

Determinants of agri-food trade: empirical evidence from North Macedonia

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ABSTRACT

The study aims to evaluate the impact of selected factors on North Macedonia's agri-food trade flows for the period 1995-2024 by using the gravity model approach. Findings indicate that within this period, agri-food trade was shaped by the economic size of the agricultural sectors in North Macedonia and its trading partners, as well as geographic distance, contiguity, free trade agreements, historical links with former Yugoslav republics and cultural proximity. Results also underscore that economic ties with the former Yugoslav republics had the highest enhancement effect on the total trade volumes and imports. However, trend analysis highlights that this effect has been gradually diminishing amidst the more dynamic development of trade ties with other countries. Simultaneously, the positive impact of trade agreements, particularly the one with the European Union, has grown stronger, offsetting the declining influence of historic regional ties and reducing the negative impact of geographic distance. In general, trade agreements, to a certain extent, have strengthened the competitiveness of the Macedonian export-oriented agri-food sector. This study fails to find conclusive evidence about the significance of religious beliefs as a determinant of agri-food trade.

Keywords: gravity model, agri-food trade, trade costs, North Macedonia, economic integration

INTRODUCTION

The agricultural sector plays a pivotal role in any economy by providing essential goods such as food, raw materials for related industries, and employment opportunities. Agriculture often employs a large portion of the workforce and catalyzes economic growth in agriculture-based developing countries (Dethier and Effenberger, 2012). In the case of North Macedonia, historically, agriculture has also been one of the main economic pillars. According to the State Statistical Office in 1992, agriculture generated 14.5% of the GDP and accounted for 27% of the total employment. However, over the last decades, growth rates in the Macedonian agricultural sector have been relatively modest vis-à-vis other sectors, which ultimately led to a decrease of its share within the national economy. The agricultural sector in 2024 accounted for 16.8% of the total employment and 7.3%

of the GDP. Nevertheless, these figures are still significantly higher than those of other more developed European economies. For instance, agriculture in Germany and France accounts for 0.8% and 1.4% of the GDP, respectively (WB, 2025).

Although it has exhibited similar trends, agri-food trade remained one of the most important categories within the trade structure. In 2024, agri-food accounted for 9.6% of the total Macedonian exports to other countries. Similarly, agri-food accounted for 11.7% of the total imports (UNCTAD 2025). In this context, it is noteworthy that North Macedonia runs an agri-food trade deficit. Moreover, this deficit in 2024 reached \$598.9 million, a 12.8-fold increase compared to 1995. In general, this deficit underscores the country's growing import dependency. Previous empirical studies indicate that this growing reliance on imports is mainly attributable to low

productivity and underdeveloped value chains as well as small and fragmented land holdings (Gjosheva Kovachevikj et al., 2025).

Considering the significance of the agricultural sector for developing countries and the challenges North Macedonia experiences, the objective of this empirical research is to identify the key factors shaping its bilateral agri-food trade flows by applying the gravity model to panel data for the period 1995-2024, covering 71 countries. This research will contribute to the empirical research on determinants of agri-food trade, especially in terms of low-income countries. The use of agricultural gross value added is a meaningful contribution, given that previous research is almost exclusively based on using the total gross value added or GDP per capita of the trading countries as a measure of their economic size and trade opportunities. The results are especially relevant for North Macedonia, given that in recent years its agricultural sector has experienced some issues that have generated a larger agri-food trade deficit.

This paper is structured as follows: Section 2 provides an overview of previous research related to determinants of agri-food trade in both developed and developing countries. Section 3 explains the methodology used to evaluate the effects of selected factors on agri-food trade. Then, Section 4 presents the main results of the empirical analysis based on the gravity model. Section 5 highlights the key conclusions and identifies the most important policy implications.

LITERATURE REVIEW

International trade theories play a crucial role in explaining why nations engage in commerce with each other. Adam Smith introduced the concept of absolute advantage based on differences in production costs between countries. David Ricardo later developed the comparative advantage theory, which argues that even if one country has lower cost advantages than another, both will still benefit from specializing according to their relative strengths. Heckscher-Ohlin theorem further refined this idea by focusing on resource endowments

rather than just labor efficiency alone (Rivera-Batiz et al., 2020; Shahriar et al., 2019). However, these traditional approaches were challenged when empirical evidence showed their limited explanatory power. Newer models emerged addressing these gaps, including Paul Krugman's New Trade Theory, which suggests that countries may specialize in producing certain goods not because they have an absolute or comparative advantage but due to increasing returns to scale and imperfect competition (Krugman et al., 2022). Krugman's theory has proven to be better suited to explain trade in similar products between advanced countries (Zhang, 2008). Another significant contribution comes from Michael Porter's Diamond Model emphasizing four determinants - factor conditions, demand structure, supporting & related industries, along with firm strategies - that together determine competitive success at the national level, influencing firms' ability to compete globally (Porter, 1985).

Another major theory is the gravity model of trade, which argues that trade flows between two countries are proportional to their economic size and geographic proximity. Although initially criticized for being merely theoretical, over the past few decades, the gravity model has become one of the most frequently used theories due to its proven ability to accurately predict bilateral trade flows across a variety of industries and regions (Kabir et al., 2017; Shahriar et al., 2019). As a result of its popularity and relative simplicity, the existing literature on trade determinants based on augmented gravity models is extensive. For instance, Martinez-Zarzoso and Nowak-Lehmann (2003) used an augmented gravity model to analyze trade patterns between Mercosur and the EU. The empirical study of Cortes (2007) researched the composition of trade between Australia and Latin America and revealed that economic distance, openness and political influence explain the trade of primary products. Sohn (2005) also used the augmented gravity model to evaluate South Korea's trade flows.

This approach has also been extensively applied to agricultural trade, as an important part of the global trade. An empirical study by Balogh and Leitão (2019) applies

the gravity model to agricultural trade between the EU and African, Caribbean and Pacific countries using the Pseudo-Poisson maximum likelihood (PPML) estimation method. They provide evidence that agricultural trade is influenced by gravity factors and that export costs are lower if the trading partners are culturally similar, share the same religion and participate in regional trade agreements. Another study by Balogh and Jámboř (2017), which analyzes the wine industry, provides similar conclusions. Hatab et al. in their 2010 study investigated the determinants of Egyptian agricultural exports using a combination of the Ordinary Least Squares (OLS), fixed and random effects estimation methods. Their findings indicate that besides the standard gravity variables, trade openness, common language, sharing a border and trade agreements have a positive impact on trade flows. Also, the authors find that in the case of Egypt, the increase in Egypt's GDP per capita causes exports to decrease. Similarly, Ševela (2002) also finds that an increase in GNI per capita reduces Czech agricultural exports. On the contrary, Łapinska in her 2014 study finds that trade in agricultural and food products between Poland and EU countries is positively influenced by an increase in their GDP per capita. Łapinska also provides evidence that economic integration, proxied by EU membership, and language similarities increase trade. Braha et al. (2017) analyze Albanian agricultural exports and also find grounds to support these arguments. Helble (2006) uses OLS estimation to analyze trade and finds that common religion, border, language, historical (colonial) links and trade agreements have a positive impact. Lewer and Van den Berg (2007) also find that certain cultures, including Eastern Orthodox, have a positive influence on bilateral trade.

Although the gravity model has already been used to identify the determinants of bilateral trade flows of North Macedonia (for instance, Kikerkova et al., 2021), it has not been explicitly used to analyze agri-food trade of the country. Therefore, by analyzing the effects of most of the variables mentioned in the literature review on the bilateral agricultural trade flows, this study will provide a meaningful insight into this matter.

METHODOLOGY

This study applies the gravity approach to panel data, compiled by the authors based on data collected by the United Nations Conference on Trade and Development (UNCTAD) and the World Bank. The panel spans a period of 30 years (1995-2024) and includes 71 countries (Appendix A). These countries accounted for 99,3% of the Macedonian agri-food trade turnover in 2024.

Based on previous studies (Bologh and Leitão, 2019; Łapinska, 2014; Hatab et al., 2010; Cortes, 2007; Helble, 2006; Ševela, 2002) and considering some country-specific factors, the specification of the empirical model is as follows:

$$\ln X_{i,j,t} = \beta_0 + \beta_1 \ln GVA_{i,t} + \beta_2 \ln GVA_{j,t} + \beta_3 \ln DIST_t + \beta_4 FTA_t + \beta_5 EX-YU_t + \beta_6 SLAV_t + \beta_7 REL_t + \beta_8 BORD_t + e_t \quad (1)$$

The dependent variables are defined as $X = \{T, E, I\}$ where T is the total agri-food trade volume (exports + imports), E - total agri-food exports and I - total agri-food imports of North Macedonia with country i in year t . The values of these indicators are based on the Standard International Trade Classification (all food items: SITC 0 + 1 + 22 + 4).

It must be noted that despite the fact that the model is based on previous research, instead of the typical variables measuring the economic dimension of the trading partners (GDP in nominal prices or GDP per capita), this study uses the agriculture, forestry and fishing (gross) value added (GVA). The rationale behind this decision is that taking GDP as a variable might provide ambiguous results due to the fact that the whole GDP does not accurately reflect the ability of a country to produce and trade in agri-food products. This is especially the case when considering developed industrial countries, which, despite having large agricultural sectors, have a relatively low share of agriculture in GDP compared to developing countries. This stance is also substantiated by other studies using this variable instead of GDP (Zolanvari Shirazy and Farajzadeh, 2023; Devadoss et al., 2022). Moreover, by using industry-level data on bilateral trade flows and output, Anderson and Yotov (2010) reveal that gravity estimates vary across industries and countries. This

indicates that a large aggregation bias is present when comparing the results with gravity coefficients estimated on aggregates, thus supporting the decision to use agricultural gross value added and not the entire GDP. It is expected that the GVA of North Macedonia and its trading partners will be a positive sign.

Geographical distance (*DIST*) refers to the straight-line flight distance from the capital of North Macedonia to the capitals of trading partners. This variable is expected to have a negative sign given that geographic distance is associated with higher transaction costs (Balogh and Leitão, 2019; Hatab et al., 2010; Ševela, 2002).

The model also uses *FTA*, *EX-YU*, *SLAV*, *REL* and *BORD* as dummy variables. *FTA* takes the value 1 if North Macedonia had a free trade area with the trading partner in year *t* and 0 otherwise. Value 1 was assigned to EU members, EFTA, CEFTA countries, Turkey, Ukraine and the UK, i.e. a total of 36 countries (Appendix A). *FTA* aims to capture the level of trade-creation effects of trade agreements. *BORD* takes the value 1 if North Macedonia shares a border with the trading partner. Value 1 was assigned to Bulgaria, Greece, Serbia and Albania. Given data limitations, Kosovo was excluded from the dataset. *EX-YU* aims to measure the effects of historical links. Hence, it takes the value 1 if the trading partner was a constituent republic of Yugoslavia (Serbia, Croatia, Slovenia, Montenegro, Bosnia & Herzegovina). *SLAV* aims to capture the effects of cultural proximity and takes the value 1 if a large share of the trade partner's population is Slavic. Value 1 was assigned to Serbia, Montenegro, Bosnia & Herzegovina, Croatia, Slovenia, Bulgaria, Slovakia, Poland, Czech Republic, Russia, Belarus and Ukraine (12 countries). Religious beliefs can also affect food preferences and consumption. For instance, Judaism and Islam prescribe particular regulations regarding the methods of preparing food (Heiman et al., 2019). Hence, *REL* aims to capture its effects on trade flows. *REL* takes the value 1 if the majority of the trading partner's population is Eastern Orthodox and 0 if not. Value 1 was assigned to Moldova, Greece, Serbia, Romania, Russia, Bulgaria, Cyprus, Belarus, Montenegro and Ukraine (10 countries).

Although frequently used, the common language dummy variable was not included in order to avoid multicollinearity issues due to the fact that all of the countries that would have been assigned the value 1 are already covered by both the *EX-YU* and *SLAV* variables.

Supported by existing literature, it is expected that all of the dummy variables will have a positive sign. The studies of Balogh and Leitão (2019), Hatab et al. (2010), Łapinska (2014) find a positive impact of regional trade agreements, contiguity, historical ties and culture on bilateral trade flows. Hwang and Guo (2006) also find that culture positively affects trade. Helble (2006) and Lewer and Van den Berg (2007) provide evidence that religious aspects positively influence trade patterns.

Table 1 presents a summary of the selected dependent and independent variables used in the sample and their expected signs.

In line with previous gravity-based studies on trade determinants (Sohn, 2005; Helble, 2006; Cortes, 2007; Anderson and Yotov, 2010), the model is estimated using a pooled OLS estimator. It should be mentioned that the presence of a large number of zero bilateral trade flows, which cannot be captured by a simple log-linear OLS regression, can be challenging in gravity estimations. Santos-Silva and Tenreyro (2006) argue that the zero issue could provide biased estimates and therefore favor the PPML estimator over the OLS. Nevertheless, given that only 11% of the observations have zero value and the countries with which North Macedonia at some point had zero trade flows currently constitute just 1% of the total trade volume, a simplified logarithmic transformation proposed by Yeyati et al. (2003) was used to address this issue. In line with this approach, zeros were eliminated by increasing them by 1 and then taking the logarithmic value. It is also noteworthy that Anderson and Yotov (2010) find a very high correlation between the PPML and OLS estimates, suggesting certain interchangeability if the purpose of the research is to establish the direction of influence.

Table 1. Macedonian agri-food trade and gravity model: summary

Variables	Description	Expected sign
<i>Dependent variables</i>		
<i>T</i>	Total trade volume (exports + imports) in current US dollars	
<i>E</i>	Exports in current US dollars	
<i>I</i>	Imports in in current US dollars	
<i>Independent variables</i>		
$GVA_{i,t}$	Agriculture, forestry, and fishing, value added in trading partners in current US dollars	+
$GVA_{j,t}$	Agriculture, forestry, and fishing, value added in North Macedonia in current US dollars	+
<i>DIST</i>	Geographic distance in km	–
<i>FTA</i>	Free trade agreements, binary variable	+
<i>EX-YU</i>	Economic ties with the former Yugoslav republics, binary variable	+
<i>SLAV</i>	Cultural proximity, binary variable	+
<i>REL</i>	Religious aspects (common religion), binary variable	+
<i>BORD</i>	Common border, binary variable	+

Source: own composition based on literature review

RESULTS

Table 2 displays the descriptive statistics of the variables used in Equation (1). As is observable, exports exhibit a lower average value than imports, which is quite logical given that North Macedonia maintains an agri-food trade deficit. Also, the average value of the trading partner's size of the agricultural sector is higher than the average value for North Macedonia. Moreover, the maximum value is likewise significantly higher. This would suggest that the country tends to trade with countries that have larger agricultural sectors and, by extension, larger economies. This aligns well with logical reasoning, given that countries with larger agricultural sectors and markets are able to export and consume (import) more and hence can be viewed as preferable trading partners.

Among the dummy variables, *FTA* has the highest average value. This signifies that most of the countries in the dataset, and by default in the agri-food trade structure of North Macedonia, are covered by trade agreements. In this context, it should be mentioned that North Macedonia's trade agreements cover a total of 40 countries, 36 of which were included in the dataset.

Correlation analysis was used in order to assess the relationship between the independent and dependent variables. Table 3 displays the results. In general, the relationship between the variables has the anticipated signs. The overall trade volume, exports and imports exhibited positive correlation with all of the independent variables, the exception being geographical distance.

Among the dummy variables, *FTA*, proxying the effects of trade agreements, exhibits the highest correlation with the trade indicators, especially with exports. It must be noted that the dummy variables correlate more with exports than with imports. This would suggest that the effect of these factors on exports might be more pronounced.

Considering the arguments of previous studies (Anderson and van Wincoop, 2003; Bergstrand, 1985) that the gravity approach heavily uses variables that have constant values or negligible variations, which do not significantly affect the reliability of statistical inferences, a unit-root test was not performed.

Table 2. Descriptive statistics

Variables	Minimum	Maximum	Mean	St Dev	Observations
$\ln T_{ij}$	0.00	20.03	14.27	3.77	2130
$\ln E_{ij}$	0.00	18.90	11.13	6.03	2130
$\ln l_{ij}$	0.00	19.63	12.96	4.71	2130
$\ln GVA_{i,t}$	18.53	27.90	22.64	1.65	2130
$\ln GVA_{j,t}$	19.71	20.87	20.42	0.39	2130
$\ln DIST$	5.04	9.65	7.75	1.15	2130
FTA	0.00	1.00	0.35	0.48	2130
EX-YU	0.00	1.00	0.07	0.26	2130
SLAV	0.00	1.00	0.17	0.37	2130
REL	0.00	1.00	0.14	0.35	2130
BORD	0.00	1.00	0.06	0.23	2130

Source: own composition based on UNCTADstat (2025) and World Bank (2025) data

Table 3. Correlation matrix of the variables

	$\ln T_{ij}$	$\ln E_{ij}$	$\ln l_{ij}$	$\ln GVA_{i,t}$	$\ln GVA_{j,t}$	$\ln DIST$	FTA	EX-YU	SLAV	REL	BORD
$\ln T_{ij}$	1.00										
$\ln E_{ij}$	0.64	1.00									
$\ln l_{ij}$	0.82	0.39	1.00								
$\ln GVA_{i,t}$	0.29	0.05	0.32	1.00							
$\ln GVA_{j,t}$	0.35	0.27	0.29	0.20	1.00						
$\ln DIST$	-0.29	-0.52	-0.19	0.46	0.00	1.00					
FTA	0.32	0.44	0.32	-0.20	0.43	-0.53	1.00				
EX-YU	0.24	0.26	0.20	-0.32	0.00	-0.43	0.16	1.00			
SLAV	0.28	0.35	0.21	-0.26	0.00	-0.49	0.19	0.61	1.00		
REL	0.18	0.28	0.10	-0.21	0.00	-0.47	0.15	0.21	0.47	1.00	
BORD	0.23	0.24	0.20	-0.12	0.00	-0.47	0.14	0.17	0.22	0.43	1.00

Source: own composition

Table 4 presents the results of the estimated gravity models. In order to assess the general enhancement effects of different variables, as well as their dynamic trends, five sets of regressions with different time periods were evaluated. Three sets have a time period of 10 years, one set has a period of 20 years, and one covers the whole period 1995-2024 (30 years). According to the designed methodology, all of the models were estimated using the pooled ordinary least squares (POLS) method. The adjusted R² of the regressions varies between 0.30 and 0.58. These values mainly correspond with similar empirical studies (Łapinska J., 2014; Hatab et al., 2010; Cortes, 2007), i.e. are generally acceptable and can be used to provide a deeper understanding of the determinants of agri-food trade. Moreover, the F-test showed that all regressions are statistically significant. Given that preliminary data analysis using the Breusch-Pagan and Breusch-Godfrey tests showcased some signs of heteroskedasticity and autocorrelation, the Newey-West estimator was used to derive heteroskedasticity- and autocorrelation-consistent (HAC) standard errors (Newey and West, 1986). Variance inflation factor (VIF) was used to check for multicollinearity. No significant presence of it was detected (Appendix 2).

In terms of the coefficients of the variables, the agriculture value added in North Macedonia and its trading partners and geographic distance in almost all of the models showed the anticipated signs. However, it's noteworthy that the coefficients of the Macedonian agriculture GVA in all of the models covering the period 1995-2004 have negative signs but are statistically insignificant. The initial negative sign indicates that during the earlier period (1995-2004), an increase in this variable was associated with a decrease in agricultural exports and imports. However, this association was not strong enough to be considered reliable or meaningful due to its statistical insignificance. Given that in the later periods the variable's impact on trade flows has changed directionally and become more robustly supported by data, it is implied that as new observations were added to the dataset, the underlying relationship became clearer and stronger, which improved the reliability of the estimation.

Overall, the full-period (1995-2024) models indicate that the economic size of the agricultural sector indeed positively impacts agri-food trade flows. When considering exports, it should be highlighted that the coefficient of the Macedonian GVA is higher than the coefficient of the GVA of trading partners, indicating that changes in the size of the domestic agricultural sector have a larger impact than the same changes in trading partners. Namely, a 1% increase in the Macedonian GVA would result in a 2.06% increase in exports, while a 1% increase in the trading partners' GVA would result in a 1.26% increase. On the other side, in terms of imports, the situation is reversed. A 1% increase in the trading partner's GVA would yield a 1.44% increase in imports, while the same increase in domestic GVA would yield a 0.9% increase in imports. Overall, this situation is logical given that exports are mostly dependent on the domestic production capabilities and imports on the production capabilities of the trading partners.

On the contrary, geographic distance has a negative effect. This aligns well with previous empirical studies (Balogh and Leitão, 2019; Hatab et al., 2010; Cortes, 2007). The negative effect of this variable is mostly related to the fact that distance increases the costs of trade. In general, the coefficient of the distance variable in the models covering exports is higher than in the models covering imports. This indicates that geographic distance has a larger negative impact on exports. To a certain extent, this is anticipated given that North Macedonia imports a variety of agri-food items (bananas, coconuts, coffee, spices, etc.) from countries that are traditionally key leaders in those segments and are geographically distant, while exports are still mainly targeting European markets. However, it is noteworthy that the negative effect of geographic distance on both exports and imports has been gradually decreasing, which signifies that North Macedonia's trade-oriented agri-food sectors are slowly expanding their horizons.

In terms of the dummy variables, for the full period, the EX-YU variable, proxying historical ties with former Yugoslav republics, has had the highest enhancement effect on the total trade volumes, as well as imports. In

Table 4. Results of the gravity model estimation

	1995-2004	2005-2014	2015-2024	1995-2014	1995-2024
Total trade					
<i>Intercept</i>	-9.00 (18.77)	-26.63*** (10.23)	-43.36* (25.94)	-37.88*** (6.12)	-43.87*** (5.28)
<i>lnGVA_{it}</i>	1.69*** (0.14)	1.07*** (0.09)	0.68*** (0.04)	1.39*** (0.09)	1.16*** (0.06)
<i>lnGVA_{jt}</i>	-0.25 (0.94)	0.93** (0.46)	2.12* (1.22)	1.38*** (0.30)	1.85*** (0.26)
<i>lnDIST</i>	-1.53*** (0.23)	-0.41** (0.19)	-0.23** (0.11)	-1.09*** (0.16)	-0.88*** (0.13)
<i>FTA</i>	1.41*** (0.50)	1.38*** (0.32)	1.62*** (0.21)	0.90*** (0.25)	1.03*** (0.19)
<i>EX-YU</i>	3.44*** (0.49)	2.77*** (0.25)	1.75*** (0.16)	3.09*** (0.30)	2.69*** (0.22)
<i>SLAV</i>	1.53*** (0.46)	1.26*** (0.15)	0.89*** (0.15)	1.33*** (0.25)	1.14*** (0.17)
<i>REL</i>	0.57 (0.51)	-0.04 (0.18)	0.04 (0.15)	0.23 (0.27)	0.16 (0.19)
<i>BORD</i>	1.01** (0.54)	2.12*** (0.31)	1.53*** (0.17)	1.45*** (0.32)	1.43*** (0.24)
<i>Adjusted R²</i>	0.35	0.47	0.58	0.40	0.43
<i>Observations</i>	710	710	710	1420	2130
<i>F</i>	48.00	78.94	125.33	119.56	202.54
Exports					
<i>Intercept</i>	4.54 (24.82)	-30.99* (14.73)	69.99 (53.17)	-32.04*** (9.84)	-39.24*** (8.38)
<i>lnGVA_{it}</i>	1.60*** (0.18)	1.38*** (0.12)	0.80*** (0.14)	1.49*** (0.12)	1.26*** (0.10)
<i>lnGVA_{jt}</i>	-0.07 (1.25)	1.10 (0.72)	-3.29 (2.56)	1.61*** (0.52)	2.05*** (0.45)
<i>lnDIST</i>	-3.90*** (0.25)	-1.75*** (0.26)	-1.22*** (0.36)	-3.17*** (0.21)	-2.74*** (0.18)
<i>FTA</i>	1.43** (0.68)	3.24*** (0.47)	3.78*** (0.61)	1.47*** (0.38)	1.87*** (0.32)
<i>EX-YU</i>	1.73*** (0.56)	2.16*** (0.83)	0.69* (0.41)	1.80*** (0.39)	1.46*** (0.33)
<i>SLAV</i>	2.15*** (0.44)	1.90*** (0.61)	1.45*** (0.32)	1.97*** (0.44)	1.72*** (0.23)
<i>REL</i>	0.36 (0.51)	0.82** (0.58)	0.93*** (0.29)	0.44 (0.32)	0.55** (0.24)
<i>BORD</i>	-1.52*** (0.62)	0.50 (0.84)	-0.23 (0.48)	-0.82* (0.44)	-0.75** (0.75)
<i>Adjusted R²</i>	0.47	0.43	0.37	0.46	0.44
<i>Observations</i>	710	710	710	1420	2130
<i>F</i>	78.15	67.67	52.87	151.73	211.99
Imports					
<i>Intercept</i>	-18.10 (23.21)	-26.67** (13.71)	-69.03 (43.13)	-31.60*** (8.43)	-37.03*** (7.07)
<i>lnGVA_{it}</i>	1.87*** (0.15)	1.32*** (0.12)	1.12*** (0.10)	1.60*** (0.10)	1.44*** (0.08)
<i>lnGVA_{jt}</i>	-0.16 (1.16)	0.18 (0.66)	2.37 (2.06)	0.57 (0.45)	0.90** (0.38)
<i>lnDIST</i>	-1.28*** (0.26)	0.50* (0.30)	0.77*** (0.29)	-0.64*** (0.20)	-0.34** (0.16)
<i>FTA</i>	2.35*** (0.62)	3.53*** (0.61)	4.31*** (2.98)	2.30*** (0.38)	2.71*** (0.32)
<i>EX-YU</i>	4.54*** (0.89)	4.02*** (0.48)	2.98*** (0.29)	4.21*** (0.52)	3.83*** (0.38)
<i>SLAV</i>	1.08 (0.82)	1.41*** (0.33)	1.27*** (0.21)	1.17*** (0.46)	1.15*** (0.32)
<i>REL</i>	-0.08 (0.81)	-0.17 (0.37)	-0.04 (0.29)	-0.22 (0.45)	-0.20 (0.32)
<i>BORD</i>	2.37*** (0.70)	3.59*** (0.52)	3.10*** (0.35)	2.76*** (0.47)	2.79*** (0.35)
<i>Adjusted R²</i>	0.30	0.36	0.42	0.34	0.37
<i>Observations</i>	710	710	710	1420	2130
<i>F</i>	39.12	51.34	65.48	92.07	157.20

Note: The standard errors of the regression coefficients have been derived using the Newey-West estimator. Statistical significance is denoted as *** - 1% level; ** - 5% level; * - 10% level.

Source: own composition.

terms of exports, the effect is smaller vis-à-vis the control variables *FTA* and *SLAV*, proxying the effects of trade agreements and cultural proximity. To a certain extent, this lower effect of the *EX-YU* variable can be explained by the fact that these countries have already been the main export markets for the Macedonian agri-food items. Moreover, Macedonian agri-food exports have not been competitive on other European markets due to relatively high tariffs and non-tariff barriers imposed by the EU prior to the implementation of the trade agreement. It should also be underlined that the *EX-YU* effect on both exports and imports is gradually decreasing. This mostly reflects the more dynamic growth of trade volumes with other countries, especially with EU members. For instance, the trade turnover with Italy and Poland increased by 2.3 times and 2 times, respectively, over the last decade, which is higher than the increase in trade with the former Yugoslav republics.

The cultural proximity variable (*SLAV*) exhibited the same patterns as the *EX-YU* variable over the last two decades. Its enhancement effect on both exports and imports has been decreasing, indicating that the role of cultural proximity as a determinant of agri-food trade has also been diminishing. Nevertheless, cultural proximity still has a significant positive influence, especially on exports.

On the other side, the enhancement effect of the *FTA* variable on both exports and imports has been increasing over the last two decades. This is mostly attributable to the fact that the country currently maintains *FTAs* with the European Union and other CEFTA countries, which are key trading partners. The enhancement effect increased especially between 2015 and 2024. This corresponds with the fact that the implementation periods of the trade agreements with the EU and CEFTA ended in 2014 and 2015, respectively (WTO, 2025). It is also noteworthy that the increasing effect of trade agreements to a sizable extent explains the decreasing negative impact of geographic distance as well as the decreasing effect of the *EX-YU* effect given that trade agreements open access to larger, in many cases new

markets and reduce trade costs (Rodrik, 2018). This, in turn, creates new trade opportunities, hence stimulating trade flows.

The *BORD* variable, proxying the effect of contiguity and relations with neighboring countries, exhibits different results in terms of the trade flows. The coefficient of the variable when analyzing exports has a negative sign, which was not anticipated. On the contrary, *BORD* has a quite strong positive effect on imports, second only to the *EX-YU* variable. When analyzing the dynamics of the bilateral trade with neighboring countries, it is obvious that this situation is mainly attributable to the fact that Macedonian exports to neighboring countries exhibited a period of significant downfall between 2008 and 2017 (40% decrease) while imports were steadily increasing, from \$262 million in 2008 to \$444 million in 2024 (UNCTAD, 2025).

The *REL* variable, proxying the effects of religious beliefs, provides ambiguous results. In all of the models analyzing imports, the coefficients are negative and statistically insignificant. In four of the models covering the total trade volume within different time periods, the coefficients are positive but also statistically insignificant. In terms of exports, data shows that there was some positive enhancement effect of religious beliefs on exports; the coefficient in the full time-period model is positive and statistically significant at the 5% level. This indicates that there are some grounds for further research on this matter that will provide more conclusive evidence.

CONCLUSIONS

The research aimed to identify the impact of selected factors on North Macedonia's agri-food trade. Estimating the gravity model using the POLS method provided some meaningful insights into the determinants of the agri-food trade of North Macedonia. Empirical evidence shows that the size of the agricultural sectors of both North Macedonia and its trading partners is an important determinant of bilateral trade flows. Consistent with previous studies, geographic distance is found to have a negative impact. Nevertheless, the negative effect of

this variable is found to be gradually decreasing against the backdrop of trade liberalization using trade agreements, which partially mitigate the higher trade costs related to the greater geographic distance.

Analysis of exports and imports separately revealed interesting observations. Among the dummy variables proxying different aspects, trade agreements and cultural proximity with trading partners had the highest enhancement effects on exports. However, ties with former Yugoslav republics and contiguity had the highest enhancement effects on imports. This would imply that factors have a differentiated influence on trade flows. It should also be highlighted that even though the effect of most determinants has been decreasing, the positive impact of trade agreements has been increasing, especially over the last twenty years.

Overall, this paper underscores some important policy implications for other developing countries. Namely, economies can improve the export competitiveness of their agri-food products on regional and global markets by working on closing trade agreements with other countries and trade blocs while at the same time pursuing closer economic ties with countries with similar cultural and historical characteristics. Similarly, centring the trade policy around these factors can yield positive benefits in terms of imports, given that closer economic ties with similar and geographically close countries decrease trade costs and, to some extent, allow for containing imported inflation.

In the end, it should be mentioned that this study is not without its limitations. This paper does not attempt to analyze all factors that might influence agri-food trade patterns. Although it is proven that the selected variables are indeed significant determinants of agri-food trade and explain a quite sizable part of the trade patterns, econometric analysis indicates that there are other factors which have not been included in the model. The use of just the pooled ordinary least squares method, to some extent, can also be considered a limitation. However, these limitations set the ground for future research that will extend the model by adding new independent

variables that might influence agri-food trade and will employ a wider range of estimation methods, such as PPML.

REFERENCES

- Anderson, J.E., Van Wincoop, E. (2003) Gravity with Gravitas: A Solution to the Border Puzzle. *American Economic Review*, 93 (1), 170–192. DOI: <https://doi.org/10.1257/000282803321455214>
- Anderson, J.E., Yotov, Y.V. (2010) Specialization: Pro- and Anti-globalizing, 1990–2002. National Bureau of Economic Research working paper 16301. Available at: https://www.nber.org/system/files/working_papers/w16301/w16301.pdf [Accessed 05 December 2025].
- Balogh J.M., Jámor A. (2017) The global competitiveness of European wine producers. *British Food Journal*, 119 (9), 2076–2088. DOI: <https://doi.org/10.1108/BFJ-12-2016-0609>
- Balogh J.M., Leitão N.C. (2019) A gravity approach of agricultural trade: The nexus of the EU and African, Caribbean and Pacific countries. *Agricultural Economics – Czech*, 65, 509–519. DOI: <https://doi.org/10.17221/131/2019-AGRICECON>
- Bergstrand, J.H. (1985) The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence. *The Review of Economics and Statistics*, 67 (3), 474–481. DOI: <https://doi.org/10.2307/1925976>
- Braha, K., Qineti, A., Cupák, A., Lazorcakova, E. (2017) Determinants of Albanian Agricultural Export: The Gravity Model Approach. *Agris on-line Papers in Economics and Informatics*, 8 (2), 3–21. DOI: <http://dx.doi.org/10.7160/aol.2017.090201>
- Cortes, M. (2007) Composition of Trade between Australia and Latin America: Gravity Model. Working Paper Department of Economics, University of Wollongong, Wollongong. Available at: <https://documents.uow.edu.au/content/groups/public/@web/@commerce/@econ/documents/doc/uow040601.pdf> [Accessed 05 December 2025].
- Dethier, J.J., Effenberger, A. (2012) Agriculture and development: a brief review of the literature. *Economic Systems*, 36 (2), 175–205. DOI: <https://doi.org/10.1016/j.ecosys.2011.09.003>
- Devadoss, S., Ugwuanyi, B., Ridley, W. (2022) Determinants of Global Agricultural Trade. *Journal of Agricultural and Resource Economics*, 47 (3), 598–615 DOI: <http://dx.doi.org/10.22004/ag.econ.313317>
- Gjosheva Kovachevikj, M., Mrdalj, V., Popovska Stojanov D., Cagalj, M., Dimitrov, L. (2025) Agri-food import dependency and certain determinants in the context of the EU integration processes: Evidence from Bosnia and Herzegovina, North Macedonia and Croatia. Book of Proceedings, XIV International Symposium on Agricultural Sciences AgroReS 2025. Available at: <https://agro.blupress.unibl.org/agrores/index.php/agrores/article/view/84> [Accessed 04 September 2025].
- Hatab A.A., Romstad E., Huo X. (2010) Determinants of Egyptian agricultural exports: a gravity model approach. *Modern Economy*, 3 (1), 134–143. DOI: <https://doi.org/10.4236/me.2010.13015>
- Heiman, A., Gordon, B., Zilberman, D. (2019) Food beliefs and food supply chains: the impact of religion and religiosity in Israel. *Food Policy*, 83, 363–369. DOI: <https://doi.org/10.1016/j.foodpol.2017.07.007>
- Helble, M. (2006) On the Influence of World Religions on International Trade. *Princeton University Journal of Public and International Affairs*, 17, 209–232. Available at: <https://jpia.princeton.edu/past-issues/2006> [Accessed 05 December 2025].

- Hwang, E.G., Guo, R. (2006) Cultural similarity and international trade in a panel of nations. *South African Journal of Economics and Management*, 9 (2), 213-229.
DOI: <https://doi.org/10.4102/sajems.v9i2.1148>.
- Kabir, M., Salim, R., Al-Mawali, N. (2017) The gravity model and trade flows: Recent developments in econometric modeling and empirical evidence. *Economic Analysis and Policy*, 56, 60-71.
DOI: <https://doi.org/10.1016/j.eap.2017.08.005>.
- Kikerkova I., Makrevska Disoska E., Toshevska-Trpchevska K., Tonovska J. (2021) Determinants of the bilateral trade flows of North Macedonia – a gravity model approach. *DIEM Dubrovnik International Economic Meeting*, 6 (1), 98-107.
DOI: <https://doi.org/10.17818/DIEM/2021/1.10>
- Krugman, P.R., Obstfeld, M., and Melitz, M. J. (2022) *International Trade: Theory and Policy*, Global Edition, 12th Edition. Pearson Education. Pearson eLibrary.
- Łapinska J. (2014) Determinants of intra-industry trade in agricultural and food products between Poland and EU Countries. *Danube*, 5 (3), 159-172. DOI: <https://doi.org/10.2478/danb-2014-0009>
- Lewer, J.J, Van den Berg H. (2007) Religion and International Trade: Does the Sharing of a Religious Culture Facilitate the Formation of Trade Networks? *The American Journal of Economics and Sociology*, 66 (4), 765-794
DOI: <https://doi.org/10.1111/j.1536-7150.2007.00539.x>.
- Martinez-Zarzoso, I., Nowak-Lehmann, F. (2003) Augmented Gravity Model: An Empirical Application to Mercosur-European Union Trade Flows. *Journal of Applied Economics*, 6 (2), 291-316.
DOI: <https://doi.org/10.1080/15140326.2003.12040596>
- Newey, W.K., West K.D. (1986) A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. National Bureau of Economic Research Technical research paper No. 55, Cambridge. DOI: <https://doi.org/10.2307/1913610>
- Porter, M. E. (1985) *The Competitive Advantage: Creating and Sustaining Superior Performance*. NY: Free Press.
- Rivera-Batiz, F.L., Erbil, C., Opanasets, A. (2020). International Trade Theory and Evidence: A Survey. In: Erbil, C., Rivera-Batiz, F.L., eds. *Encyclopedia of International Economics and Global Trade - Volume 3: International Trade and Commercial Policy*. Boston: World Scientific, pp. 85-144.
- Rodrik D. (2018) What Do Trade Agreements Really Do? *Journal of Economic Perspective*, 32 (2), 73-90.
DOI: <https://doi.org/10.1257/jep.32.2.73>
- Santos, J. M. C., Tenreyro, S. (2006) The Log of Gravity. *The Review of Economics and Statistics*, 88 (4), 641-658.
DOI: <https://doi.org/10.1162/rest.88.4.641>
- Ševela, M. (2002) Gravity-type model of Czech agricultural export. *Agricultural Economics*, 48 (10), 463-466.
DOI: <https://doi.org/10.17221/5353-AGRICECON>.
- Shahriar, S., Qian, L., Kea, S., Abdullahi, N.M. (2019) The Gravity Model of Trade: A Theoretical Perspective. *Review of Innovation and Competitiveness: A Journal of Economic and Social Research*, 5 (1), 21-42.
- Sohn, C. (2005) Does the Gravity Model Explain South Korea's Trade Flows? *Japanese Economic Review*, 56 (4), 417-430.
DOI: <https://doi.org/10.1111/j.1468-5876.2005.00338.x>
- State Statistical Office of North Macedonia (2025): Economic account in agriculture. Available at: <https://makstat.stat.gov.mk/PXWeb/pxweb/mk/> [Accessed 06 September 2025].
- World Bank (2025) Agriculture, forestry, and fishing, value added (current US\$). Available at: <https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS> [Accessed 05 September 2025].
- World Trade Organization (2025) Regional Trade Agreements Database: RTAs in force. Available at: <https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx> [Accessed 06 September 2025].
- Yeyati, E., Panizza U., Stein, E. (2003) The cyclical nature of North-South FDI flows. *Inter-American Development Bank Working Paper No. 479*, Washington, D.C. DOI: <http://dx.doi.org/10.18235/0010807>
- Zhang, W.B. (2008) *International trade theory. Capital, knowledge, economic structure, money, and prices over time*. Berlin: Springer Berlin, Heidelberg.
- Zolanvari Shirazy, S., Farajzadeh, Z. (2023) Determinants of Agricultural Export and Trade Balance in Iran. *Journal of Agricultural Economics & Development*, 36, (4), 413-429.
DOI: <http://dx.doi.org/10.22067/jead.2023.77925.1148>

APPENDIX

Appendix 1. List of countries included in the panel dataset in alphabetical order

Nº	Country	FTA	EX-YU	SLAV	REL	BORD	Nº	Country	FTA	EX-YU	SLAV	REL	BORD
1	Albania	+				+	37	Jordan					
2	Argentina						38	Kyrgyzstan					
3	Australia						39	Latvia	+				
4	Austria	+					40	Lithuania	+				
5	Azerbaijan						41	Luxembourg	+				
6	Belarus			+	+		42	Malaysia					
7	Belgium	+					43	Mexico					
8	Bosnia	+	+	+			44	Montenegro	+	+	+	+	
9	Brazil						45	Morocco					
10	Bulgaria	+		+	+	+	46	Netherlands	+				
11	Canada						47	Norway	+				
12	Chile						48	Paraguay					
13	China						49	Philippines					
14	Colombia						50	Poland	+		+		
15	Costa Rica						51	Portugal	+				
16	Cote d'Ivoire						52	Republic of Korea					
17	Croatia	+	+	+			53	Republic of Moldova	+			+	
18	Cyprus	+			+		54	Romania	+			+	
19	Czechia	+		+			55	Russia			+	+	
20	Denmark	+					56	Serbia	+	+	+	+	+
21	Ecuador						57	Slovakia	+		+		
22	Egypt						58	Slovenia	+	+	+		
23	Estonia	+					29	South Africa					
24	Finland	+					60	Spain	+				
25	France	+					61	Sri Lanka					
26	Germany	+					62	Sweden	+				
27	Greece	+			+	+	63	Switzerland	+				
28	Hungary	+					64	Thailand					
29	India						65	Turkiye	+				
30	Indonesia						66	Uganda					
31	Iran						67	Ukraine	+		+	+	
32	Iraq						68	UAE					
33	Ireland	+					69	United Kingdom	+				
34	Israel						70	USA					
35	Italy	+					71	Viet Nam					
36	Japan												

Source: compiled by authors.

Appendix 2. Variance inflation factors of the independent variables

	1995-2004	2005-2014	2015-2024	1995-2014	1995-2024
Total trade					
$\ln GVA_{it}$	1.29	1.37	1.45	1.36	1.41
$\ln GVA_{jt}$	1.15	1.02	1.00	1.46	1.45
$\ln DIST$	2.08	3.64	4.08	2.55	2.86
FTA	1.20	2.17	2.66	1.77	1.98
EX-YU	1.75	1.79	1.78	1.76	1.76
SLAV	2.06	2.07	2.08	2.06	2.07
REL	1.59	1.63	1.63	1.60	1.61
BORD	1.44	1.48	1.46	1.45	1.45
Exports					
$\ln GVA_{it}$	1.29	1.37	1.45	1.36	1.41
$\ln GVA_{jt}$	1.15	1.02	1.00	1.46	1.45
$\ln DIST$	2.08	3.64	4.08	2.55	2.86
FTA	1.20	2.17	2.66	1.77	1.98
EX-YU	1.75	1.79	1.78	1.76	1.76
SLAV	2.06	2.07	2.08	2.06	2.07
REL	1.59	1.63	1.63	1.60	1.61
BORD	1.44	1.48	1.46	1.45	1.45
Imports					
$\ln GVA_{it}$	1.29	1.37	1.45	1.36	1.41
$\ln GVA_{jt}$	1.15	1.02	1.00	1.46	1.45
$\ln DIST$	2.08	3.64	4.08	2.55	2.86
FTA	1.20	2.17	2.66	1.77	1.98
EX-YU	1.75	1.79	1.78	1.76	1.76
SLAV	2.06	2.07	2.08	2.06	2.07
REL	1.59	1.63	1.63	1.60	1.61
BORD	1.44	1.48	1.46	1.45	1.45

Source: compiled by authors.