND IN UKRAINE

VICTOR SHEVCHUK

Institute of Economics, Sociology and Philosophy, Cracow University of Technology

Based on the monthly data from four aggregated agricultural sectors for the 2001−2014 period, this paper investigates the determinants of demand for agricultural imports in Ukraine by using the time-varying parameter technique (the Kalman filter). The outcome suggests that the real exchange rate depreciation contributes to a lower demand for meat, fish and dairy products; vegetable oil and foodstuffs, while not affecting demand for wheat and vegetables. Domestic industrial output correlates with a higher demand for all four groups of agricultural imports. Import substitution effect of domestic agricultural production is found for three out of four groups of agricultural imports, except meat, fish and dairy products. Following an increase in international prices, there is a decrease in demand for wheat and vegetables, as well as for foodstuffs, while there is an opposite effect in demand for other groups, i.e. meat, fish and dairy products and vegetable oil.

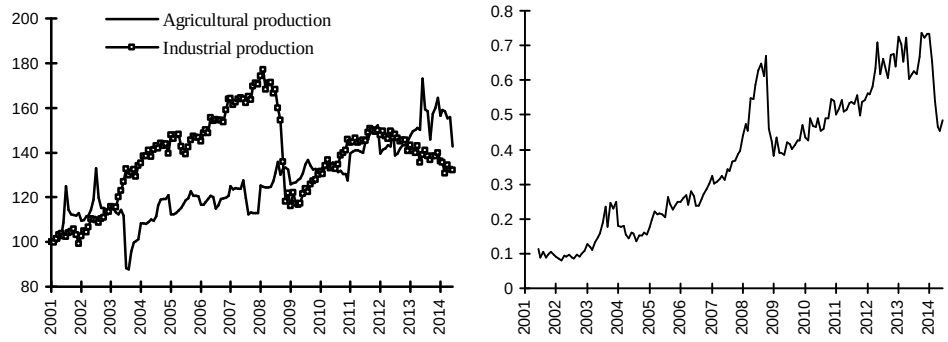
Keywords: agricultural imports, the Kalman filter, exchange rate effects, price and income effects

1. Introduction

A dynamic increase in the agricultural production in Ukraine over the last decade has not hindered demand for agricultural imports (Fig. 1). As of 2013, Ukrainian imports have more than tripled in less a decade with meat, fish and dairy products, vegetables and foodstuffs showing the fastest import growth. The value

of agricultural imports had decreased in the wake of the 2008–2009 financial crisis due to income reduction and expenditure-switching effects, then recovered in the following few years, with a new drop in demand for imports since the beginning of 2014 following the banking crisis and depreciation of the *hryvna*. Rapid reduction in the amount of agricultural imports in the first half of 2014 can be explained by a mix of income-reducing and expenditure-switching policies. The pattern of demand for agricultural imports is further complicated by the volatility of world agricultural commodity prices.

Determinants of agricultural imports are important in the assessment of trade liberalization effects, productivity growth, sectoral spillovers and resistance to international price shocks. In a wider context, estimation of import demand functions is motivated by the preoccupation of policymakers with the persistence of trade deficits, volatility in exchange rates, and the desirability of effective trade policies [13, pp. 43–53]. For practical purposes, a log-linear specification is regarded as an adequate approximation of the functional form of the import-demand equation [12, p. 5]. Most of empirical studies of import demand functions report that the price elasticities of agricultural commodities and processed goods tend to be way below unity, while income elasticities used to be above unity [10]. For informative studies on agricultural import demand functions, see [5, pp.22–44], [10], [13, pp. 43–53], [14, pp. 155‑169].



a) output (index, 2001=100); b) agricultural imports (USD bn);

Figure 1. Ukraine: selected macroeconomic indicators, 2001─2014
Source: Ukraine's State Statistical Committee

The purpose of this paper is to empirically estimate the determinants of demand for agricultural imports in Ukraine. Our main empirical result is that the real (nominal) exchange rate depreciation contributes to a lower demand for two out of four groups of agricultural imports. It is also found that domestic industrial output

contributes to a higher demand for all four groups of agricultural imports, while domestic agricultural production is of an opposite import-substitution effect.

The remainder of this paper is structured in the following way. A brief survey of theoretical and empirical issues is provided in the next section. Data and statistical model are presented in the third section. The empirical results are explained at length in the fourth section, followed by the conclusions in the fifth and final section.

2. Literature survey

It is common to assume that demand for imports is a function of domestic income and domestic prices relative to the price of import substitutes. Following Santos-Paulino [10], the import function can be written as:

$$M = \left(\frac{EP^*}{P} \right)^{\psi} Y^{\gamma}, \quad \psi < 0, \quad \gamma > 0, \tag{1}$$

where Y represents domestic income, P and P^* are domestic and foreign price levels, respectively, E is the nominal exchange rate, ψ is the price elasticity of demand for imports, and γ is the income elasticity of demand for imports. The price elasticity of demand for imports is expected to be negative, while the income elasticity is positive (it is assumed that imported agricultural commodities and products are not inferior goods).

Taking logs of equation (1) and differentiating with respect to time, the growth of imports can be presented as follows:

$$m = \psi(e + p^* - p) + \gamma y. \tag{2}$$

Assuming partial adjustment of import dynamics, the actual growth of imports is represented as:

$$m_t = \alpha_0 + \alpha_1 m_{t-1} + \psi q_t + \gamma y_t + \varepsilon_t, \tag{3}$$

where q_t is the growth in relative prices, and ε_t is the error term.

According to (3), import of agricultural goods is inertial, being dependent on its lagged value, and it is boosted by domestic income, while being depressed by the depreciation of the nominal (real) exchange rate. Empirical studies used to reveal that the price elasticities of agricultural import tend to be low, in most cases significantly below unity, while income elasticities used to exceed unity. It means that an increase in income more than proportionally affects demand for the imported agricultural goods, revealing rather high consumer preferences for these

items. On the other hand, observed weakness of relative price effects can be explained by the lack of import-substitution effects, at least in the short run.

The importance of relative prices and domestic income as determinants of demand for import of agricultural commodities and products is found for France, Italy, the Netherlands, the U.S. [13, pp. 43–53], Japan and Mexico [9, pp. 6–23], the BRIIC group of countries [1], China [14, pp. 155–169], Japan [11, pp. 585–602], Venezuela [8, pp. 351–358]. Compared to other middle-income countries, demand for agrifood products seems to be more income elastic in China, Russia and Brazil, but it is not the case in India [3, pp. 1–14]. For a sample of African countries, it is found that import demand appears to be more elastic in sectors that have relatively high levels of domestic production or exports [6]. As mentioned by Song [12], by estimation of import demand elasticities for agricultural products in both aggregated and disaggregated levels it is possible to predict the plausible effects of trade liberalization on agriculture. For South Korea, it is established that the more agricultural import is disaggregated, the higher the import demand elasticity is.

Among transformation economies, the value of price and income elasticities within the range usually reported in the literature on this subject is found for the Czech Republic [5, pp. 22–44]. A high GDP growth and the exchange rate appreciation are referred to as two main causes of the rise in Russia's agricultural imports [7, pp. 43–49]. Using aggregated data of Ukraine's agricultural trade, Ivaniuk [14] found weak evidence that agricultural exports and imports are neutral in respect to the real exchange rate. Higher wages contribute to an increase in agricultural imports. As higher agricultural production is associated with lower import growth, it is possible to argue that there is an import substitution in Ukraine's agriculture.

3. Data and statistical model

The data includes the period 2001M6:2014M6, using monthly series of the four agricultural import groups and the set of independent variables, as it is implied by the equation (1). Real industrial output is used as a proxy for the domestic total expenditure, as a more direct measure, gross domestic product, is not available at the monthly frequency. The data is available from the Ukraine's State Statistical Committee (www.ukrstat.gov.ua). The exchange rate variable is proxied by the real effective exchange rate (REER). As a measure of the international commodity price, indices of agricultural raw materials and food prices are used. Agricultural import series in constant dollars, deflated by the U.S. Consumer Price Index, were taken from the Ukraine's State Statistical Committee. All other data are obtained from the International Monetary Fund (IMF) International Financial Statistics

online database. Since production and import variables reveal a marked seasonal pattern, the series are seasonally adjusted by the X11 procedure.

Our focus on disaggregated agricultural imports is motivated mainly by possible heterogeneity in import demand elasticities across particular groups, with clear policy implications for trade and exchange rate policies to be outlined. Also, it is of interest to compare results in both disaggregated and aggregated levels, as it is obtained by Ivaniuk [14].

The stationarity of variables in the model (1) is tested using the ADF unit root test procedure (Table 1). According to the MacKinnon critical values, for all series, the null of unit root cannot be rejected at 1 and 5 percent statistical significance level for their levels, while it is the case for first differences.

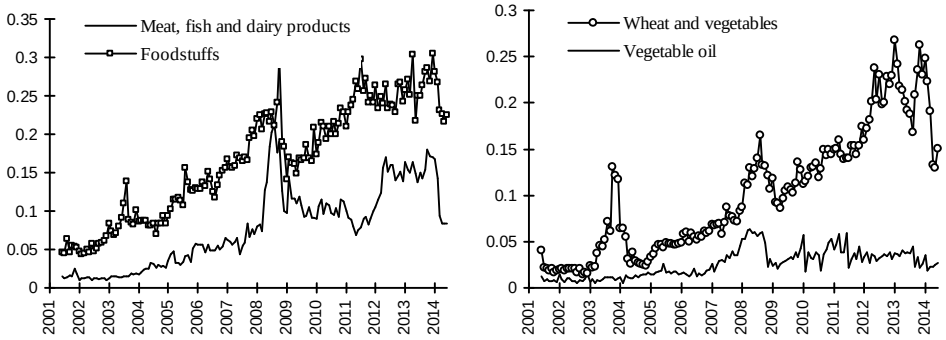


Figure 2. Ukraine: disaggregated agricultural imports (USD million), 2001–2014
Source: Ukraine's State Statistical Committee

Table 1. Unit Root Test for agricultural imports

Lags	Agricultural import groups							
	Meat, fish and dairy products (I)		Wheat and vegetables (II)		Vegetable oil (III)		Foodstuffs (IV)	
	L	FD	L	FD	L	FD	L	FD
3	–1,54	–6,76*	–2,44	–5,16*	–1,93	–8,14*	–2,06	–7,73*
6	–1,38	–5,95*	–2,43	–4,62*	–1,94	–5,04*	–2,02	–4,80*
9	–1,89	–3,58*	–2,05	–4,94*	–1,92	–4,89*	–2,66	–3,79*
12	–2,21	–3,32**	–1,41	–4,88*	–1,75	–3,44**	–2,45	–4,11*
15	–2,16	–3,34**	–1,01	–4,61*	–2,01	–3,81*	–2,53***	–3,92*

Note: * null hypothesis of a unit root can be rejected at 1 percent level of confidence (** at 5 percent level of confidence, *** at 10 percent level of confidence); L and FD stand for levels and first differences, respectively. Source: own calculations.

As income and price elasticities of export demand can change over time (Abler 2010), the choice of time-varying parameters (TVP) technique which allows the coefficients to vary over time seems to be reasonable, in addition to more traditional estimation methods. In order to analyse whether some significant variation in the estimates of coefficients does occur (especially, in the context of significant world price instability since the middle of last decade), the TVP estimator (the Kalman filter) is used. For this purpose, statistical model can be defined in a state space formulation:

$$X_{i,t} = \mathbf{Y}_t \beta_t + \varepsilon_t, \quad (4)$$

$$\beta_t = \beta_{t-1} + \xi_t, \quad (5)$$

where equations (4) and (5) are respectively the measurement equation and transition equation.

The vector of time-varying coefficients β_t is formed through a stochastic generating process, with priors β_0. For the purposes of our study, the recursive procedure is used. Besides the magnitude of a particular effect, it is possible to trace whether any significant variation in the estimates of the coefficients occurs.

The vector of the determinants of agricultural imports $\mathbf{Y}_t$ includes the real effective exchange rate (REER), industrial and agricultural output, international agricultural raw materials and food prices. In respect to the Ukraine's economy, price and income responsiveness in demand for agricultural imports might be expected to reveal some instability in the wake of the 2008–2009 financial crisis, which had been marked by a steep depreciation of the *hryvna*. Another large exchange rate depreciation has occurred in the spring of 2014, with further weakening of the currency to take place in the following few months.

4. Empirical results and discussion

Our TVP estimates are reported in Fig. 3–6 (the estimates were obtained with EViews 6.1 program). Autoregressive coefficients are negative for all four groups of agricultural imports, with a rather stable pattern over last few years. The magnitude of the autoregressive coefficient is somewhat higher for import of vegetable oil (Fig. 5) and foodstuffs (Fig. 6). For meat, fish and dairy products (Fig. 3), there is a gradual decrease in the value of autoregressive coefficient since 2007. Also, a change in the trend of the coefficient on the lagged value of import of foodstuffs since 2009 can be mentioned. As all autoregressive coefficients are negative (for import of meat, fish and dairy products it is observed on a statistically significant level since 2008), it means that there is a correction of the amount of

agricultural imports, with no sign of inertial behaviour, and this constraint is most bounding for vegetable oil imports.

Depreciation of the REER contributes to a lower demand for meat, fish and dairy products (Fig. 3) and foodstuffs (Fig. 6) since 2009, while being neutral in respect to imports of these two groups for the previous years. The opposite developments are identified for the import of wheat and vegetables (Fig. 4), which is not affected by relative prices over last few years though demonstrating a negative effect of the REER depreciation over the 2004–2008 period. A similar pattern of time-varying coefficients is demonstrated by the estimates of REER effects on the import of vegetable oil, but in this case a weak negative impact is observed during the 2006–2010 period (Fig. 5). Similar results are obtained by using the nominal effective exchange rate (NEER) as an alternative to the REER. In general, our results do not contradict those ones obtained by Ivaniuk [4] for aggregated agricultural imports, as the price sensitivity of demand for imported agricultural goods does not seem to be strong enough on the whole. Except vegetable oil, there is a clear structural break in the price-related (expenditure-switching) demand for import of other three groups of agricultural imports around 2008, which can be regarded in connection with the financial crisis that struck the Ukraine's economy in the wake of such unfavourable external shocks as stagnation

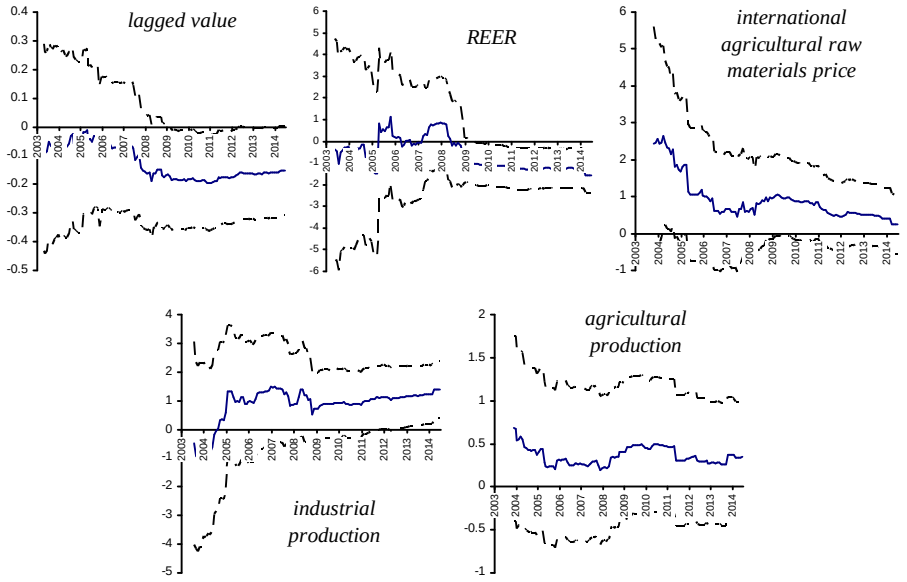


Figure 3. Determinants of demand for import of meat, fish and dairy products
Note: the solid line is the point estimate here and hereafter, while the dotted lines represent a two-standard error confidence band around this point estimate.
Source: own calculations

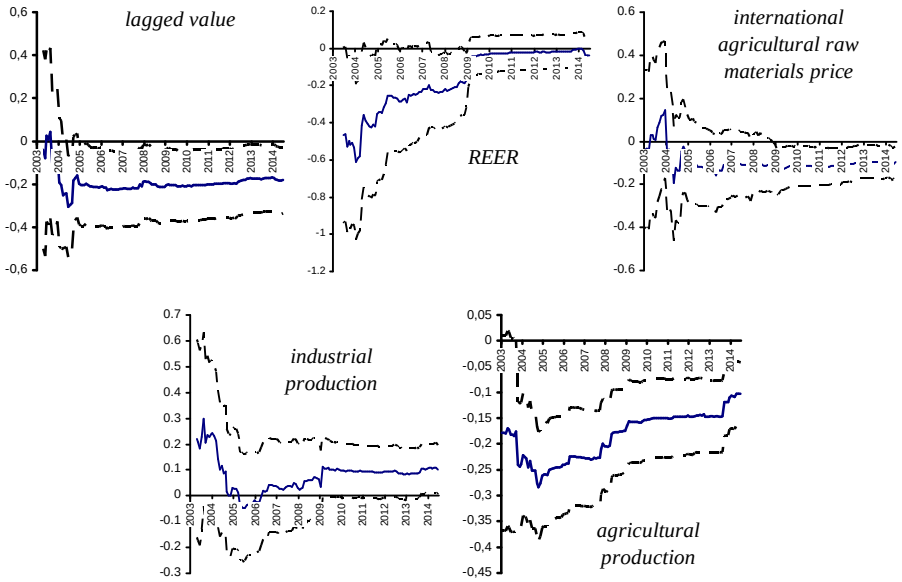


Figure 4. Determinants of demand for import of wheat and vegetables
Source: own calculations

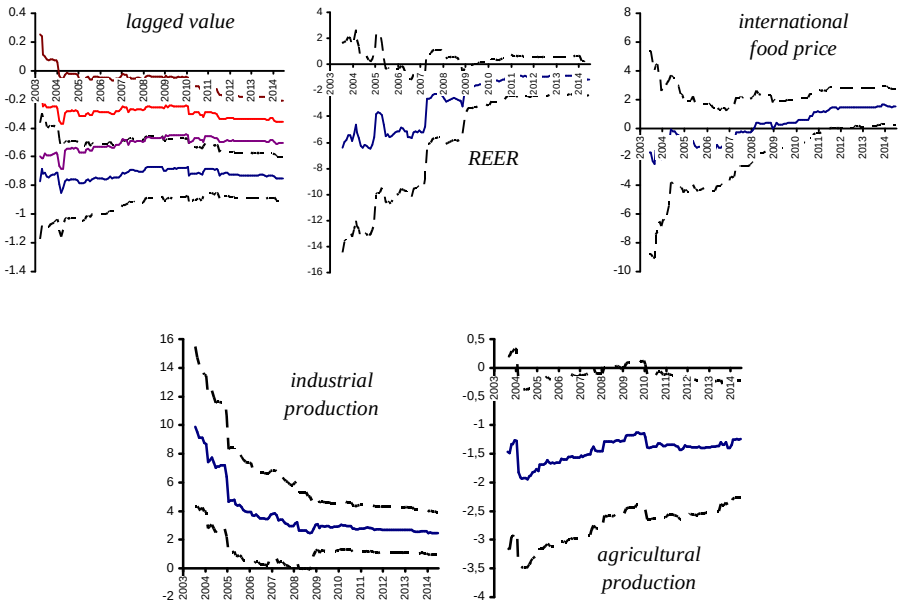


Figure 5. Determinants of demand for import of vegetable oil
Source: own calculations

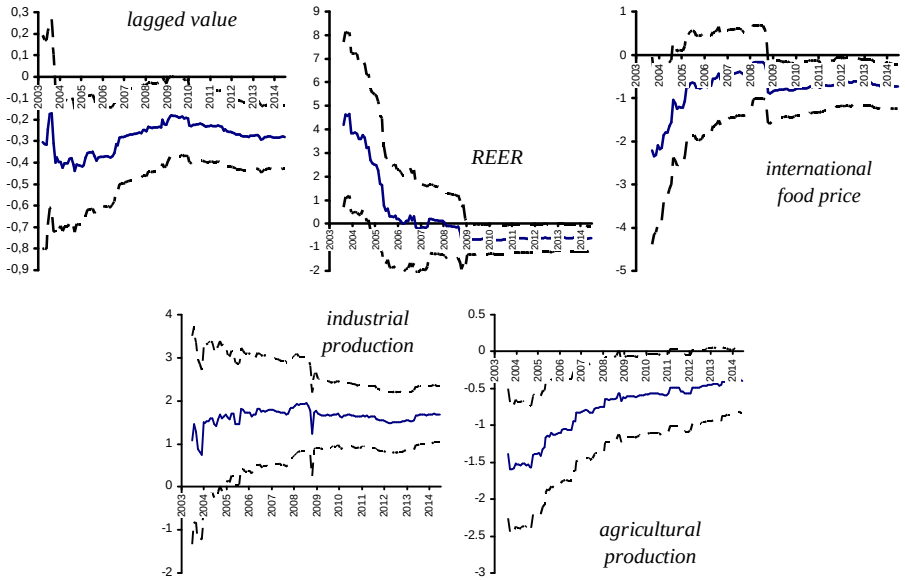


Figure 6. Determinants of demand for import of foodstuffs
Source: own calculations

of demand for traditional export of steel and chemical products and 'sudden stop' in capital inflows.

International price effects are quite heterogeneous. For two groups (meat, fish and dairy products, as well as vegetable oil), there is an increase in the value of imports following an increase in the international price, while the opposite effect is observed for other two groups (wheat and vegetables, foodstuffs). Rapid increase in values of (negative) international price sensitivity for foodstuffs since 2008 can be attributed to the growing food-processing industry in Ukraine and its side-effects on the demand for import of processed goods.

Domestic income, as measured by the index of industrial production, is a factor behind higher demand for agricultural imports. The magnitude of this effect is weaker for wheat and vegetables, with a structural break in 2008. Income-induced demand for vegetable oil and foodstuffs has been quite stable over the post-crisis period, while a weak upward trend is observed for meat, fish and dairy products.

Except meat, fish and dairy products, there is a similar declining trend in the values of domestic agricultural output effects. It can be explained by import substitution in the Ukraine's agricultural sector, but this feature has been weakening over last decade. Although no particular structural breaks have been noticed in the link between domestic agricultural output and demand for imports of vegetable oil and foodstuffs, there is a sign of rapid reduction in the import substitution for wheat and vegetables since the end of 2013.

5. Conclusions

Using the time-varying parameter technique (the Kalman filter), determinants of Ukraine's agricultural imports are estimated. It is established that the real (nominal) exchange rate depreciation contributes to a lower demand for meat, fish and dairy products (group I), as well as for foodstuffs (group IV), while not affecting demand for wheat and vegetables (group II) and vegetable oil (group III) imports. Except vegetable oil, there is a clear structural break for other three groups of agricultural imports around 2008, which suggests a causal link to the developments of the 2008–2009 world financial crisis. Following an increase in international prices, there is a decrease in demand for wheat and vegetables imports, as well as for foodstuffs (since 2008), while an opposite effect in demand for two other groups of agricultural imports, i.e. meat, fish and dairy products and vegetable oil, is observed. It is possible to argue that the realities of 2008–2009 financial crisis had created incentives for the Ukraine's food-processing industry, with an import substitution effects in the demand for processed goods to follow. As expected, domestic industrial output correlates with a higher demand for all four groups of agricultural imports. Import substitution effect of domestic agricultural production is found for three out of four groups, except meat, fish and dairy products. However, there is a declining trend in the values of coefficients on agricultural production, implying weakening of import substitution over time.

REFERENCES

[1] Abler D. (2010) *Demand Growth in Developing Countries*, OECD Food, Agriculture and Fisheries Papers, no. 29, OECD Publishing, Paris.

[2] Erjavec E., Gambelli D., Turk J. (1998) *The supply response and structural breaks in Slovene agriculture*, in: Agricultural price reform under transition in Bulgaria, Romania, and Slovenia, Mergos G. (ed.), Options Méditerranéennes: Série B. Etudes et Recherches, no. 22, CIHEAM, Chania, pp. 132–146.

[3] Haq Z., Meilke K. (2010), *Do the BRICs and Emerging Markets Differ in Their Agrifood Imports?*, Journal of Agricultural Economics, vol. 61, no. 1, pp. 1–14.

[4] Ivaniuk U. (2014) *Determinants of Ukraine's Agricultural Trade: The Time-Varying Estimates*, World Applied Sciences Journal, vol. 30, no. 11, pp. 1593–1598.

[5] Janda K., McCluskey G., Rausser G. (2000), *Food Import Demand in the Czech Republic*, Journal of Agricultural Economics, vol. 51, no. 1, pp. 22–44.

[6] Jones C. (2008) *Aggregate and Sector Import Price Elasticities for a Sample of African Countries*, CREDIT Research Paper No. 08/03, University of Nottingham: Centre for Research in Economic Development and International Trade, Nottingham.

[7] Liefert W., Liefert O., Shane M. (2010) *Russia's Agricultural Imports: Will the High Growth of the 2000s Continue?*, EuroChoices, vol. 9, no. 3, pp. 43–49.

[8] Melo O., Vogt M. (1984) *Determinants of the demand for imports of Venezuela*, Journal of Development Economics, vol. 14, pp. 351–358.

[9] Orden D. (2000) *Exchange Rate Effects on Agricultural Trade and Trade Relations, Policy Harmonization and Adjustment in the North American Agricultural and Food Industry*, Proceedings of the 5th Agricultural and Food Policy System Information Workshop (Acapulco, Mexico, 4-5 March 1999), pp. 6–23.

[10] Santos-Paulino A. (2002) *The effects of trade liberalization on imports in selected developing countries*, World Development, vol. 30, no. 6, pp. 959–974.

[11] Schmitz T., Seale J. (2002) *Import Demand for Disaggregate Fresh Fruits in Japan*, Journal of Agricultural and Applied Economics, vol. 34, no. 3, pp. 585–602.

[12] Song W. (2006) *Import Demand Elasticities for Agricultural Products in Korea*, http://www.apeaweb.org/confer/sea06/papers/song.pdf

[13] Tsionas E., Christopoulos D. (2004) *International Evidence on Import Demand*, Empirica, vol. 31, no. 1, pp. 43–53.

[14] Zhuang R., Abbott P. (2007) *Price Elasticities of Key Agricultural Commodities in China***,** China Economic Review, vol. 18, no. 2, pp. 155–169.