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## POLISH AGRI-FOOD TRADE WITH NON-EU COUNTRIES – A GRAVITY MODEL ANALYSIS

Key words: agri-food trade, gravity model, Poland, non EU-countries

**ABSTRACT.** The main aim of the article was to indicate the influence of selected determinants of Poland's agri-food export to countries outside the European Union. Although European Union countries have been the Poland's main trading partners for years, the share of third countries in total Polish trade has gradually been increasing. In the case of Polish agri-food trade, a different tendency is observed, as the importance of non-EU countries is decreasing. In the analysis, covering the years 2000-2016, the gravity model was used. The dependent variable was Poland's agri-food export to third countries, while independent variables included GDP, the geographical distance between partners, differences of GDP per capita of exporter and importer, agricultural value added, the preferential trade agreement and variable describing whether a given country was a post-socialist country. Research confirmed that the masses of economies expressed in GDP attract trade between countries, while the distance between partners limits it. A positive impact on Polish agri-food exports was observed for agricultural value added and more liberal trade regulations between partners, which were a result of preferential trade agreements between the European Union and selected third countries. On the other hand, historical conditions related to the fact that the country was in the group of socialist countries with economies undergoing a transformation process since the 1990s have limited Polish agri-food exports.

### INTRODUCTION

Agri-food trade plays an important role in shaping Polish foreign trade, although the contribution of agriculture to GDP is decreasing. In 2018, the share of agri-food trade in the total trade of Poland was over 13% for exports and around 9% for imports, and was higher than in 2000 (over 8% and 6.5%, respectively). In the trade of agri-food products, Poland achieves a positive balance, but a negative one with countries which do not belong to the European Union (so-called third countries). Although the trade of non-EU countries in total Polish trade is increasing, in the case of agri-food products this share is decreasing. Poland's trade relations with third countries are determined by many factors, the significance and scope of impact of which are changing. This is a premise for conducting research in this area. Therefore, the main objective of the study is to determine the impact of selected factors on Polish agri-food export with third countries in the years 2000-2016. To solve the problem, the gravity model was involved in the analysis. The gravity model

is a tool that is relatively often used in the studies of international trade. Most conducted research focuses on general trade flows, less often on trade in agri-food products. The latter include studies in which selected factors determining agri-food trade (export or import) of particular countries are identified [Hatab et al. 2010, Melece, Hazners 2014], also in relation to specific agricultural markets [Kułyk, Augustowski 2018]. The gravity model was also applied to determine the border effect for integration on the international agricultural market [Olper, Raimondi 2008]. A number of studies were devoted to the assessment of the impact of regional trade agreements and trade liberalization on agri-food trade [Grant et al. 2008, Grant 2013, Matkovski et al. 2017]. A kind of continuation of the mentioned works are studies aimed at identifying non-tariff barriers and their effects in agri-food trade [Pomichowski, Parlińska 2018].

The structure of this paper is organized as follows. The first part is devoted to the research method used in the study. The second part describes the results of the study related to the agri-food trade performance between Poland and third countries and the effects of the estimated gravity model. The last part presents the conclusions.

## MATERIAL AND RESEARCH METHODS

The research is based on the gravity model, which is a popular instrument used in the empirical analysis of foreign trade and allows to determine the direction and strength of the determinants of international trade. The initial lack of theoretical foundations of the gravity model has been completed over time. The gravity equation is derived based on, among others, the imperfect competition theory, the Heckscher-Ohlin theory or the new theory of trade [e.g. Anderson 1979, Bergstrand 1985, Helpman, Krugman 1985, McCallum 1995]. The gravity model is based on Newton's universal gravity law, which says that the attraction of bodies depends on their mass and distance. Thus, similarly, trade between two countries is proportional to the size of their economies and inversely proportional to the distance between them. It is assumed that Tinbergen [1962] was the first to describe the gravity model and applied it in economic research. In the basic version, the model equation has the following formula:

$$T_{ij} = A \frac{Y_i Y_j}{D_{ij}}$$

where:  $T_{ij}$  – trade value from country  $i$  to country  $j$ ,  $A$  – constant,  $Y_i Y_j$  – gross national product of exporting country  $i$  and importing country  $j$ ,  $D_{ij}$  – distance between country  $i$  and country  $j$ . Depending on the purpose and scope of research, the set of independent variables introduced in the model is still expanded [Drzewoszewska et al. 2013]. Consequently, the general form of the gravity equation is assumed to be broadened and linearized [Folfas 2012]:

$$\ln T_{ij} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln D_{ijt} + Z_{ijt} + c_{ij} + \eta_{ijt}$$

where:

$T_{ijt}$  – trade between country  $i$  and country  $j$  in the time period  $t$ ,

$GDP_{i(j)t}$  – Gross Domestic Products of country  $i(j)$  in the time period  $t$ ,

$D_{ijt}$  – geographic distance between trade partners – country  $i$  and country  $j$ ,

$Z_{ijt}$  – vector of other independent variables that may affect bilateral trade between country  $i$  and country  $j$  in the time period  $t$ ,

$C_{ij}$  – random variable describing unobservable, but time-stable characteristics of country pairs that affect the flow of goods between countries  $i$  and country  $j$ ,

$\eta_{ijt}$  – random variable describing random changes in trade between country  $i$  and country  $j$  in period  $t$ , not included in the model.

In gravity models, many methods of estimating panel models are used. These can be linear models (dynamic and static) and binary dependent variable models (e.g. logit and probit models). The static models, with one-way individual effects, are used relatively often. Their basic estimators are the fixed effects estimator and the random effects estimator. But the limitations of these estimators (e.g. the necessity to remove variables assuming constant values in time in the case of a model with fixed effects, or the assumption of no correlation between explanatory variables and individual effects in a model with random effects) support the application of the Hausman-Taylor method [Czarny et al. 2013, Pietrzak, Łapińska 2014]. This estimator uses random effects, however, it allows to correlate some explanatory variables with an unobservable random individual effect. Taking the above and the objective of the study into account, the estimated gravity equation has the following form:

$$\ln Exp_{it} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln Dist_{ij} + \alpha_4 \ln |GDP_{pc_i} - GDP_{pc_j}| + \alpha_5 \ln AVA_{jt} + \alpha_6 Agree_{jt} + \alpha_7 Post\_com_{jt} + cij + \eta_{ijt}$$

Variables applied in the model are described in Table 1.

The value of bilateral agri-food export between Poland and third countries ( $Exp_{it}$ ) was adopted as a dependent variable, while agri-food products are defined as groups of products 1-24, according to the combined nomenclature (HS) of foreign trade. The independent variables include the GDP of Poland ( $GDP_{it}$ ) and the GDP ( $GDP_{jt}$ ) of third countries that import products of the Polish agri-food sector. On the one hand, these figures make it possible to determine how Poland's economic potential affects the supply of exports and, on the other hand, how the demand for Polish agri-food exported products is affected by the GDP of the importing country [Czarny et al. 2013]. A positive sign of the coefficient is expected for these variables. According to the theory of the gravity model, Poland's agri-food export to third countries should be negatively affected by the distance between trading partners ( $Dist_{ij}$ ). The geographic distance represents the transactional costs of trade including, among others, transport and insurance costs. Although, in the era of globalisation, the physical distance is becoming less and less important, it can be assumed that it

Table 1. Variables used in the estimated gravity model

Variable	Description	Source
$Exp_{it}$	Value of agri-food export from country $i^*$ to country $j^{**}$ in time period $t$ (current prices, in thousands of USD)	WITS (World Integrated Trade Solutions)
$GDP_{it}, GDP_{jt}$	Gross Domestic Product of an exporting country $i$ and an importing country $j$ in time period $t$ (current prices, in thousands of USD)	World Bank, WDI (World Development Indicators)
$Dist_{ij}$	Geographic distance between capital cities of country $i$ and country $j$ (in kilometers)	CEPII (Centre d'Etudes Prospectives et d'Informations Internationales)
$ GDPpc_i - GDPpc_j $	Absolute value of difference in GDP per capita of country $i$ and country $j$ in time period $t$ (current prices, USD)	World Bank, WDI
$AVA_{jt}$	Share of agricultural value added in GDP of an importing country $j$ in time period $t$ [%]	World Bank, WDI
$Agree_{jt}$	Dummy variable takes value 1 if a preferential trade agreement between exporter and importer $j$ was in force, the opposite is true for value 0	WTO RTA (World Trade Organisation Regional Trade Agreement) Database
$Post\_com_j$	Dummy variables takes value 1 for post-socialist country $j$ , the opposite is true for value 0	IMF (International Monetary Fund)

\* In this study country  $i$  means Poland, \*\* country  $j$  signifies a country which did not belong to the European Union in 2016; a so-called third country

Source: own elaboration

will be decisive and have a negative impact on trade turnover [Ellis 2007]. Apart from these classic variables, which form the gravity model, other variables, discussed below, have also been taken into account.

A positive impact on Poland's agri-food export can be expected in the case of the module of GDP per capita difference between Poland and non-EU countries ( $|GDPpc_i - GDPpc_j|$ ). It is assumed that the smaller the difference, the greater the trade exchange between analysed countries, which is explained by the Lindner theory of similar preferences [Lindner 1961]. The agricultural value added ( $AVA_{jt}$ ) was also included in the set of independent variables. Less developed countries are characterized by a higher share of agricultural value added in their GDP. At the same time, the higher the share of agriculture in GDP, the more one could expect that the country is able to meet the food needs of its citizens, and thus reduce imports. However, in countries with a high share of agriculture in GDP, there is also a poorly diversified range of products for domestic and foreign consumers. Therefore, it can be expected that the relationship between Polish agri-food exports and the share of AVA in the GDP of a non-EU importing country may be positive. A positive relation is also expected for the trade integration variable ( $Agree_{jt}$ ). The point is, whether

a preferential trade agreement between two countries, reducing trade barriers, positively influences the intensification of agri-food bilateral trade. In this study, it will be possible to check if the implementation of preferential trade agreements between the European Union (and thus Poland) and other countries has a positive impact on the value of Polish agri-food exports. Thus, the conducted research is in line with the theory of regional integration [Viner 1950, Koo et al. 2006]. It was also decided to estimate whether being third countries in the group of socialist countries (*Post\_com<sub>j</sub>*) before 1990 and their subsequent entry into the path of economic transformation had a positive impact on trade relations with Poland. It can be assumed that similar political and institutional conditions in the past may positively stimulate mutual trade within a group of countries. The inclusion of such a variable assumes that contemporary trade relations are determined by historical and institutional conditions (“history matters”), which is part of a theory of the new institutional economy and the concept of the path-dependency [North 1986, Krugman 1991]. It is worth noting that, in the adopted function, dependent and independent variables are logarithmic excluding the qualitative factors coded as zero-one variables.

## RESEARCH RESULTS

In the years 2000-2018 (excluding 2013 and 2014), there was a deficit in agri-food trade between Poland and non-EU countries, although export and import was growing steadily (see Table 2). In the period under review, the value of agri-food exports to non-EU countries increased 7.3 times, and imports 6 times, respectively. At the same time, Poland had recorded a positive and systematically growing trade balance in agri-food trade with the world. This means that it was mainly generated by trade with European Union countries<sup>1</sup>, with which the vast majority of the trade turnover is carried out.

Over the years, the importance of the share of third countries in Poland’s agri-food trade has decreased. In 2018, the share of non-EU countries in Polish agri-food export amounted to about 18.5% and was lower by 15.5 percentage points (p.p.) compared to 2000. In the case of import, these figures were at 30.8% and around 7 p.p.<sup>2</sup>, respectively. At the same time, in the years 2000-2018, the share of agri-food products in Poland’s trade with third countries decreased and was, on average, twice as high in the case of export (12.2%) compared to import (6.5%). Therefore, non-EU countries are mainly recipient of agri-food products from Poland (see Table 2).

Considering the above, it should be stated that there was a clear shift in Polish agri-food trade towards European Union countries during the considered period. In 2018, the share of EU countries in Poland’s agri-food trade amounted to over 80% and about 69% for exports and imports, respectively. Furthermore, the importance of EU countries has steadily increased during the analysed period. This situation is consistent with the theory of economic integration and the occurrence of trade creation and diversion effects [Baier,

<sup>1</sup> Poland has had a surplus in agri-food trade with EU countries since 2000. In the years 2000-2018, the value of Polish agri-food export to the EU increased 16.7 times, and imports 8 times, respectively.

<sup>2</sup> The opposite relation occurs for total trade. In 2018, the importance of non-EU countries in Poland’s turnover was 20% for exports and nearly 42% for imports. These shares were correspondingly higher compared to 2000 (18.2% for exports and 30.8% for imports).

Table 2. Polish agri-food trade with non-EU countries in 2000-2018

Years	2000	2002	2004	2006	2008	2010	2012	2014	2016	2018
Value of Polish agri-food export, import and balance [mln USD]										
Export	869,0	1,054.0	1,698.2	2,292.6	3,236.9	3,693.9	5,327.0	6,167.4	5,160.9	6,385.3
Import	1,169.0	1,288.8	1,964.2	2,924,0	4,493.9	4,527.2	5,463.1	6,102.0	5,29.9	7,213.9
Balance	-300.1	-234.8	-266.0	-631.5	-1,257.0	-833.3	-136.1	65.4	-569.0	-828.6
Share of Polish agri-food trade with non-EU countries in trade with non-EU countries [%]										
Export	15,4	14.2	11.7	9.9	8.5	11.2	12.0	12.2	12.3	12.2
Import	7.9	7.9	7.1	6.4	5.6	6.3	6.5	6.7	7.5	6.5
Share of Polish agri-food trade with non-EU countries in total Polish agri-food trade [%]										
Export	33.9	33.0	26.2	21.7	19.2	21.1	24.1	22.1	20.2	18.4
Import	37.5	36.7	36.0	36.7	30.3	32.0	32.6	31.8	32.4	30.8

Source: own elaboration based on WITS database

Bergstrand 2007, Cheong et al. 2015]. It also reflects comparative advantages of Polish agri-food products on the EU market [Szczeplaniak 2019]. In the context of economic integration, it is worth noting that Poland, as an EU member, not only participates in the process of EU economic integration, but also in the process of economic integration between the EU and other countries. That is manifested in preferential trade agreements concluded by the EU with third countries. Since 2000, the EU has implemented about thirty preferential trade agreements (free trade agreements, an economic integration agreement or custom union) mainly with developing countries. In this respect, it is interesting whether and how the introduced preferential trade agreements between the EU and selected non-EU countries determine Polish agri-food export.

In order to determine the influence of selected factors on the agri-food export between Poland and countries outside the European Union, a panel gravity model was used. The dependent and independent variables adopted in the analysis were discussed earlier (see Table 1). Research was conducted for agri-food exports of Poland to 138 countries (not belonging to the EU) in the years 2000-2016 (the time scope was determined, among others, by the availability of data). In total there were 1912 observations. The Hausman-Taylor method was applied to estimate the parameters of the adopted panel model and the obtained results are presented in Table 3.

As a result of conducted research, it can be stated that the basic variables in the gravity model are significant and have positive signs for GDP and negative signs for the distance between the exporter and importer. Such results are consistent with the expectations and theory of the model of gravity and the results of other researchers [Grant 2013, Kułyk, Augustowski 2018]. The value of agricultural and food exports of Poland is positively influenced by the size of its GDP, but also, to a greater extent, the GDP of the importing country. One can venture to say that, in the case of the analyzed turnover, the size of the economy had a relatively greater impact on the demand for imported agri-food goods than on the creation of a production offer by the exporter. On the other hand, a significant

Table 3. The results of the estimated gravity model for agri-food export between Poland and non-EU countries (Hausman-Taylor model)

Variables	Coefficient	Standard errors	p-value	Significance
$\ln GDP_{it}$	0.6578339	0.16394	0	***
$\ln GDP_{jt}$	0.998983	0.0835472	0	***
$\ln Dist_{ij}$	-8.197577	2.370062	0.001	***
$\ln  GDPpc_i - GDPpc_j $	0.0694153	0.0833612	0.405	
$\ln AVA_{ij}$	0.3794076	0.1412384	0.007	***
$Agree_{it}$	0.3996442	0.1402474	0.004	***
$Post\_com_j$	-7.007348	3.043592	0.021	**
Constant	35.3341	19.96573	0.077	*

Years: 2000-2016, number of country pairs: 138, number of observations: 1,912

\*\*\*, \*\*, \* donates the significance level: 99%, 95% and 90%, respectively

Source: own calculation using STATA software

variable that has a strong negative impact on Polish agri-food exports is geographical distance, which means that the greater the physical distance between Poland and the non-EU importer, the smaller the agri-food export from Poland is. This means that, in the case of Polish agri-food exports “distance still matters” [Ellis 2007], which can be perceived as a premise for identifying the reasons for this, in further, in-depth studies.

The research results also confirmed the assumed positive impact of the importance of agricultural value added in the importing country on the Polish agri-food export. Within analysed countries the majority were developing countries, which partially justifies the direction of the discussed relationship. In 2016, in the discussed group of countries, importing Polish agri-food products, the share of agriculture in GDP was over 12.5%, and the average level of GDP per capita was about USD 10,000. However, after removing 12 economies with the highest GDP per capita with this group<sup>3</sup>, for the remaining importers, the average level of GDP per capita was around USD 6,000 USD and the share of agriculture in their GDP was about 13.5%<sup>4</sup>. The impact of implemented preferential trade agreements between third countries and the European Union is also significant and positive. These agreements, by limiting or eliminating trade barriers between exporter and importer, contribute positively to the growth of Polish agri-food export. It is worth underlining that the effects of these agreements are not fully visible yet. Many of these agreements have been implemented relatively recently, and often also cover transitional periods, which means that some regulations of reducing trade barriers are introduced gradually over several years. However, the obtained results confirm the positive impact

<sup>3</sup> It is worth emphasizing that, within these 12 richest (measured GDP per capita) economies, the Faroe Islands cropped up, where the share of agriculture in GDP amounted to over 20%, while in the remaining 11 economies it was around 2%.

<sup>4</sup> Undoubtedly, a broader explanation of this relationship in the context of the level of development of countries importing Polish agri-food products requires in-depth research and the construction of appropriately changed gravity models.

of trade liberalization (in the form of regional trade agreements) on the export of countries participating in such agreements (the trade creation effect). Moreover, they are in line with other studies of the impact of regionalization on international trade [Koo et al. 2006, Baier, Bergstrand 2007, Grant et al. 2008, Grant 2013]. An important variable affecting agri-food exports is a variable showing the country's belonging to the group of post-socialist countries. Similar institutional conditions related to the previously binding economic system have a negative impact (unlike assumed) on Polish agri-food export. That can be partly explained by Poland's membership in the European Union, the pace of structural changes in post-socialist economies, as well as restrictions introduced in agri-food trade with Russia, for example. This means that, in the case of agri-food exports with the non-EU countries, the path determining dependency is not obvious. The applied gravity model did not confirm the expected dependence between the difference in GDP per capita of the exporter and importer and the value of agri-food export. This variable turned out to be insignificant. The obtained result is, therefore, different from those gained by other researchers [Klimczak 2015, Folfas 2017], which, however, may result from the other research scope (time, space, subject) adopted.

## CONCLUSIONS

The conducted research showed the occurrence of both attractive and limiting forces in the Polish agri-food export to countries outside the European Union. The applied gravity model confirmed that the size of economies expressed in GDP attract agri-food trade flows, while the geographical distance between the importer and Poland has a negative impact on Polish agri-food exports. The phenomenon of attraction also occurred for added value in agriculture and liberalized trade regulations between partners, which are a result of implementing preferential trade agreements concluded by the European Union. Institutional conditions, understood as being in the group of socialist countries in the past, limited Polish agri-food exports. Thus, in the application dimension, research results suggest directing agri-food exports towards large and relatively less remote economies with a high share of agriculture in GDP, with which the EU has preferential trade agreements and which are not in the group of post-socialist countries. It should also be noted that the limitations of the gained results and their interpretation depend on the limitations of the gravity model itself as well as the selected set of explanatory variables. Hence, the conducted research should be a prelude to broader in-depth analyzes of Poland's agri-food trade.

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## HANDEL ROLNO-ŻYWNOŚCIOWY POLSKI Z KRAJAMI SPOZA UNII EUROPEJSKIEJ – ANALIZA Z WYKORZYSTANIEM MODELU GRAWITACJI

Słowa kluczowe: handel rolno-żywnościowy, model grawitacji, Polska, kraje trzecie

### ABSTRAKT

Głównym celem artykułu jest określenie wpływu wybranych determinant eksportu rolno-żywnościowego Polski do krajów spoza Unii Europejskiej, z wykorzystaniem modelu grawitacji. Kraje Unii Europejskiej od lat są wiodącymi partnerami handlowymi Polski, ale mimo to zwiększa się udział krajów trzecich w handlu ogółem Polski. W przypadku obrotów rolno-żywnościowych obserwuje się tendencję odwrotną – udział krajów spoza UE obniża się. Analiza obejmowała lata 2000-2016. Zmienną objaśnianą był eksport rolno-żywnościowy Polski do krajów trzecich, w skład zmiennych objaśniających weszły: PKB, odległość geograficzna między partnerami, różnica PKB *per capita* eksportera i importera, wartość dodana w rolnictwie, preferencyjna umowa handlowa między importerm a Unią Europejską oraz zmienna opisująca czy dany kraj jest krajem postsocjalistycznym. Przeprowadzone badania potwierdziły, że masy gospodarek wyrażone w PKB przyciągają wymianę handlową, natomiast odległość ją ogranicza. Dodatni wpływ na polski eksport rolno-żywnościowy zaobserwowano dla wartości dodanej w rolnictwie oraz zliberalizowanych regulacji handlowych między partnerami, które były wynikiem wprowadzonych w życie preferencyjnych umów handlowych zawieranych przez Unię Europejską. Natomiast historyczne uwarunkowania, rozumiane jako uczestnictwo w grupie państw socjalistycznych, ograniczało polski eksport rolno-żywnościowy.

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