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The economic effect of Russia imposing a food embargo on the European Union with Hungary as an example

In the summer of 2014, Russia imposed a food embargo on most agricultural products from countries that supported the anti-Russian sanctions. In this study we use vector autoregression and neural network modelling to assess the effect of the embargo on the bilateral trade relations between the European Union (EU) (using the example of Hungary as an EU Member State) and Russia. In particular, the changes in the dynamics of Hungary's aggregate agricultural exports in response to the shock of the embargo, as well as to Russia's imports of products banned under the embargo, are analysed. The work also looks at the effectiveness of the introduction of the embargo with the aim of implementing import substitution policies and supporting domestic producers. Our results show the ineffectiveness of the Russian import substitution policy and the negative effects on both Russian and Hungarian parties.

Keywords: Russian embargo, Hungarian economy, shock analysis, artificial neural networks, vector autoregression

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Introduction

On 7 August 2014, Russia introduced an embargo on a number of agricultural products from Australia, Canada, the European Union (EU), Norway and the United States (US)[2]. The list of banned products included all meat, milk and dairy products, fruits, vegetables, fish and crustaceans. The embargo was introduced as a response to economic, technological and financial sanctions against Russia.

There is no agreed opinion among economists regarding the effect of imposing sanctions on the optimal allocation of resources, as well as the magnitude of losses incurred by both the exporters and the importers of products falling under the embargo. Moreover, a food embargo can have a significant effect on the distribution channels of both the country that imposes sanctions and the countries against which these measures are directed (McGillivray and Smith, 2005; Kaempfer and Lowenberg, 2007). In this case, the final impact on prices and the number of products produced will depend on the demand for imports and the elasticity of supply, the production volume affected by the restrictions, and the degree of substitution of imports by domestic production and the possibilities of imports from other sources (Caruso, 2003; Marinov, 2005; Eyler, 2007).

The literature on economic sanctions shows that they can be ineffective tools to achieve the desired goals since they have a limited effect on the welfare of the country on which sanctions are imposed. This becomes especially notable when an import embargo is imposed since the exporting country can redirect exports to other countries effectively, or resell products through countries that did not fall under these sanctions. In particular, the EU, despite the reduction in exports of agricultural commodities, food and beverages to Russia by 2 per cent in value terms in 2016, has increased food exports to China, Japan, Switzerland and the US[3].

It should also be noted that, according to some authors (for example, Kutlina-Dimitrova, 2015), the countermeasures introduced by Russia have had a rather ambivalent effect on the EU economy. In particular, the embargo led to a decrease of only 0.02 per cent in total EU exports, which indicates a strong mitigating effect of the EU internal market. At the same time, the general changes in exports are strongly limited by the boundaries of individual countries and products. Dairy products, and vegetables and fruits are the sectors in which the EU's exports experienced a significant decline, in particular from Lithuania, Finland and Poland. In the short term, the EU can replace about one fifth of the lost trade in banned goods with Russia by expanding exports to other markets, particularly to Asia. Although Russia can replace the imports of certain banned products, alternative sources are limited. Regions with increasing exports to Russia include Turkey and the Commonwealth of Independent States (CIS) countries (dairy products, and fruits and vegetables), and South America (meat) (Van Acoleyen, 2015; Boulanger *et al.*, 2016; Firanchuk, 2017).

For Russia, the embargo led to a change in the commodity and geographical structure of its imports. The ban on the importing of certain food products led to a sharp restriction of competition in the Russian market, which in turn led to an increase in the prices of substitute products for sanctioned products. There are two effects of the embargo on the domestic Russian market: consumer and production. The consumer effect was expressed in the decrease in the level of the welfare of citizens, due to the rise in prices. The production effect is the result of the growth of profits of agricultural producers, caused by the restriction of import competition.

The imposed prohibitions enforced the search for alternative import channels for products through countries that were not on the ban list. For individual goods, for instance, cheese, importing of products continues to be carried out under the guise of a de-lactose. At the same time, the quality of the products produced, due to a ban on imports of milk,

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2 Decree No. 778 of the Government of the Russian Federation of 7 August 2014 'On Measures for the Implementation of the Decrees of the President of the Russian Federation of 6 August 2014 No. 560, 24 June 2015 No. 320 and 30 June 2016 No. 305' (Collected Legislation of the Russian Federation, 2014, No. 32, Article 4543, 2015, No. 26, Article 3913, No. 33, Article 4856, No. 39, Article 5402, 2016, No. 10, Article 1426, No. 23, Article 3320, No. 28, Article 4733, No. 38, Article 5546, No. 44, Article 6142).

3 See http://ec.europa.eu/trade/policy/eu-position-in-world-trade/statistics/ and https://www.vedomosti.ru/business/news/2017/01/18/673513-evrosoyuz-eksport-prodovolstviya.

has significantly deteriorated, which has led to the spread of falsified and counterfeit products.

Ponomareva and Magomedov (2017) assessed consumer losses as a measure of compensated variation in income when Russia imposed an embargo on certain types of goods from the EU and the US. Estimates were made on the basis of a comparison of actual and forecasted price indices for goods. It was assumed that, in the absence of a product embargo, the dynamics of prices for consumer goods can be described by the standard ARIMA model (Contreras *et al.*, 2003; Al-Zeaud, 2011; Uko and Nkoro, 2012). To take into account the peculiarities of certain types of goods, they were divided into groups of analogue goods to sanctioned ones and non-sanctioned goods. The results of the analysis showed negative consequences for both the consumer and the domestic producer. The assessment of consumer losses which resulted from the embargo showed that, in the absence of restrictions, the prices of the sanctioned goods would be lower than current values by about 3 per cent, and the prices of the non-sanctioned goods by 2.9 per cent. The monetary losses of consumers in annual terms for the period 2014-2016 amount to RUR 4,380 per year per consumer. From the manufacturer's point of view, the greatest benefit of imposing sanctions came in the first 6-12 months; the increase in prices and the drop in consumption volumes are the result of a reduction in commodity markets. This fact confirms the negative effect of the introduction of Russia's retaliatory sanctions for the manufacturer: the imposition of an embargo gives advantages to producers only in the short term, thereby having a positive effect on import substitution, but in the long term the effect of the embargo on market indicators is reduced.

Our paper adopts a novel approach in analysing the dynamics of agricultural trade, concerning the effect of the embargo. The research published in the literature has been of limited scope, being mostly in the form of depictive statistics about the embargo or estimations of the geopolitical risks (see Bond *et al*., 2015). In contrast to papers by, for example, Antimiani *et al*. (2014) and Kutlina-Dimitrova (2015), who modelled simulations of calibration of the prohibitive tariff rates, with results on the equilibrium, our paper assesses the effects of export/import shocks. The novelty of our research is how the dynamics of possible exports/ imports can be analysed, with propositions to that case, if the embargo had not been introduced.

We study the effect of introducing Russia's embargo on the EU using the example of Hungary. According to Hungarian Central Statistical Office data, Russia has been the fifth to the twelfth largest trading partner of Hungary during the period of our research. The country's share of trade peaked eighteen months before the start of the embargo.[4,5]

Within the framework of the study, a vector autoregressive model was constructed to analyse the dynamics of Hungary's agricultural exports before and after the introduction of the embargo. We also employed artificial neural network for the modelling of the scenario, in which no embargo would be imposed. The main objectives of the study were the following: (a) analysis of the impact of the Russian embargo on Hungary's total exports; (b) analysis of the dynamics of Russian imports of agricultural products after the introduction of the product embargo; and (c) analysis of the effectiveness of import substitution policies.

Methodology

Data sets

As a methodological basis for the embargo analysis, we employed the indicators listed in Table 1. These indicators were implemented for the groups of goods listed in Table 2. By the targeting of the Russian import substitution policy, the most relevant goods were chosen. Consequently, this scope of (Hungarian exports/Russian imports) goods reflects the most significant changes in export/import relations.

Table 1: Indicators used for the embargo analysis.

Hungary	Russia
• Statistics of total exports from August 2014 to December 2015; • Neural network forecasts (the statistics for the neural network learning are from January 2011 to July 2014), which allows analysing the dynamics of possible exports, provided that the embargo would not have been introduced; • Responses to the export shock (we use the statistics of Hungary's total exports and exports to Russia, it is important in terms of the analysis of the results to note that exports to Russia are included in total exports).	• Statistics of imports from CIS countries from August 2014 to December 2015; • Statistics of production of sanctioned goods from 2011 to 2016 (only yearly statistics are available); • Neural network forecasts (the statistics for the neural network learning are from January 2011 to July 2014); • Reaction to the import shock (there are significant differences from Hungary, as the data on the CIS and on the import from the other world are presented separately).

Data sources: Hungary: Hungarian Central Statistical Office (http://statinfo.ksh.hu/Statinfo/); Russia: Russian Federal Service of State Statistics (http://www.gks.ru/) Both these data providers apply the Standard International Trade Classification

Table 2: Groups of Hungarian export goods and Russian import goods used in the analysis.

Hungarian export goods	Russian import goods
Meat • ts1: Pork, fresh, chilled or frozen; • ts2: Meat and edible offal of poultry of heading, fresh, chilled or frozen; • ts3: Salted meat, in brine, dried or smoked; • ts4: Sausages and similar meat products, meat offal or blood; Ready-made food products made on their basis. ***Fruits and vegetables*** • ts5: Vegetables, edible root vegetables and tubers (excluding seed potatoes, onion, maize sugar for seeding, peas for sowing); • ts6: Fruits and nuts. ***Cheese*** • ts7: Food or ready-made products manufactured using cheese manufacturing techniques and containing 1.5 per cent by weight or more of milk fat.	***Meat*** • ts1: Fresh and frozen meat; • ts2: Fresh and frozen poultry. ***Fish*** • ts3: Fresh and frozen fish. ***Milk and dairy products*** • ts4: Milk and cream; • ts5: Butter and other dairy fats. ***Fruits*** • ts6: Citrus fruits.

4 2011: 2.8 per cent, 2012: 5.7 per cent, 2013: 3.4 per cent, 2014: 3 per cent, 2015: 2.3 per cent.

5 The importance of trade is even higher for some agricultural goods. For example, in 2013 Russia took 12 per cent of Hungary's pork exports, being the fourth most important destination for the country, while Hungary supplied 2.5 per cent of all Russian pork imports, which ranked the country in twelfth place.

Vector autoregression

Vector autoregression (VAR) has the following form:

$$y_t = a_0 + A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + \varepsilon_t = a_0 + \sum_{n=1}^{p} A_n y_{t-n} + \varepsilon_t \quad (1)$$

where a_0: constant vector; $A_1 \ldots A_p$: matrices of model parameters (autoregression coefficients); y_t: the vector of time series; y_{t-p}: the vector of previous values of time series; and ε_t: the vector of random errors.

Model fitting

We used Akaike Information Criterion (AIC) (Akaike, 1973) and Bayesian Information Criterion (BIC) (Adkison *et al.*, 1996) to determine the optimal lag order in terms of model accuracy. We chose the minimal lag from both criteria which is 2. We applied root mean squared error for estimation of the model. After fitting VAR, we were able to provide shock analysis. For this purpose, we employed impulse response function analysis (Pesaran and Shin, 1998), we used exports to Russia as a shock for Hungary and imports from sanctioned countries as a shock for Russia. The value of the shock is one standard deviation of time series.

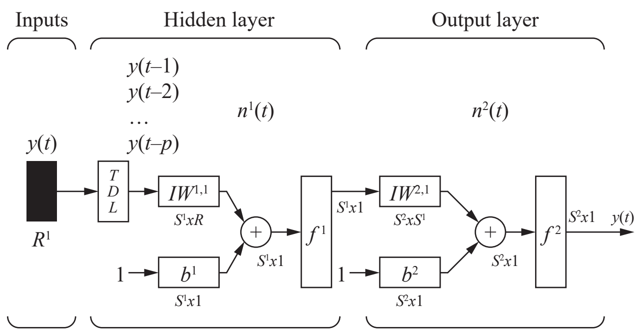

Figure 1: Nonlinear autoregressive neural network architecture.
Source: Leontaritis and Billings (1985)

Neural network

As a neural network, we employed nonlinear autoregressive neural network (NAR) (Leontaritis and Billings, 1985; Figure 1). NAR is defined by the following expression:

$$y_t = F(y_{t-1}, y_{t-2}, \ldots, y_{t-p}) + \varepsilon_t \quad (2)$$

where $F(\cdot)$: nonlinear function, approximated by neural network; y_t: the vector of time series; y_{t-p}: the vector of previous values of time series; and ε_t: the vector of random errors.

In order to train the neural network, we divided the raw data into three groups: Train: 70 per cent; validation: 15 per cent; and test: 15 per cent. We chose a mean squared error as a parameter for neural network performance estimation and levenberg-marquardt algorithm for training. All the data were standardised before the neural network processing.

Results

From the modelling, we provided an analysis of the impact of the embargo shock on the change in the dynamics of Hungary's aggregate exports to all countries for agricultural products banned from import into Russia. In addition, we assessed the changes in the dynamics of the production of banned agricultural products and, as a consequence, the evaluation of the effectiveness of import substitution policy.

Analysis of Hungarian exports

To a large extent, the embargo affected the change in Hungary's total exports of meat, as well as fruits and vegetables (Figures 2 and 3). Among meat products the embargo has had the most negative impact on sausage exports. The reaction to the shock of the embargo showed a 5 per cent drop in Hungary's total exports to all countries. At the same time, the stabilisation of exports occurred only five months after the shock, which exceeds the average value for the rest of meat products for a month.

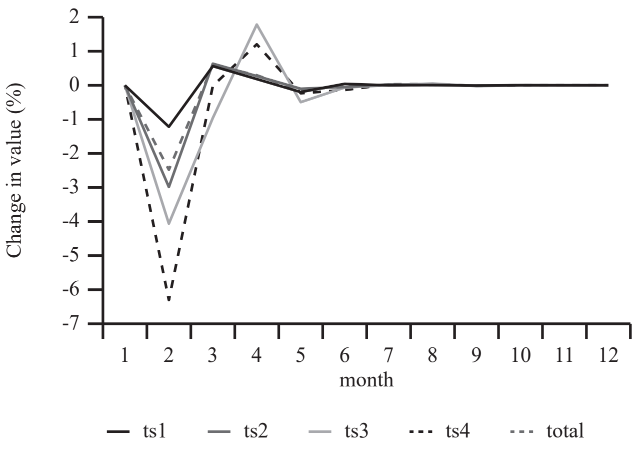

Figure 2: Monthly percentage change in the value of meat exports from Hungary following the imposition of the Russian embargo, 1 August 2014 to 1 July 2015.
See Table 2 for groups of goods
Source: own data

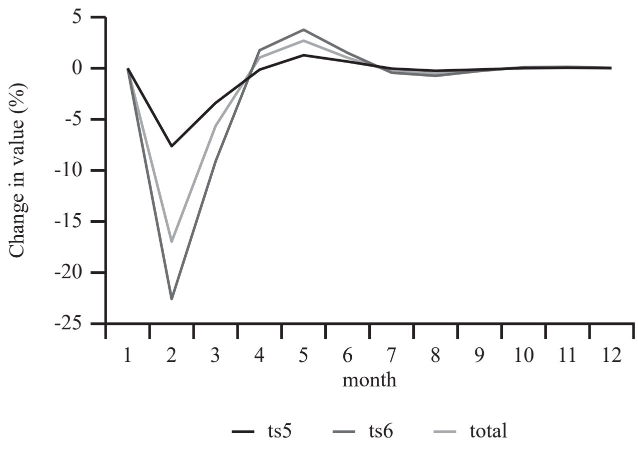

Figure 3: Monthly percentage change in the value of fruit and vegetable exports from Hungary following the imposition of the Russian embargo, 1 August 2014 to 1 July 2015.
See Table 2 for groups of goods
Source: own data

The forecast of the NAR model showed an improvement in the exports of meat products over the same period of time (Table 3). This can be explained by the fact that the NAR forecast was built on the basis of normal economic relations between the two countries, i.e. the 'no embargo' scenario. At the same time, the real dynamics of Hungary's total exports of meat products remained on average unchanged. Thus, the agricultural embargo led to a reduction of the possible positive dynamics of exports which, ultimately, reflects the absence of changes in the real dynamics of the total exports of meat products by Hungary.

The dynamics of Hungary's exports of vegetables and fruits are also strongly negative. The impulse responses from this analysis reveal the ineffectiveness of the redistribution of banned goods intended for export from Hungary to Russia. In particular, as regards fruit exports, the reaction of the model to shock is an 18 per cent drop in export dynamics. Stabilisation comes seven months after the introduction of the embargo. The NAR shows mixed forecasted dynamics over a period of six months after the introduction of the embargo in fruit and positive dynamics in vegetables. The

Table 3: Nonlinear autoregressive neural network forecasting for Hungarian exports, August-December 2014 (per cent).

	Meat	Fruits	Vegetables	Cheese
August	3	7	4	-1
September	10	6	2	-3
October	8	-1	-3	5
November	-8	-10	9	-1
December	2	3	5	2

Source: own data

real dynamics of Hungary's exports to all countries over the same period is negative. Comparison of the real dynamics with the dynamics of both models showed that exports of fruits and vegetables were the most sensitive to the embargo. At the same time, Hungary failed effectively to redirect the former Russian exports of fruits and vegetables to other countries, which eventually led to a coincidence of the results of embargo shock modelling and real export dynamics.

Concerning cheese exports, the models did not show any significant change; nonetheless, the results correlate with the real dynamics (Figure 4). We conclude that cheese is not an indicative parameter for the analysis of the embargo effect since there are no significant movements from all the models and in real dynamics.

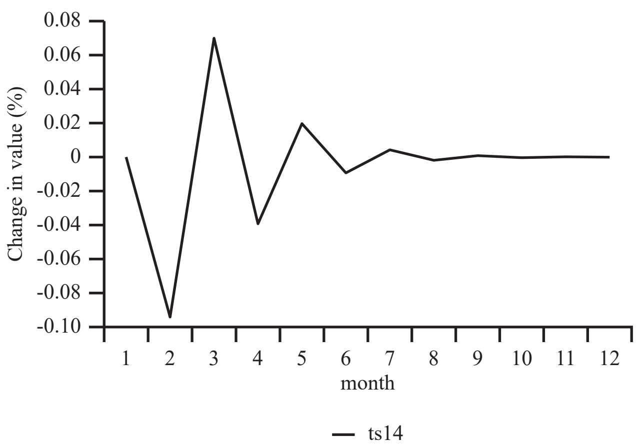

Figure 4: Monthly percentage change in the value of cheese exports from Hungary following the imposition of the Russian embargo, 1 August 2014 to 1 July 2015.
Source: own data

Analysis of Russian imports and production

The shock of the embargo has led to a regional transformation of import flows. In this case, for different groups of goods, substitution is not homogenous. In particular, the impulse responses show that the imposition of the embargo causes a sharp increase in imports of meat products from the CIS (Figure 5), but a sharp drop in imports is observed for fish and citrus fruits (Figure 6). In particular, imports of citrus fruits fell by 11 per cent, although the dynamics of the decline in imports is significantly reduced, it can be viewed as impossible to substitute imports of this agricultural product with supplies from the CIS countries.

The forecast of the NAR also confirms the reorientation of Russia's imports to the CIS countries after the imposition

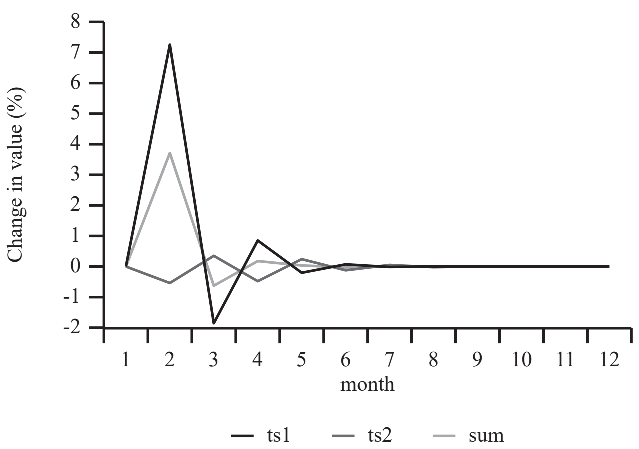

Figure 5: Monthly percentage change in the value of Russian meat imports from CIS countries following the imposition of the Russian embargo, 1 August 2014 to 1 July 2015.
See Table 2 for groups of goods
Source: own data

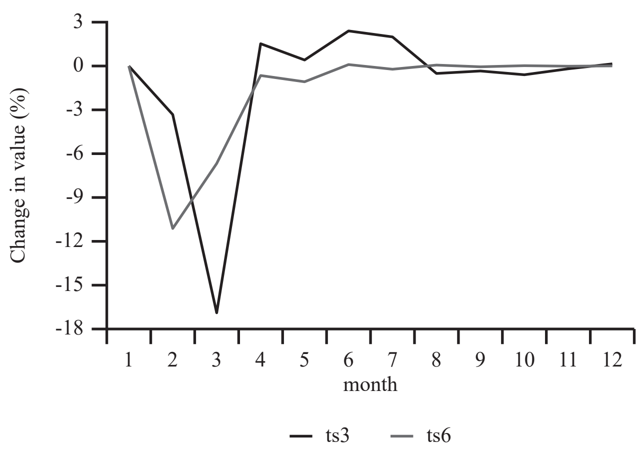

Figure 6: Monthly percentage change in the value of Russian citrus fruit imports from CIS countries following the imposition of the Russian embargo, 1 August 2014 to 1 July 2015.
See Table 2 for groups of goods
Source: own data

of the embargo. The decline in imports from the whole world leads to a simultaneous increase in imports from the CIS countries (Table 4). Nevertheless, the real dynamics for the period of September-December 2014 confirm the model data only in terms of fish imports. In particular, there was a 17 per cent decrease in fish imports during the first six months of the embargo. The most significant decrease in real dynamics, 34 per cent, occurred for cattle meat. As regards imports of vegetables and fruits (Figure 6), which for the same period fell by no more than 15 per cent, Russia succeeded in coping with the consequences of the embargo relatively effectively.

Thus, the introduction of the food embargo did not change significantly the annual indicators of agricultural production. (Table 5). This shows that the effectiveness of the import substitution policy is limited and brings no significant positive effect of the embargo on domestic producers in a long-term perspective.

Table 4: Nonlinear autoregressive neural network forecasting for Russian imports from all countries and from CIS, August-December 2014 (per cent).

	All countries				CIS			
	Meat	Fish	Milk	Fruits	Meat	Fish	Milk	Fruits
August	3	-5	0	-4	-4	10	5	-2
September	10	-10	-7	0	5	3	15	-6
October	8	1	3	-1	18	2	1	13
November	-8	-2	-2	-8	3	-3	-2	-7
December	2	-4	7	-17	1	1	10	-11

Source: own data

Table 5: Agricultural production growth in Russia, 2011-2015, per cent.

	2011	2012	2013	2014	2015
Meat	4	6	5	6	4
Fish	-1	0	-4	1	0
Milk	55	-10	2	4	7
Vegetables	21	0	0	5	4
Fruits	17	6	10	2	-3

Source: own data

Discussion

In this paper, an econometric analysis of the food embargo imposed by Russia since August 2014 was conducted. The analysis was carried out using the vector autoregressive model, which allowed the effect of the product embargo on the dynamics of Hungary's aggregate agricultural exports to be simulated and the responses of export-dynamics to the embargo shock to be analysed. The NAR was implemented to assess the forecast of the dynamics of Hungary's exports and imports of Russia in the absence of an embargo and in the normal bilateral trade turnover of the countries.

The study examines the influence of the embargo policy on the development of the Russian agricultural sector. The results confirm the negative effect of the introduction of the embargo for both countries, in particular, for most of the general exports. Hungary has failed to replace exports to Russia effectively. In turn, Russia has managed to replace the supply of agricultural products effectively only for vegetables and fruits, reorienting imports to the CIS countries, but has failed in other directions. Thus, contrary to the opinion that the Russian embargo has had an insignificant impact on the EU economy and the changes in exports of certain countries are very limited (Kutlina-Dimitrova, 2015), our results show that the embargo has had a negative effect on Hungary. However, the effect of the embargo on Russia is negative too, because of the limited possibilities of redirection of the imports as shown by Van Acoleyen (2015). Also, the results of the modelling reveal the ineffectiveness of the Russian import substitution policy, aimed to maintain domestic producers. Thus, it is minus-minus game, which brings no profit for both parties of international trade.

The production of domestic agricultural products in Russia, despite the introduction of the food embargo, has remained predominantly at the level of 2012-2013, continuing the trend to reduce production growth rates after the active overheating of the food market in 2011. Thus, the advantage for the domestic producer was exhausted in the first six months of import stabilisation after the embargo was imposed. Thereafter, the growth in prices for domestic and imported products and, as a consequence, the decline in the level of the welfare of people caused a reduction in the demand for domestic agricultural products.

Our work emphasises the problem of assessment of embargo policy effectiveness, which is reflected in the methodology. However, most existing models employ principles which were initially developed for scenario analysis and could not provide any estimation of policy effectiveness. Thus, the proposed model includes the following output signals for the analysis: statistics of imports/exports, statistics of production of banned goods, neural network forecasts, and responses to the shock from the food ban. We would like to extend the implementation of the neural network forecasts and response to shock from the VAR model. Neural network forecasts allowed the dynamics of possible exports/imports to be analysed as if the embargo had not been introduced. Responses to the shock illustrated the course of events if there was no regulation targeted to stabilise the situation. This approach employs mathematical modelling for the analysis itself, but not for the hypotheses confirmation, thus the model allows deeper analysis of the effectiveness of the embargo policy.

The Russian embargo has caused great concern for the Hungarian dairy and pork industry. It has pushed down the purchase prices for farms, causing them severe operating losses. This deterioration of profitability has contributed to delays in planned investments and capital expenditure. As our results show, the shock has been asymmetric: the Hungarian economy (with its smaller market size and absorption capacity) has suffered for more than the Russian economy since the introduction of the embargo. The ban runs until 31 December 2018, and a major policy question is what kind of fiscal initiatives are to be introduced in the meantime in favour of Hungarian agricultural producers (e.g. assistance with exports to Russia). This question goes beyond the scope of our study, and can be a subject of further research.

Concerning the limitations of the study and possible development of this research, the proposed model is based on machine learning techniques, which are rather universal. On the one hand, it gives significant benefits in model estimation and specification, since it is unstructured by its nature and can be adjusted to any data patterns. On the other hand, it brings limitations to the research, because such models serve as 'black boxes' and do not provide the ability for analysis of intermediate states of cash flows and goods.

In the continuation of this work, it would be interesting to develop a model with a strict structure, such as DSGE or system dynamic models. We would like to implement this model for the scenario analysis and use artificial neural networks for the probability estimation of each scenario. Thus, we will obtain a model which can provide detailed, structural analysis.

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