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NEIGHBORHOOD EFFECTS AND THE EFFECTS OF REGIONAL TRADE AGREEMENTS ON GLOBAL MAIZE TRADE

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1. BACKGROUND AND OBJECTIVE OF THE RESEARCH

Cereal seeds have been a major component of human nutrition for thousands of years and have contributed significantly to the development of human civilization today. The daily survival of billions of people depends directly or indirectly primarily on the cultivation of wheat, rice and corn, and to a lesser extent other cereals. More than half of these three plants are responsible for meeting human consumption (Awika, 2011). Their blending began about 10,000 years ago, in the case of rice in Asia, in the Yangtze Valley, in the case of wheat in the Middle East, and in the case of maize in Central America, in the Mexican Valley area of present-day Mexico, in Oaxaca and Tehuacán.

Maize was rapidly incorporated into agricultural production following geographical discoveries, initially mainly as animal feed and as food for the poorer sections of society. The new crop from the "new world" was well adapted to different environmental factors, had a shorter ripening time than many indigenous crops, and its productivity was remarkable, as almost twice as much could be harvested per unit area as in the case of wheat. According to Cengage (2020), the European discovery of maize had a significant cultural, economic, and political impact on subsequent population growth. Outside Europe, Africa and China had even more dramatic effects, as the introduction of corn was followed by exponential population growth. In addition to relatively low production and transportation costs, cheap food and feed materials have become available worldwide to many crops and economies. The mechanization of industrial production has been followed worldwide by the mechanization of agriculture, which has been helped in many areas, such as the production of maize, one of the dominant crops in agricultural production.

Today's globalizing agriculture and food production play a key role in the daily lives of humankind and its future, as the earth's population has only quadrupled in the last hundred years and now exceeds 7 billion 792 million (Worldometer, 2020). Recently, a growing number of literature has addressed the effects of the global food crisis on commodity markets (Akhter, 2017; Tadassee et al., 2016), the various effects of price spikes on commodity markets, the effects of poverty on developing countries, and some studies concentrates on agri-food trade (Headey, 2011; Giordani et al., 2016). Although the significance of trade events in the rice and wheat markets is widely analysed today, similar analyses are practically lacking for maize. The lack of research is partly understandable due to important features of the global corn market (Headey, 2011). First, the United States dominates global corn trade, which accounts for about 60% of world exports, and consequently restricting trade elsewhere is less important in influencing international prices. Second, corn is used as animal feed in many parts of the world (unlike rice and wheat, which are typically staple foods), so demand for corn is relatively flexible, making it less susceptible to trade shocks. Third, early studies confirm that rising oil prices have significantly increased the cost of corn production and transportation (Headey and Fan, 2008; Mitchell 2008). Finally, the increasing use of corn as a biofuel is having a major impact on the global corn market.

The dissertation aims to contribute to research on international agricultural trade in three points. Worldwide corn trade has traditionally been the subject of trade intervention. The number of significant players in the global market is limited. On the export side, exporting countries use various promotion programs, while importing countries use wide-ranging trade barriers to protect domestic markets. These trade policies play an important role in determining maize flow (Koo and Karemera, 1991). Despite the significant role of maize in global agriculture, research on international trade in maize is rather limited. Only a few studies deal with international maize trade, such as Jayasinghe et al. (2010) and Haq et al. (2013) for global players, or Fertő and Szerb (2017) for small corn exporting countries. The aim of the dissertation is to contribute to the scarce literature on international trade in maize.

Examining neighbourhood impacts is one of the central themes of the new economic geography. Agriculture is generally outside the scope of such studies because researchers assume that the agricultural sector is characterized by perfect competition, so agglomeration effects are less likely to emerge here. Central to the international trade literature is the study of the impact of trade costs on trade processes, in which the distance between trading partners plays a prominent role. Nevertheless, the analysis of neighbourhood effects with spatial statistical / econometric tools is still in its infancy, especially with regard to international agricultural trade. Another contribution of the dissertation to the previous literature is to examine the presence of neighbourhood effects in international maize trade.

Another highlight of the research is the analysis of the impact of regional trade agreements. Within this, I also pay special attention to the methodological problems of examining regional trade agreements. For the first time in the international literature, I look at the impact of globalization on the international maize trade.

2. MATERIAL AND METHOD

2.1. Data used

The dissertation examines maize export data for the period 1996–2015 from the UN Comtrade database (UNSD, 2017), the World Integrated Trade Solution (WITS) database, and software (denominated in U.S. dollars) (The World Bank, 2017a). The empirical analysis is based on bilateral trade in maize at the 4-digit level of the Harmonized System (code HS1005).

2.2. Methodology for examining neighbourhood effects

In the dissertation, I examine the spatial dependence of maize exports by country in several steps. I examine the presence of spatial dependence by a statistical method, by measuring and testing the spatial autocorrelation. In our case, the territorial autocorrelation is the correlation between the maize export value of a given country and the average of the maize export value of the neighbouring countries.

I use one of the most common methods to measure autocorrelation (Tiefelsdorf, 2002), the Moran I indicator. There are both global and local versions of the indicator. Global Moran's I measures the spatial autocorrelation between all data points, i.e., whether the spatial pattern of the entire data set is characterized by spatial dependence (Zhang et al., 2016). Moran's global formula I:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})^2} = \frac{\sum_{i=1}^{n}\sum_{j\neq i}^{n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{S^2\sum_{i=1}^{n}\sum_{j\neq i}^{n} w_{ij}},$$

where n is the number of observation units (countries), x_i and x_j are the natural logarithms of the annual maize export value of the i-th and j-th countries, and w_{ij} is the row-standardized “queen” type neighbourhood weight matrix in row i and column j located element. The elements of the matrix express the neighbourhood relationship of two countries, their value before row standardization is determined according to the following rule (Anselin, 1995):

- w_{ij}= 1 ha *bnd(i)∩bnd(j)≠∅*,
- w_{ij} = 0, ha *bnd(i)∩bnd(j)=∅*,

where *bnd(i)* and *bnd(j)* denote the set of points forming the boundary of the i-th and j-th observation units (countries), respectively.

The global Moran I set of values depends on the number of observation units, so its value is not fixed between -1 and +1, as is usually the case for correlation coefficients. The global Moran I value is interpreted as follows (Cliff-Ord, 1973):

- I > -1/(n-1) positive spatial autocorrelation,
- I < -1/(n-1) negative spatial autocorrelation,
- I = -1/(n-1) and in this case we cannot talk about spatial autocorrelation.

Local Moran I measures partial spatial autocorrelation, measures and tests the degree of spatial dependence per observation unit. In its use, we are essentially looking for the answer to the extent to which the maize exports of a given observation unit correlate with the maize exports of units adjacent to that observation unit (with common border point (s)). Using it, we can identify territorial clusters of countries with similarly high or similarly low corn export values. Calculation of the local Moran I value of the i-th monitoring unit (Anselin, 1995):

$$I_i = \frac{(x_i - \bar{x})}{{S_i}^2} \sum_{j=1}^{n} w_{ij}(x_j - \bar{x}),$$

$${S_i}^2 = \frac{\sum_{j=1}^{n}(x_j - \bar{x})^2}{n-1} - \bar{x}^2,$$

where $i \neq j$, x_i and x_j, and w_{ij} is identical to the elements of the weight matrix described in Global Moran I.

Two types of countries with significantly positive local Moran I values can be distinguished, depending on whether they have above-average or below-average corn export values:

- We speak of a High-High (HH) relationship if the value of maize exports of the studied country and its neighbours is also above average;
- We speak of a Low-Low (LL) relationship if the value of maize exports from the country under study and its neighbours is also below average.

Countries with a significantly negative Moran I value are identified as emerging islands, outliers, as their corn export values differ upwards or downwards from the average of their neighbours. Two groups of such countries can also be distinguished:

- We speak of a high-low (HL) relationship if the country under study has a high value in a typically low-value neighbourhood environment;
- We speak of a low-high (LH) relationship if the country under study has a low value in a typically high-value neighbourhood environment.

By including the spatial autocorrelation clusters and protruding islands in the table, I present the effect of past performance on the given year on LISA / local Moran I maps created with the help of GeoDa 1.14.0 software. LISA is the abbreviation for Local Indicator of Spatial Association in this case. For reasons of length, in the dissertation I present the LISA maps for 2001, 2006, 2011 and 2015.

2.3. Methodology used for the gravity model

The standard formula for the gravitational equation can be described for the value of Xij, which is the value of the export of the exporting country (i) to the importing country (j) within a certain time (t) (Anderson and Van Wincoop 2003):

$$X_{ijt} = G_t M_{it}^{x} M_{jt}^{m} \varphi_{ijt}$$

where $M^x it$ and $M^m jt$ denote the characteristics of the exporting and importing country, G_t is the trade-defining vector for an average year. The change in trade intensity enters through φijt. Following Head et al. (2010) I refer to M_{it}^{x} and M_{jt}^{m}, as monadic effects and φijt, as a dyadic effect.

Based on Eaton and Kortum (2002), I estimate the logarithm of the diadic expression to be φijt as a linear combination of factors affecting foreign trade costs between partner countries:

$$\ln\varphi_{ijt} = \delta D_{ijt} + u_{ijt}$$

D_{ijt} and u_{ijt} describe the observed and unnoticed elements of bilateral trade costs. The standard approach to estimating the gravity model is to take the logarithm of Equation (1) and substitute it in Equation (2) to obtain the following formula:

$$\ln X_{ijt} = \ln G_t + \ln M_{it}^x + \ln M_{jt}^m + \delta D_{ijt} + u_{ijt}$$

A number of variables can help express trade costs in the gravity model. Among the variables, the size of the geographical distance between countries / regions / municipalities, customs duties, common borders, geographical isolation, regional cooperation agreements, but also variables expressing cultural similarities, such as common language, religion or the former colonial relationship (Balogh, 2016). Shipping costs usually increase with distance. According to Linders and Groot (2006) and Bacchetta et al. (2012), a common cultural background, language and religion can encourage trade, as the parties can better understand each other's trade habits and traditions. The development of outcome variables is often significantly influenced by quality variables, so we cannot disregard their representation in the model. According to Neumanné-Virág (2014) and Dusek (2016b), the outputs or groups of nominal properties must be coded, since numerical data are required for regression. If the artificial variables take a value of 0 or 1 during encoding, they are called dummy variables. If the observation value is 0, the condition encoded in the variable is satisfied, if 1, it is not satisfied. Dummy variables can be used to express both time-varying and unchanged control variables. The time-invariant control variables often used in the gravity model are, for example, common border, distance, common language, or colonial relationship. These variables also serve to control multilateral resistance and unobservable heterogeneity (Fertő and Szerb, 2017). Time-varying controls include, for example, regional trade agreements (RTAs) or joint EU membership.

An important issue is the possibility of dealing with zero-value trade relations. It is well known that zero commercial traffic cannot be easily handled by standard gravity models. There is a widespread practice in the early literature to ignore zero traffic in bilateral trade analyses. However, zero-value observations contain important information for a more accurate understanding of bilateral trade patterns, so they should not be discarded from the outset, as excluding these values from the sample may result in significant information loss (Linders and Groot, 2006). Over the past decade, researchers have developed several methodological procedures to solve the problem of zero trade turnover.

a; The first most common solution is to limit the sample to observations larger than zero to avoid estimation problems associated with zero trade.

b; The second solution is to replace the zero values with a small constant (such as $ 1). Thus, the double logarithm model can be estimated without taking these zero foreign trade traffic country pairs from the sample.

c; A third solution is to use a standard Tobit model in studies to estimate the gravity equation with zero foreign trade turnover (Rose, 2004; Anderson and Marcouiller, 2002).

d; A fourth solution is to use Heckman's (1979) selection model to handle zero foreign trade values (Francois and Manchin 2013; Linders and Groot, 2006), arguing that this model is advantageous from both a theoretical and econometric point of view.

e; Finally, Santos Silva and Tenreyro (2006) recommend the PPML (Poisson pseudo-maximum-likelihood estimation) estimation function to solve the heteroscedasticity problem. Martin and Pham (2015) argue that if the proportion of zero values in the sample is relatively small, then the PPML model is the most advantageous solution for the estimation function. However, Santos Silva and Tenreyro (2011) show that the PPML estimator generally behaves well, even when the proportion of zeros in the sample is very high. Thus, the PPML estimation technique is used to treat heteroskedasticity.

In the last 30 years, the number of RTAs has increased tenfold and the number of agreements notified to the WTO today exceeds 300 worldwide (WTO, 2020). Within the WTO, regional trade agreements are reciprocal bilateral or multilateral agreements that cover all types of trade contractual relations, from the customs union to free trade agreements. The gravity model was not originally developed to study the effects of regional trade agreements, but its novel application for this purpose is now attractive to researchers (Jámbor and Török, 2019; Jámbor et al., 2020). In my case, I am curious about the effects of RTAs on world corn trade. The empirical specification includes traditional gravitational covariates, including time constraints set by the exporting country and the importing country, and only takes into account international trade for i and j:

$$X_{ij,t} = \exp[\pi_{i,t} + \chi_{j,t} + \beta_1 \ln DIST_{ij} + \beta_2 CNTG_{ij} + \beta_3 LANG_{ij} + \beta_4 CLNY_{ij} + \beta_5 RTA_{ij}, + \pi_{it} + \chi_{jt}] \times \varepsilon_{ij,t}$$

The dyadic variables are divided into two groups: on the one hand, control variables, which are typically used in the gravity model, and on the other hand, variables that represent trade agreements. The time-constant control variables are distance and common boundary. For the world market, the usual variables such as common language and colonial relations can be examined. Time-invariant variables also serve to control multilateral resistance and unobservable heterogeneity. Time-varying controls include affiliation to a joint regional trade agreement (RTA).

Dealing with domestic sales problems:

Following the work of Dai et al. (2014) and Anderson and Yotov (2016) using the gravity model, I re-estimate that the sample no longer includes not only international trade turnover but also internal trade data of nations. These authors hypothesize that regional trade agreements may divert domestic trade toward international sales and therefore may skew estimates for the RTA variable based on international trade.

Dealing with the possible endogeneity of the RTA:

Following the work of Baier and Bergstrand (2007) to modify the potential endogeneity of RTAs, we modify the gravity model by adding country-pair fixed effects in addition to export year and import year fixed effects.

$$X_{ij,t} = \exp[\pi_{i,t} + \chi_{j,t} + \mu_{it} + \beta_5 RTA_{ij}] \times \varepsilon_{ij,t}$$

Due to perfect collinearity, the use of fixed effects does not allow the inclusion of time-invariant standard variables (distance, neighbourhood, common language, colonial relationship) in the model, so they are taken out during estimation. Following the work of Yotov (2016), I also remove the fixed effect on internal trade from the specification. In fact, this means that the value of all internal trade costs is taken as one, while the fixed effect of international trade costs is estimated relative to the fixed effect of internal trade.

Dealing with the potential reverse causation:

To test whether model (4) adequately considered the possible "reverse causal relationship" between trade and RTAs through the country pair fixed effect, we perform a simple test to assess the "strict exogenicity" of RTAs. I extend the model by adding a new variable that fixes the future level of RTAs.

$$X_{ij,t} = \exp[\pi_{i,t} + \chi_{j,t} + \mu_{it} + \beta_5 RTA_{ij} + \beta_6 RTA_{ijt,+4}] \times \varepsilon_{ij,t}$$

If RTAs are exogenous to trade, the coefficient β_6 associated with the variable $RTA_{ij,t+4}$ should not be statistically different from zero.

Effect of possible nonlinearity of RTAs:

Consider the possible nonlinear effect of RTA, I supplement model (4) with different delays of RTA variables (maximum 12 years).

$$X_{ij,t} = \exp[\pi_{i,t} + \chi_{j,t} + \mu_{it} + \beta_5 RTA_{ij} + \beta_6 RTA_{ijt,-4} + \beta_7 RTA_{ijt,-8} + \beta_8 RTA_{ijt,-12}] \times \varepsilon_{ij,t}$$

Taking into account the effects of globalization:

For the last test, I use the method developed by Bergstrand et al. (2015), which takes into account the possibility that the estimate from model (4) may skew upward the effect of RTA because they also include effects of globalization such as technology and innovation. Therefore, I add a new group of variables to the model that are related to the borders between partner countries at a time *t*.

$$X_{ij,t} = \exp[\pi_{i,t} + \chi_{j,t} + \mu_{it} + \beta_5 RTA_{ij} + \beta_6 RTA_{ijt,-4} + \beta_7 RTA_{ijt,-8} + \beta_8 RTA_{ijt,-12}] \times \exp[\beta_9 INTL\_CNTG_{1996} + \beta_{10} INTL\_CNTG_{2000} + \beta_{11} INTL\_CNTG_{2004} + \beta_{12} INTL\_CNTG_{2008} + \beta_{13} INTL\_CNTG_{2012}] \times \varepsilon_{ij,t}$$

The new variable $INTL\_CNTG_t$ is a dummy variable with a value of 1 in the given year if the exporter has a common boundary with the importing country in the given year *t*, otherwise 0.

3. RESULTS

3.1. Results on neighbourhood effects

The results show three zones. In North America, the United States and Canada form a large-scale “hot zone,” Mexico has shown significant ties to its neighbours since the middle of the period. In 2006, the United States was one of the countries with no significant neighbourhood relations. I see the primary reason for this in the extremely high value of U.S. maize exports, its unique export dominance around the world. Based on this, the United States should be an “outstanding” HL island, but I also wrote that its immediate neighbours are also very active players in the maize market. The United States is therefore also part of the zone, but its export volume is “hanging out” from neighbouring countries. This tension in the data may lead to a non-significant value of local Moran I in the year in question.

The presence of a hot zone in South America can also be justified. Each year, in the rows of the table, we find countries that are on the continent, and the number of countries that make up the cluster was also stable during the study period. Another issue is that the local autocorrelation is only partially significant for the true cluster core in this case as well, as Argentina shows a significant value throughout the period (however, in my opinion, Brazil can also play such a role). Countries with smaller export volumes adjacent to the cluster core (Bolivia, Paraguay, Peru, Uruguay) are stable in the hot zone cluster except Uruguay in 2006 and Chile in 2011.

The data in the table for the European hot zone show a really spectacular transformation. In 1996, I can’t even talk about a real, connected zone: only a few countries, Austria, Denmark, Hungary, Moldova, Italy, Slovakia, Switzerland, and Ukraine, had significant HH connections. However, after the turn of the millennium, a much larger cluster emerged on the continent, comprising the countries of Western and Central Europe. In addition to these countries, Belgium, the Czech Republic, France, the Netherlands, Luxembourg, Germany, Portugal and Romania formed the zone (with the exception of Ukraine). From 2006 onwards, this European cluster shifted to the east, first leaving Portugal and then Switzerland, while from 2006 Bulgaria and from 2011 Poland, Croatia and Serbia emerged and Ukraine returned to the cluster. Undoubtedly, this process constituted the most dynamic geographical rearrangement in the global maize market during the period under review.

It is worth mentioning that the expansion of maize exports from the spectacularly forward-looking Asian countries (India, China) and Russia during the period under review did not result in the inclusion of neighbouring countries in the maize market. All three countries listed here became leading maize exporter during the period but other players in the region have not benefited from their position, at least through neighbourhood effects. Only two countries, Laos and Nepal, played the role of Asian HH country in the first half of the period.

Significant LL zones, i.e., cold spots and smaller zones, rarely developed based on the data, primarily in the Arabian Peninsula and the Gulf countries. In 1996, Iran and Iraq, followed by Iraq and Palestine, were LL countries. In 2011, several countries in the Persian Gulf (Iran, Kuwait, Qatar), while in 2015, Iraq, Qatar and Lebanon were LL countries in the region. In West Africa, a LL cluster group formed by Senegal and Guinea-Bissau was discovered, mainly in the first half of the period. Only in the last year studied can Sweden be singled out among the Scandinavian countries.

In the two decades of the period under review, there are countries on almost every continent whose exports deviate downwards from that of their neighbours. Lesotho is the only country that falls into this category throughout the period. Taiwan can be included in this cluster until 2006 and Bhutan until 2011. Mainly due to a high-value neighbourhood environment, we see Uruguay located in the hot zone of the South American cluster temporarily appear in 2006. Among the European countries, from the second half of the examined period, Belarus and then Switzerland are in the LH category. These two countries were able to fall into this category mainly due to their high export value neighbours due to the previously mentioned Central and Eastern European hot zone.

The emergence of high-low countries occurred only in an island-like manner during the study period, mainly in different regions of Africa, the Arabian Peninsula, and the east coasts of Asia.

At the end of the chapter, I show how the exports of a given country are affected by the exports of the neighbouring countries five years ago, ie how the past has affected the present. To examine the effects to be sought in the past, I evaluated the two-decade period of the study period divided into four phases. Countries where neighbours' exports five years earlier had a significant positive effect on that country's subsequent exports are shown in red (High-high). The hot zones mentioned earlier also appear to emerge in this part of the study. In the case of North America, the corn export activity of Canada, Mexico and the United States was also affected by the previous export performance of the neighbours. In South America, in the case of Argentina, Paraguay, Bolivia, Chile, Peru, and in 2001 in the case of Brazil, we can say that the temporal dynamics of the neighbourhood effect of maize exports can also be demonstrated on the continent. In Europe, the shift of HH countries to the east during the period from the Atlantic (France) to the Black Sea (Ukraine) is clearly visible in the temporal neighbourhood analysis of export markets. Exports from Nepal and Laos in the Southeast Asian region were positively impacted by the neighbours 'previous export performance in 2001 and 2006. In the south-east of the African continent, a smaller region with the participation of Mozambique and Tanzania emerged in the second half of the period, which was positively impacted by the neighbours 'past export performance.

Island-like countries and regions are marked in blue where a neighbour's negative past export performance also has a negative impact on that country's current exports. Periodic appearances of such countries on the map are mainly found in the Arabian Peninsula (Iraq, Kuwait) and West Africa (Mali, Niger, Senegal, Cameroon).

According to the results, the neighbourhood effects in the maize market also have a temporal dynamics, ie the exports of a given country are influenced not only by the current market activity of the neighbouring countries, but also by their past export activities.

3.2. Results of the gravity model

The distance between the partners is found to reduce maize trade between the partner countries and the estimated elasticity is between 1.845 and 1.847, which is higher than the typical value found in the literature (one). The result is in line with preliminary expectations, as in the case of maize we are talking about a relatively cheap agricultural raw material, for which the higher logistics costs due to distance can represent a significant part of the selling price. This means that an exporting country with a greater geographical distance from the country of destination has to produce maize more efficiently or cheaper if it wants to remain competitive on the world market, a physically closer but for some reason less efficient producer (outdated production technology, unsuitable climatic conditions, etc.). Surprisingly, however, the common border does not show significant value, which in turn is inconsistent with the results of previous studies (Haq et al., 2013; Ghazalian, 2015). The cultural dummy variables used in this case are the common language and the colonial relationship. The common language shows positive but not significant values, while the colonial relationship shows negative and significant values. Examining the time-varying dyadic variables, we observe that regional trade agreements have a positive effect on maize exports for both the Model 1 and Model 2 specifications. These results are expected to be consistent with typical results in the agricultural trade literature (Haq et al., 2013; Ghazalian, 2015; Koo et al., 2006; Serrano and Pinilla, 2012; Serrano and Pinilla, 2014).

The results of model 2 show that the inclusion of domestic trade in the model specification does not substantially change the coefficients belonging to the standard gravitational variables or their significance. The results of model 2 show that extending the sample to domestic trade is minimal, but it increases the expected impact of regional trade agreements. This finding supports that regional trade agreements increase trade between members to the detriment of domestic sales.

Model 3 shows the PPML estimation results for the fixed effect per country pair. It is still important for the application that the coefficient of the RTA variable is statistically significant and positive, but smaller than the estimated coefficient obtained with the previous specifications. The positive and significant estimation of RTA is in line with Baier and Bergstrand (2007) predictions that estimates of the impact of regional trade agreements on trade, which were made without due consideration of endogeneity, are skewed upwards, as RTA coefficients are higher in Model 1 2. as in model 3, which treats endogeneity with a pairwise fixed effect. In models 1-3., the significant, positive coefficients of the RTA variable suggest that common RTA membership, regardless of any static control variables examined, clearly leads to an increase in international trade in maize trade.

To test whether the specification took due account of possible "reverse causal relationships" between trade and RTA membership through fixed country pair effects, i.e., that trade between two countries has already intensified in the years leading up to joint RTA membership. Following the work of Wooldridge (2010), I performed a test by adding a new variable that captures the impact of future RTA membership. The results of model 4 show that future RTA membership has a significantly positive effect on current trade between members. This suggests that trade relations between future members may develop even before membership is established, which will have a positive effect.

Model 5 shows the delays in belonging to a regional trade agreement (RTA) by 4, 8, and 12 years, respectively. This allows us to examine the "permanence" of the effect of RTA membership over time, i.e., whether this effect increases or decreases over time after membership. In Model 5, in the presence of delayed RTA variables, the significant effect of the current year RTA variable disappears. This suggests that past intensity is much more important in the intensity of trade relations between the two countries than whether there is a free trade agreement between them in the current year. It is telling that a significant, positive effect is seen only in the case of the eight-year delay (RTAt-8) in Model 5. This also suggests that bilateral trade relations within the RTA can only be expected to "flourish" years after the conclusion of the agreement.

The last specification of the model is applied based on the methods developed by Bergstrand et al. (2015), which takes into account the possible effects of globalization. We supplement the model with a new indicator that records the existence of international borders between countries *i* and *j* for each year *t*. Due to the perfect collinearity of the other fixed effects in the specification, it is impossible to estimate these international boundaries for all years in the sample. Compared to 2015, we interpret the results of the other years *t* (1996, 2000, 2004, 2008, 2012). There are two main results of the calculations. On the one hand, the effect of regional trade agreements describes a similar trajectory as in model 5, with the difference that the value of significant coefficients is lower. On the other hand, the effect of boundaries describes a nonlinear trajectory. The data show that the overall RTA effect decreases when the effects of globalization are taken into account.

4. CONCLUSIONS AND RECOMMENDATIONS

In the chapter examining the neighbourhood effects for the period 1996–2015, I examined whether a spatial dependence can be detected in the maize export activity of the countries of the world, which suggests the presence of neighbourhood effects (although spatial dependence alone does not prove the presence of a neighbourhood effect). By neighbourhood effect, in this case, I mean that a country's corn export activity (past or present) influences the corn export activity of neighbouring countries. I also examined whether neighbourhood effects have this demonstrable temporal dynamics in different regions and continents.

Based on the global Moran I values, it can be said that the global maize export was characterized by a weak but significant spatial dependence and a positive spatial autocorrelation in the whole period. The degree of spatial dependence fluctuated significantly in the years under review, showing no trend that could be explained by the radical expansion of the maize market. This fluctuation also shows that the presence of spatial dependence can hardly be explained solely by natural features, zones defined by climatic conditions. In the case of spatial dependence formed by natural factors, we should experience a much more stable temporal dynamics. Based on these, I can assume that the presence of spatial dependence is partly due to neighbourhood effects determined by economic phenomena and market processes. It is worth highlighting the strong autocorrelation decline between 1997-1999 (i.e. before the market expansion period). In light of the studies at the local level, it can be stated that this decrease was caused by three processes. On the one hand, the extremely high maize export activity of the United States in 1996, large

South American maize exporters (Argentina and Brazil) appeared, a major South American maize trade hub has emerged in the southern part of the continent. On the other hand, the previously insignificant European HH zone, which affects a few countries, has become an increasingly large territorial cluster of global significance. Third, the expansion of exports of "out-of-zone" members of the BRICS group of countries (South Africa, India, China) has also greatly increased the spatial dispersion of maize exports. In addition, no HH neighbourhood relations have developed around these countries, so it is probably the latter process that has had the greatest impact on reducing spatial dependence.

The results on local area autocorrelation showed that the number and extent of "hot zones" (HH clusters) increased during the study period (despite the decrease in global autocorrelation). Based on this, it can be stated that the radical expansion of the maize market has primarily led to the strengthening of spatial dependence (and presumably, in the background of this, neighbourhood relations) at the local level, limited to few region at a time. Statistically, I identified the stable presence of three HH clusters: the North American, the South American, and the European clusters. Among the examined regions, neighbourhood relations play a key role in maize export activity in Europe, especially among the EU member states that make up the single market. The results also demonstrate the positive impact of a single market and free trade institution of the EU on neighbourhood relations. On the other hand, it can be seen that some of the countries with the largest export growth (especially India, China, South Africa, and partly Russia) form "emerging" islands from their own territories, zones. True, the results show that the advance of the maize market in the countries listed here did not even worsen the export positions of neighbouring countries. The analysis revealed that neighbourhood effects also show dynamics over time, i.e., past neighbours 'export performance may have an impact on subsequent maize exports for certain countries and regions. The temporal dynamics of the neighbourhood effects were also observed in the case of the three "hot zones" that had already emerged during the spatial autocorrelation.

The second empirical chapter examined the influencing effects of world maize trade between 1996 and 2015 using a gravity model. World maize trade has more than tripled in two decades and there have also been significant changes among market participants for both exporters and importers.

The results suggest that during this period of radical growth, the volume of bilateral maize trade was negatively significantly affected by the distance between the two countries and the past colonial relationship. The significant negative effect of distance is fully consistent with those described in the literature (Disdier and Head, 2008; Head and Mayer, 2013). The magnitude of the distance coefficient, on the other hand, contradicts expectations (Disdier and Head, 2008; Yotov, 2012) that the relative importance of transaction costs (and thus distance) decreases significantly in globalized markets (such as the maize market). This contradiction is known in the international literature as the "distance puzzle" problem (Coe et al., 2002). Following the work of Borchert and Yotov (2017), I also considered the commercial distance within the country, however, the distance puzzle remained in this case as well. In the market of mass agricultural products, (such as maize) transport distance, due to the specific logistical characteristics of these products, still seems to be a factor of paramount importance.

The results on the influencing effect of regional trade agreements are in line with the results of other research. In the present case, with regard to RTA membership, it can be stated that accession to the RTA is generally preceded by a resurgence of bilateral trade relations. I can also say that there is a reciprocal positive feedback effect between the level of bilateral trade and RTA membership. However, after the establishment of the joint RTA membership, its trade-increasing effect is not immediately perceptible, they show a significant positive effect in the case of an eight-year delay. The results suggest that the effects of globalization may weaken the effects of the regional trade agreements.

5. NEW RESEARCH RESULTS

In the case of the examination of the neighbourhood relations of the maize market, the theoretical importance of the results is mainly given by the novelty of the research topic itself. I am not aware of any research that has previously looked at the subject of countries 'export activity. This is presumably due to the fact that export activity and its instability over time are much larger than most of the economic phenomena that are the subject of regional autocorrelation studies. This is especially true for agricultural products with specific supply and demand. At the same time, the chapter proves that spatial dependence is also a significant factor in international trade in maize. Based on this fact, it is worthwhile to conduct further research on whether the development of spatial dependence is indeed underpinned by the economic effects of neighbourhood relations. The tools (spatial regression models, bivariate and differentiated autocorrelation estimates) are available to clearly address the issue. Their application can form the basis for further studies.

The practical significance of the results of the neighbourhood impact chapter is to draw attention to the regional significance of free trade agreements and the single market. Developments in Europe support the integration impact of EU enlargement, but similar free trade effects can be assumed for North and South America. Neighbourhood relations play a particularly important role in the Central and Eastern European region, where a significant number of countries do not have maritime / port connections. Further research is also worthwhile in this area. The chapter has two new research findings:

1. Spatial dependence is a significant factor in international trade in maize.

2. Neighbours' export performance is also dynamic over time for some countries and regions.

The second empirical chapter can be seen as a continuation of the chapter on neighbourhood relations, as it previously drew attention to the importance of regional and free trade agreements for international trade in maize. In addition, during the examined period, it can be seen that not only is there a significant increase in the maize trade on a global scale, but the number of different regional trade agreements is also growing rapidly worldwide. What is new about this chapter is that, in the case of international trade in maize, no studies have previously been carried out to address the various effects of regional trade agreements on the sector at a global level.

As I expected, as the geographical distance increases, maize trade between countries will decrease. Regional trade agreements between countries clearly lead to an increase in international maize trade, beside any static control variable. Furthermore, RTAs have boosted trade between members to the detriment of domestic sales in member countries. Based on this new practical result, it may be worthwhile to carry out further research, which will focus on the impact of a regional trade agreement on the member states of a given RTA and on non-member countries. Based on the free trade effects assumed in the previous chapter of the dissertation, I propose for further research the following RTAs: European Union, North American Free Trade Agreement (NAFTA), Southern Common Market (MERCOSUR), Andean Community and the latter Union of South American Nations.

During the examination of influential impact of regional trade agreements, I covered their past and future effects. Based on the results, it can be said that the regional trade agreement has a positive effect on maize trade between the countries even before they were concluded, as I have experienced an increase in bilateral trade between the countries. The results also show that there will be no further recovery among member states immediately after membership. I experienced a trade-increasing effect only in the case of an eight-year delay. Based on the results, it can also be said that the impact of RTAs in the international maize trade decreases if I take into account the impact of globalization.

The second empirical chapter of the dissertation has two further new research results:

3. RTAs can lead to an increase in international trade in the maize market, even to the detriment of domestic trade.
4. The effects of globalization may weaken the effects of regional trade agreements.

6. SCIENTIFIC PUBLICATIONS ON THE TOPIC OF THE DISSERTATION

Publication in an international journal

Fertő I., **Szerb A.B.** (2017): The role of food crisis and trade costs in the Hungarian maize exports, Zagadnienia Ekonomiki Rolnej, 353 (4) 110-124. Poland (e-ISSN 2392-3458)

Fertő I., **Szerb A.B.** (2018): The duration of the Hungarian maize exports, Bulgarian Journal of Agricultural Science, 24 (3) 352-359. Bulgaria

Publication in a domestic journal

Szerb A.B. – Csima F. (2016): *A magyar gabonaexport szállítmányozási trendjei*, Köztes-Európa, 8 (1-2) 19-20. Szeged (ISSN 2064-437X)

Fertő I., **Szerb A.B.** (2019): A Magyar kukorica exporttartóssága 1996 és 2015 között, Gazdálkodás. 63 (6) 474-485. DOI: 10.22004/ag.econ.298734

Szerb A.B. (2016): *The opportunities of the Hungarian corn at the international agricultural markets in 2016*, Regional and Business Studies, 8 (1) 59-67. Kaposvár University

Paper published in full in a domestic scientific conference

Fertő I. – **Szerb A.B.** (2017): *The role of economics crisis and trade costs in the Hungarian maize exports,* Proceedings of 6th International Conference of Economic Sciences, Kaposvár, 4-5 May 2017. Hungary

Szerb A.B. – Fertő I. – Csonka A. (2019): *Determinants of global maize export: The gravity model approach,* Proceedings of International

Conference on Sustainable Economy and Agriculture, 14th November 2019. Kaposvár University, Kaposvár

Abstract or poster published in a domestic scientific conference

Szerb A.B. – Csima F. (2017): *A hazai gabonaszektor potenciális versenyelőnyeinek megteremtése a logisztikai szolgáltatások fejlesztésének köszönhetően.* A fantázi (erő)terei Tudományos Konferencia, Kaposvár, 2017.05.19. (ISBN 978-615-5599-39-2)

Szerb A.B. – Fertő I. – Csonka A. (2019): *Determinants of global maize export: The gravity model approach,* International Conference on Sustainable Economy and Agriculture, 14th November 2019. Kaposvár University, Kaposvár, pp. 83. (ISBN978-615-5599-72-9)

In press

Szerb A.B. – Fertő I. – Csonka A. (2021): Szomszédsági hatások a világ kukorica piacán 1996 és 2015 között, *Acta Agraria Kaposváriensis*

Szerb A.B. – Csonka A. – Fertő I. (2021): A regionális kereskdelemi megállapodások hatása a világ kukorica kereskedelmére, *Statisztikai Szemle*

Fertő I. – **Szerb A.B.** (2021): A külkereskedelmi költségek és az élelmiszer-válság hatása a magyar kukoricaexportra, *Gazdálkodás*