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FACTORS INFLUENCING THE EXPORT OF RAW MILK: THE CASE OF LITHUANIA

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Dairy products, including raw milk, play an important role in Lithuania's total gross agricultural output. The statistical data showed that the export flows of raw milk (excluding milk powder) are not stable over the years. Different results were found for exports of milk powder, where export flows do not fluctuate, and the chosen trading partner ensures export stability. In contrast, exports of raw milk (excluding milk powder), where the trading partner changes annually, have to be analysed. Therefore, the present research aims to provide insight into the main factors influencing the flow of exported raw milk (excluding milk powder) in order to ensure more stable export flows in Lithuania. To achieve the aim and objectives, the analysis, systematisation and comparison of previous empirical research were made; the present empirical research was conducted using the gravity model and collected Lithuanian raw milk (HS0401) export data for 2014-2023 using Gretl software. The present empirical research results showed that the number of milk animals has a statistically significant and higher positive impact on the export flow of raw milk. This result differs from previous empirical research and gives insight that in order to ensure raw milk export, more attention must be paid to the number of milk animals in Lithuania. The highest and statistically significant negative impact was corruption, this gives insights that agricultural organisations need to analyse corruption factors when choosing trading partners, as this leads to a decrease in raw milk export.

Keywords: *export, gravity model, international trade, raw milk*

INTRODUCTION

The production of dairy products and grain crops accounts for the largest share (about 50%) of total gross agricultural output in Lithuania (Mikelionytė & Eičaitė, 2023). The dairy sector is an important part of agricultural activity, and it is one of the priorities of agriculture in Lithuania taking into account the context of export flows (SE Agricultural Data Center, 2024). The majority of attention of the dairy sector is on the production of raw milk, unfortunately, the export of raw milk to third countries (non-EU) is not stable. According to the Access2Market database, the flow of raw milk (excluding milk powder) exported to non-EU countries was three times higher in 2023 than in 2022, but two times lower than in 2021. Over the 10 years (2014-2023), the flows of raw milk (excluding milk powder) exported differed, as in each year the largest share was exported to different partners. Based on Access2Market database was found that the export market changes due to geopolitical situations, in some periods export flows of raw milk (excluding milk powder) were to Belarus, and Moldova, now new partners are Ukraine and the United Kingdom. Looking at the data of export flows to European countries (EU), here the flows of exported raw milk (excluding milk powder) are more stable. The majority of raw milk (excluding milk powder) exported to Poland accounted for 60-70% in different years of the total export in the EU. The next two important partners in the EU are Latvia and Germany.

According to SE Agricultural Data Centre (2024), the number of milk producers decreases each year in Lithuania, in 2023 there were about 13 thousand milk producers, and the decrease counted about 10% compared to 2022 and about 20% compared to 2021. The situation does not show a bad tendency, because milk producers became larger and milk bought increased by 7 thousand tonnes in 2022-2023 compared to 2021, and its quantity was stable. This shows that a smaller number of milk producers can guarantee a similar quantity of raw milk, which means that stable export flows are also possible. There may be various barriers that need to be found out. Since 2004, when Lithuania became a part of the EU, to ensure the quality of milk, producers have to follow the Common Agricultural Policy (CAP), which is connected with various schemes of subsidies, quotas, licenses, etc. (Mikelionytė & Eičaitė, 2023). All these factors may affect the flow of exported raw milk (excluding milk powder).

The unstable situation of exports of raw milk (excluding milk powder) to non-EU countries cannot be explained, without in-depth analysis. To understand the existing situation, it is necessary to identify the main factors influencing the export flows of raw milk (excluding milk powder) to non-EU countries. Revealing the factors could help to find the right decisions to help the dairy sector subjects ensure the stability of export flows to non-EU countries. Raw milk in powder form is not included in the present research because based on Access2Market database the export flow is more stable, and the export partners of non-EU countries are more diverse.

The aim of the present research is to provide insight into the main factors influencing the flow of exported raw milk (excluding milk powder) in order to ensure more stable export flows in Lithuania. To achieve this aim, the main objectives are (1) to identify the factors based on the analysis, systematisation and comparison of the scientific literature; (2) to apply the gravity model to find out which factors have an impact on the flow of exported raw milk (excluding milk powder) from Lithuania to non-EU partners.

RESEARCH METHODS

Theoretical background of the research method

The gravity model is often used in the studies of international trade. The analysis of previous research carried out for the dairy sector using the gravity model was carried out and the variables used were compared. Table 1 identifies the variables used in gravity models.

Table 1. The variables used in the gravity model for international trade research in the dairy sector

Variables	Bai et al. (2023)	Kondaridze & Luckstead (2023)	Basu (2022)	Fertő et al. (2021)	Luo & Bano (2020)
Logarithmic Variables					
Gross domestic product (GDP) growth rate	X				X
Gross domestic product (GDP)			X		
Difference in income per capita	X				
Populations size			X		
Annual population change	X				X
Geographic distance	X		X	X	X
Number of years of trade relationship with the partner					X
Total number of non-tariff measures					X
Tariff rates for dairy products		X	X		
Number of export markets of dairy products					X
Export price index of dairy products					X
Number of suppliers of dairy products in the destination market					X
Number of trade relationships in dairy products				X	
Ratio of capital and agricultural land		X			
Total number of dairy cows					X
Annual temperature change					X
Legal systems score		X			
Rule of law score		X			
Corruption score		X			
Dummy Variables					
Common border	X			X	
Common language	X		X		
Shared colonial history			X		
Trade agreements	X	X	X		
Common currency in euro				X	
Censored trade relationships					X
Multiple trade sequences					X
Landlocked					X
Contiguity			X		
Trade facilitation measures			X		
EU membership			X		

After analysing previous empirical research (see Table 1), it was found that the key variables of the gravity model were GPD, population, and distance between trading partners. It can be seen that the variables mentioned have different forms of measurement, in some studies quantity, and in others changes or size per capita. It is important to highlight the empirical research related to the specificities of the dairy sector, including variables related to the activities of the dairy sector. Kondaridze & Luckstead (2023) included a specific variable – the ratio of capital to agricultural land, calculated per 1000 hectares. This can provide insight into how capital affects international trade in dairy products. Fertő et al. (2021) focus on the number of trade relations in dairy products, this variable may reveal what is more efficient for a country – to have more trade partners or several trade partners that take a larger share of dairy trade flows. Luo & Bano (2020) included five specific variables reflecting the activity of the dairy sector – the number of export markets for dairy products, the number of suppliers, changes in dairy products export price, the number of dairy cows, and annual temperature change. Two empirical studies by Kondaridze & Luckstead (2023) and Basu (2022) in the gravity model included tariff rates for dairy products in international trade. Tariffs used for international trade play an important role in dairy products' international trade flows and could be one of the reasons for the choice of trading partners. Discussed factors can show

how changes in the dairy sector (partners, suppliers, cow numbers, prices), taxation (tariffs), and climatic conditions (temperature) influence international dairy trade.

Table 1 showed that other variables affecting international trade could be significant for dairy production international trade, such as non-tariff measures, years of trade relationship with the partner (Luo & Bano, 2020), institutional factors including the legal system, law rules, and corruption in the country (Kondaridze & Luckstead, 2023).

All previously mentioned variables in the gravity model are logarithmised. Also in the gravity model, the researcher includes dummy variables that have a value of 0 or 1. Among the dummy variables analysed, there were no specific variables reflecting the dairy sector (see Table 1). The majority of the dummy variables used in previous research (Bai et al., 2023; Kondaridze & Luckstead, 2023; Basu, 2022; Fertő et al., 2021) indicated the relationship situation between the partners: common border, common language, common currency, colonial history, trade agreements, common currency, and others.

Research Model

According to the variables identified in the scientific literature and after checking the availability of data, it was decided to include the core variables of the gravity model, such as export volume, GDP, population rate, and distance. To analyse the dairy sector in specific, it was decided to include tariffs on raw milk, information on land, temperature, and the number of milk animals. For the characteristics analysis of trading partners, variables for the legal system and corruption were included, as well as two dummy variables for trade agreements and landlocked status. The selected variables and data sources are presented in Table 2.

Table 2. Variables selected for the present research

Abbreviation	Definition	Source
Dependent logarithmic variable		
EXP_{ijt}	Exports of raw milk (excluding milk powder) from the host country (i) to partner country (j); kg.	Access2Markets Available at: https://trade.ec.europa.eu/access-to-markets/en/statistics
Independent logarithmic variables		
GDP_H_{it}	GDP growth rate in the host country (i); annual %	World Bank Database Available at: https://data.worldbank.org
GDP_P_{jt}	GDP growth rate in the partner country (j); annual %	
POP_H_{it}	Rate of population change in the host country (i); annual %	
POP_P_{jt}	Rate of population change in the partner country (j); annual %	
$DIST_{ijt}$	Distance between capitals of the host country (i) and partner country (j); kilometres.	CEPII data (WP No 2011 – 25) Available at: http://www.cepii.fr/CEPII/
TAR_P_{jt}	Tariff rates for raw milk (excluding milk powder) imported to the partner country (j); %	Access2Markets (on the update of 10 January 2025) Available at: https://trade.ec.europa.eu/access-to-markets/
$LAND\_H_{it}$	Agricultural land area in the host country (i); % of land area	World Bank Database Available at: https://data.worldbank.org
$LAND\_P_{jt}$	Agricultural land area in the partner country (j); % of land area	
LEG_P_{jt}	Strength of legal rights in the partner country (j); ranking value 1-12 (best) on 2019 data.	
$TEMP\_H_{it}$	Temperature change on land in the host country (i); annual change in °c	The Food and Agriculture Organization (FAO) data Available at: https://www.fao.org/faostat/en/#data/ET
$TEMP\_P_{jt}$	Temperature change on land in the partner country (j); annual change in °c	
ANI_H_{it}	Milk animal in the host country (i); number of animals	United Nations (UN) statistical system UNdata Available at: http://data.un.org/Data.aspx?q=Milk%2C+whole+fresh+cow&d=FAO&f=itemCode%3A882
ANI_P_{jt}	Milk animal in the partner country (j); number of animals	
CPI_P_{jt}	Corruption Perceptions Index (CPI) in the partner country (j); CPI scale of 0-100 on 2014-2023.	Transparency International data Available at: https://www.transparency.org/en/cpi/2023/index/afg
Dummy variables		
TA_P_{jt}	Dummy variable = 1 if the EU has trade agreements in place with the trading partners, otherwise 0.	*Authors Calculation* on European Commission information Available at: https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/negotiations-and-agreements_en
LL_P_{jt}	Dummy variable = 1 if the trading partner is a landlocked country, otherwise 0.	*Authors Calculation* on Shipsgo from CNTR Inc. Information Available at: https://shipsgo.com/ocean/ports

On the basis of selected variables, the gravity model was designed to assess the variables influencing raw milk export flows (1).

$$\log(EXP_{ijt}) = \beta_0 + \beta_1 \log(GDP\_H_{it}) + \beta_2 \log(GDP\_P_{jt}) + \beta_3 \log(POP\_H_{it}) + \beta_4 \log(POP\_P_{jt}) + \beta_5 \log(DIST_{jit}) + \beta_6 \log(TAR\_P_{jt}) + \beta_7 \log(LAND\_H_{it}) + \beta_8 \log(LAND\_P_{jt}) + \beta_9 \log(LEG\_P_{jt}) + \beta_{10} \log(TEMP\_H_{it}) + \beta_{11} \log(TEMP\_P_{jt}) + \beta_{12} \log(ANI\_H_{it}) + \beta_{13} \log(ANI\_P_{jt}) + \beta_{14} \log(CPI\_P_{jt}) + \beta_{15} TA\_P_{jt} + \beta_{16} LL\_P_{jt} + \varepsilon_{ijt} \quad (1)$$

For the gravity model presented (1), several econometric models are used: Ordinary Least Squares (OLS) model, Robust OLS model, Random Effects Model (REM) and Robust REM on Gretl software. Several econometric models are chosen for the gravity model to consider that panel data are used and, in some cases, the difference in selected countries may affect the results. If there are significant differences between trading partners, it would be more reliable to test for random effects in REM. Robust OLS and Robust REM were chosen to reduce the influence of deviations in the gravity model, thus providing more stable and reliable estimates and comparing the differences with the OLS and REM models.

The main limitation of the research is that not all data are available for a specific country. In some cases, there is a lack of new data, usually, it is late for 2-3 years. Also, some of the variables may have problems of multicollinearity as they are interrelated.

Data Selection

Seeking to analyse factors influencing the export of raw milk for the present research, based on the harmonised system (HS) for international trade, the HS code 0401 was selected taking into account raw milk (excluding milk powder). HS0401 covers milk and cream not concentrated nor containing added sugar or other sweetening matter and is divided into four groups: (1) not exceeding 1%, (2) exceeding 1% but not exceeding 6%, (3) exceeding 6% but not exceeding 10%, (4) exceeding 10%.

Based on previous similar research, the period chosen for the present research was 10 years (2014-2023). Based on the export of raw milk data in the Access2Market database, 21 non-EU trading partners were identified to which Lithuania exported raw milk during the 10-year period. Based on the data collected from 21 trading partners, it was seen that the quantity of raw milk (excluding milk powder) exported varied between years (see Figure 1).

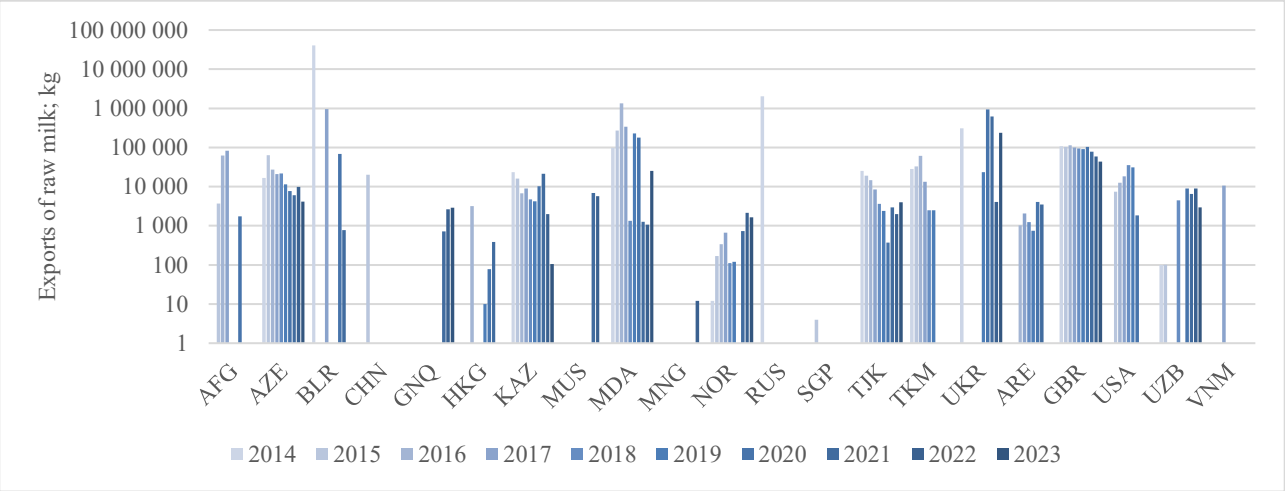

Figure 1. Exports of raw milk by trading partner 2014-2023 (Source: created by the author in MS Excel based on Access2Market data).

As shown in Figure 1, the data over 10 years are very diverse. For some trading partners, there are one-off export cases in different years. With other trading partners, the flow of raw milk export has changed due to the geopolitical situation with Belarus (BLR), Russia (RUS), and Turkmenistan (TKM). Lithuania's dairy sector has found a new trading partner in recent years, such as Uzbekistan (UZB), Equatorial Guinea (GNQ), and Mauritius (MUS). The data showed that Lithuania has renewed export flows of raw milk to some trading partners, such as Ukraine (UKR) and Norway (NOR). The main trading partners for raw milk exports from Lithuania are Azerbaijan (AZE), Kazakhstan (KAZ), Moldova (MDA), and the United Kingdom (GBR). Unfortunately, the flow of raw milk export with these trading partners is not stable and has been decreasing in recent years.

For raw milk (HS 0401), export volumes (EXP_{ijt}) from Lithuania and the tariffs (TAR_P_{jt}) applied by trading partners were collected from the Access2Market database. The collection of data on tariffs (TAR_P_{jt}) applied to the majority of trading partners has been based on clear tariffs. Only for two trading partners, Norway and the United States of America (USA), the raw milk tariffs significantly differ from other trading partners. Norway has a preferential tariff for the EU, which varies according to the fat content of the raw milk, ranging from 388% to 443%. In other countries, the rate was between 0% and 30%. In the present research for the Norway case, the average rates were used for the gravity model. The USA does not apply a tariff as a percentage but as a rate per liter of raw milk. In the present research for the

gravity model, the percentage was recalculated using data from Access2Market on the quantity of raw milk exported and the customs value to approximate the percentage.

To assess the influence of specific dairy sector factors, the problem was addressed with a collection of variables, such as agricultural land area ($LAND\_H_{it}$; $LAND\_P_{jt}$) and number of milk animals (ANI_H_{it}; ANI_P_{jt}). In order to overcome the problem of unavailable data in the present research, proxy variables were used. Data on agricultural areas ($LAND\_H_{it}$; $LAND\_P_{jt}$) in 2023 were not available. Checking data of agricultural land area in 2021-2022 in most cases land area was the same or changed insignificantly, therefore, it was decided to use the proxy variable for 2023 same data as 2022. Due to the lack of 2022-2023 data on the number of milk animals (ANI_H_{it}, ANI_P_{jt}), proxy variables were calculated in MS Excel using the 2014-2021 trend formula.

RESEARCH RESULTS AND DISCUSSION

Data collected from 21 non-EU trading partners where Lithuania exported raw milk from 2014-2023 were analysed and gravity models were designed using Gretl software. The results of the empirical research are presented and discussed in this section.

Previous research has found that the number of milk animals (Luo & Bano, 2020) and tariff rates on dairy products (Kondaridze & Luckstead, 2023; Basu, 2022; Luo & Bano, 2020) have an impact on dairy export flows. Having logarithmised the data collected, the analysis of these variables was carried out (see Figure 2 and Figure 3).

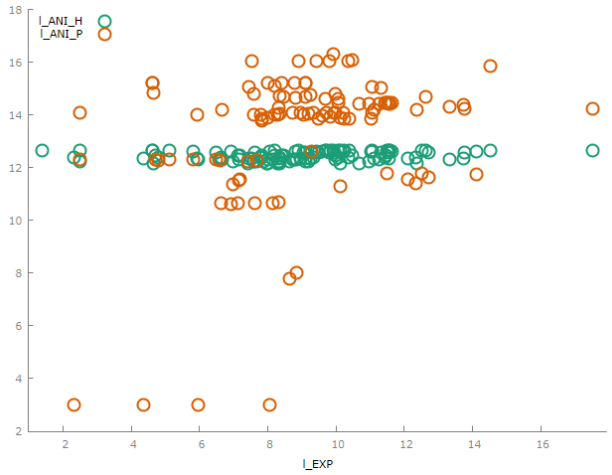

Figure 2. Scatter plot of the logarithm of exports and number of milk animals (Source: compiled by the author using Gretl software)

Figure 2 shows how the number of milk animals in Lithuania and the trading partners related to the export flows of raw milk. Logarithmic variables showed a tendency that the number of milk animals in Lithuania around 12 logarithmic values ensures export flows between 7 and 12 logarithmic values. Concerning the number of milk animals in the trading partners, it appears that if the number of milk animals in the trading partners is around 14 logarithmic values, then the export flows are between 8 and 11 logarithmic values.

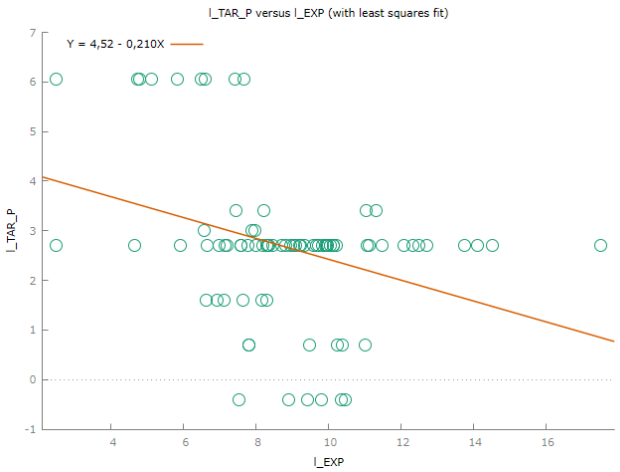

Figure 3. Scatter plot of the logarithm of exports and tariff rates for raw milk (Source: compiled by the author using Gretl software)

Figure 3 shows the correlation between the export of raw milk and the applied tariff rate for raw milk in the trading partner country. As can be seen, if the applied tariff rate for raw milk is close to 3 logarithmic values, then export flows

are between 8 and 10 logarithmic values. Individual cases are seen when the applied tariff rate for raw milk is high (6 logarithmic value), and then export flows are lower.

The gravity model (formula 1) presented in the previous section was first tested with OLS. The collinearity problem was in OLS model. Variables population rate ($l\_POP\_P_{jt}$), distance (l_DIST_{ijt}), tariff ($l\_TAR\_P_{jt}$), agriculture land area ($l\_LAND\_H_{it}$; $l\_LAND\_P_{it}$) had a VIF value more than 10. The decision was made to reject variables of agricultural land area ($l\_LAND\_H_{it}$; $l\_LAND\_P_{it}$) as it intercorrelate with country size (including GDP and population) and the number of milk animals. Then, multicollinearity was identified with GPD ($l\_GPD\_H_{it}$) and population rate ($l\_POP\_H_{it}$) in the host country, so these variables were also rejected. An initial gravity model was designed based on OLS (see Table 3).

Table 3. Results of an OLS estimated gravity model for raw milk exports from Lithuania (Source: author calculations made with Gretl software)

Variables	**Coefficient**	**Std. Error**	**t-ratio**	**p-value**	**VIF**
const	27.2997	20.1838	1.353	0.1838	
l_GDP_P	−0.321782	0.281133	−1.145	0.2592	1.477
l_POP_P	−0.210690	0.342686	−0.6148	0.5422	3.509
l_DIST	−2.73930	0.568392	−4.819	<0.0001***	4.156
l_TAR_P	−1.19027	0.237951	−5.002	<0.0001***	4.307
l_TEMP_H	−2.92196	1.14879	−2.544	0.0149**	1.199
l_TEMP_P	−1.43006	0.593793	−2.408	0.0207**	1.303
l_ANI_H	1.06143	1.45096	0.7315	0.4687	1.568
l_ANI_P	0.368658	0.200498	1.839	0.0734*	3.368
l_LEG_P	−0.758804	1.08015	−0.7025	0.4864	3.206
l_CPI_P	−1.92742	0.656470	−2.936	0.0055***	3.258
dummy_LL_P	−0.285460	0.863053	−0.3308	0.7426	3.632
dummy_TA_P	−0.428052	0.604168	−0.7085	0.4827	1.945
R-squared	0.777161				
Adjusted R-squared	0.710310				
F test	F(12, 40) = 11.62517 (1.47e-09***)				

*Note: Using 53 observations. Included 11 cross-sectional units. Time-series length: minimum 1, maximum 10. Significance showed as * p<0.10, ** p<0.05, *** p<0.01.*

Table 3 presents the results of the gravity model estimated using OLS. It can be seen that the adjusted R-squared is high (0.71), which means that the model explains 77% of the variance in the dependent variable, taking into account the number of predictors. Collinearity problems do not exist in this model (see Table 3), as the VIF does not reach 5. The first findings are that raw milk export flows decrease with distance (l_DIST), temperature changes in Lithuania (l_TEMP_H), and the corruption perceptions index (l_CPI_P) in the trading partner country. The increase in raw milk export flows is only related to the number of milk animals (l_ANI_H; l_ANI_P). Unfortunately, some of the variables are not statistically significant as the p-value is higher than 0.05.

Insignificant variables were rejected to find a gravity model with all significant variables. The final gravity model is presented in Table 4.

Table 4. Results of gravity model for raw milk exports from Lithuania (Source: author calculations made with Gretl software)

Models / Variables	OLS		OLS Robust		REM		REM Robust	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
const	−25.9563	0.1267	−27.2180	0.3276	−27.8530	0.1080	-27.8530	0.3166
l_POP_P	−0.775672	0.0061***	−0.416424	0.0612*	−0.371609	0.2219	-0.371609	0.0809*
l_DIST	−1.39288	0.0047***	−1.53071	<0.0001***	−1.55314	<0.0001***	-1.55314	3.10e-10***
l_TAR_P	−0.758681	<0.0001***	−0.840312	0.0004***	−0.833107	<0.0001***	-0.833107	1.95e-05***
l_ANI_H	4.32206	0.0006***	4.50461	0.0487**	4.56436	0.0006***	4.56436	0.0325**
l_CPI_P	−1.71876	<0.0001***	−1.56328	0.0015***	−1.56637	0.0027***	-1.56637	0.0002***
R-squared	0.6214		0.5322		0.5319		0.5319	
Adjusted R-squared	0.5903		0.4956		0.4954		0.4954	
F test	F(5, 61) = 20.02036 (9.28e-12***)		F(5, 13) = 15.76224 (0.000040***)					
Wald test					53.8878 (2.21013e-10***)		72.4573 (3.15424e-14***)	

*Note: Using 70 observations. Included 14 cross-sectional units. Time-series length: minimum 1, maximum 10. Significance showed as * p<0.10, ** p<0.05, *** p<0.01.*

Table 4 presents the results of the final gravity model tested with four econometric models. An adjusted R^2 is between 0.4954 and 0.5903 of the models presented in Table 4. It indicates that the gravity models explain about 50-59% of the variation in the dependent variable, which means that the results can be trusted in economic research. F and Wald tests confirm the viability of the models too, as the p-value of the models is less than 0.05. There are no collinearity problems in the gravity models presented in Table 4.

The OLS showed, as expected, that the distance (l_DIST) between Lithuania and its trading partners reduces the export flows of raw milk. This confirms that when the distance between Lithuania and its trading partners is long export flows are expected to be lower. This was also confirmed as a statistically significant factor by OLS Robust, REM and REM Robust with a p-value of less than 0.05. The gravity model results (see Table 4) show that when trade partners' characteristics are taken into account (with REM and REM Robust), the distance (l_DIST) coefficient is slightly higher, indicating that distance reduces raw milk export flows more.

It was noted that previous research in the dairy sector had differences. Ferto el al. (2021) analysed new trade relations in dairy product trade focusing on the period of old EU members (until 2004) and new EU members (after 2004). The empirical research results of Ferto et al. (2021) showed that distance does not affect old EU members for dairy product trade and for new EU members, it has little effect. The empirical research of Bai et al. (2023) is in line with the present research, the distance was always negative. Usually in the majority of international trade research, the distance is negative, but in Luo & Bano's (2020) previous research, the distance was positive and statistically significant. This gives some ideas for future research. For the raw milk trade, the present research did not analyse the EU countries, the export analysis focused on non-EU countries. For future research, it is possible to find a new way of grouping trading partners into two groups based on trade agreements signed or continents.

The core variables of the gravity model, such as GDP and population rate, were not statistically significant. Just the population rate (l_POP_P) of trading partners was statistically significant (p-value = 0.0061) in the OLS model with the implication of decreasing export flows of raw milk. After correcting the standard errors, the OLS Robust model indicates that the population rate (l_POP_P) becomes statistically insignificant. Similar results are found in the REM and REM Robust models taking into account the characteristics of the trading partners. Previous research has shown differences including GDP and population in gravity models. The insights that some differences influenced different research periods, different dairy product selections, and different dependent variables.

Bai et al. (2023) included more dairy products (HS0401-0406) in the previous empirical research. The gravity models in the Bai et al. (2023) empirical research were developed separately for each 5-year period, not for all 20 years (2000-2020), and each model gives slightly different results. The similarities between the present research and Bai et al. (2023) research were that GPD and population size do not affect the international dairy trade and the majority of the models were statistically insignificant. The empirical results of Basu (2022) differ from the present research as the GDP of the host country and the GDP of the trading partner were statistically significant and had a positive effect on the export flow of dairy products. Basu's (2022) results are different from the present research in that the host country's population size has a negative effect and the trading partner's population size has a positive effect, whereas in the present research, the trading partner's population rate has a negative effect. Empirical research by Luo & Bano (2020) shows that population changes in trading partners have a negative impact on dairy trade relations, in line with present research. In the previous research (Luo & Bano, 2020), the GDP of the host country was not statistically insignificant, and the GDP of the trading partner was statistically significant, but with a small negative effect. This is partly consistent with the present research, as GDP was not included in the gravity models presented in Table 4 due to multicollinearity and statistical insignificance.

The tariffs (l_TAR_P) applied by trading partners to exports of raw milk from Lithuania are statistically significant (p-value < 0.05). As expected, tariffs (l_TAR_P) reduce the export flows of raw milk in all four econometric models (see Table 4). After correcting for standard errors (OLS Robust) and taking into account the characteristics of trading partners (REM, REM Robust), the tariff reduces exports slightly more compared to the OLS model results. The previous empirical research by Kondaridze & Luckstead (2023) analysed 17 years of dairy trade and found that tariffs for dairy products had small negative effects on exports and were statistically insignificant as the p-value was higher than 0.05 because the tariff used was about 4% for dairy products. In the present research, the negative effect of tariffs was higher and statistically significant as in the majority of the trading partners the tariff rate was around 15% for raw milk. Basu's (2022) previous empirical study, conducted on 2018 data, is consistent with the present research and confirms that tariffs on dairy products are statistically significant and have a negative effect.

The corruption perceptions index (l_CPI_P) was found to have the greatest negative impact on the export flows of raw milk. This shows that if the corruption perceptions index (l_CPI_P) in the trading partner country is higher, Lithuania exports less to these countries. The corruption perceptions index (l_CPI_P) was statistically significant (p-value < 0.05) in all four econometric models (see Table 4). The largest negative effect was found in the OLS model, but after correcting for standard errors (OLS robust) and after taking into account the characteristics of trading partners (REM, REM robust), the negative effect of the corruption perception index (l_CPI_P) was slightly smaller.

The previous empirical research by Kondaridze & Luckstead (2023) analysed institutional factors such as the legal system, rule of law, and corruption. Kondaridze & Luckstead's (2023) gravity model results showed that corruption was statistically insignificant, and the rule of law was positive and significant for dairy exports. This is not consistent with the present research, as the variable strength of legal rights (l_LEG_P) was rejected as statistically insignificant (see Table 3), and the corruption perception index (l_CPI_P) plays an important role (see Table 2).

Although attempts were made to include several variables in the initial gravity model (see Table 2) relating to agricultural land area, temperature change, trade agreements, and others, most were rejected as statistically insignificant in the final gravity model (see Table 4).

The most important variable in the gravity model (see Table 4) was the number of milk animals (l_ANI_H). The variable number of milk animals (l_ANI_H) in Lithuania was statistically significant (p-value < 0.05) and the coefficient is the highest. The model results showed that export flows of raw milk increased between 4.3% (OLS) and 4.5% (OLS Robust, REM, REM

Robust) every time then the number of milk animals increased by 1%. This shows that the number of milk animals reared in Lithuania is the most important factor, regardless of the tariffs applied by trading partners or the distance.

The results of Luo & Bano (2020) differ from present research results, as the number of milk animals had a negative effect on creating relationships with trade partners and the variable was statistically insignificant. Luo & Bano (2020) previous research is important in two different aspects compared with the present research: firstly, the long period of 29 years for analysis of trade partner relationships; secondly, the dependent variable in the model focused not on export.

In the present research, the temperature variable was rejected as statistically insignificant (see Table 3), but Luo & Bano (2020) previous research showed different results. The weather conditions as changes in temperature were statistically significant and had a positive effect on creating new relationships with trading partners for the trade of dairy products in Luo & Bano (2020) empirical research.

The present research results, based on the gravity model, gave logical results. Taking into account that the number of milk animals plays the most important role in the export of raw milk, a political decision should be made to support the higher number of dairy animals in Lithuania. As tariffs have a negative impact on the export of raw milk, this must be discussed at the EU level in order to have more trade agreements and reduced tariffs for dairy products in the trading partner country. As it was found that the corruption level of trading partners decreases export volume, this showed that agricultural subjects choosing trading partners must take the corruption level into account. Usually, corruption creates barriers to export and better to have trustworthy trading partners.

CONCLUSIONS

The present empirical research results showed that the statistically significant factor influencing the export of raw milk was the population rate in the trading partners, the distance between Lithuania and the trading partners, the tariff applied to dairy products in the trading partner country, the number of dairy animals in Lithuania and the level of the corruption perception index of the trading partners. Statistically significant and with the highest positive impact on raw milk exports was the number of milk animals in Lithuania. This shows that if the number of milk animals in Lithuania increases by 1%, raw milk exports will increase by 4%. The distance between Lithuania and its trading partners also plays an important role. The gravity model shows that a 1% increase in distance reduces export flows by 1.39%. Other factors were related to the characteristics of trading partners. Here, corruption has a statistically significant and highest negative impact on Lithuania's raw milk exports. If the corruption index of the trading partner increases by 1%, export flows decrease by 1.72%. Therefore, Lithuanian agricultural subjects must analyse the corruption situation in their trading partners before planning to export, as corruption usually creates barriers to legal international trade. In the present research, the export flows of raw milk were measured in kg, in future research it is worth analysing the export flows in currency (EUR), as the price aspect may also have an influence. Temperature changes were rejected as a statistically insignificant factor in the final gravity model. A different data period could be chosen due to constantly changing trading partners and based on previous research ideas, a five-year period is the most appropriate for future research. Future research should also analyse the effect of temperature on milk exports over a shorter period. The factor of temperature changes was statistically significant in the initial gravity model. In future research, this could present new results and have the link between climate change and the export of raw milk.

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