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THE IMPACT OF THE PANDEMIC YEAR ON EXPORT: LITHUANIAN GRAVITY

Vaiva PETRYLĖ *

Department Economics and Business Administration, Vilnius University, Saulėtekio al. 9-II, Vilnius, Lithuania

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Abstract. In this paper I construct gravity model for Lithuania and analyse pandemic-related changes of Lithuania's goods export. Results suggest that pandemic resulted in a decreased export of aircraft, railway products, meat and preparations of cereals and milk. Positive influence was registered for beverages and spirits, tobacco, furniture, electric appliances, fuels, vehicles and medical and pharmaceutical products. I find that Lithuania's export of products of higher complexity was more often affected positively by the pandemic. Results show positive influence of the pandemic for Lithuania's export to countries of higher economic complexity and the ones having stronger trade relations with Lithuania. There was no relationship between the effects of the pandemic and the size of the destination countries.

Keywords: COVID-19, pandemic, export, gravity model, Lithuania.

JEL Classification: F14, F62.

Introduction

The year 2020 in Lithuania was very different from any other years in more than a third of century. Covid-19 pandemic which broke up in China at the end of 2019 and reached Europe and Lithuania in the beginning of 2020, dramatically changed people's habits, way of life, work methods, leisure and demand for goods. Countries one-by-one imposed travelling bans, closures of stores, cinemas, theatres, restaurants and bars, even "stay-home" requirements. It would be a surprise if these restrictions did not result in at least minor changes of countries' export structures.

The most important impact of the pandemic could be the increase of transport cost and the shift of demand and supply (Hayakawa & Mukunoki, 2021). Higher transport cost could be the result of different regulations of border crossing that were imposed by almost all the countries. These regulations not only differed by country, but they also changed often and unpredictably. Therefore, transporting goods from one country to another resulted in higher cost of both tracking these changes and trying to implement them.

The shift of the demand and supply of goods could be the result of the forced change of consumer habits. People had much lower possibilities to travel, therefore, they might go camping, sailing or buy a holiday home. People could no longer spend their free time in a cinema or at a restaurant, hence, they might decide to buy a larger TV and a more comfortable sofa. People had to work from home and schools were closed, therefore, consumers might reduce their spendings on perfume, clothing and footwear, and invest in computers and fast Internet instead.

These and many more changes in consumption could happen because of the impact of the pandemic, and could result in the changes of export structure. Export structure could change in terms of products, e.g. less clothes and more TVs could be demanded and exported. But export structure could also change in terms of export destinations, e.g. closer-by markets could become preferred to further away markets because of the increased transport cost.

There are still limited analyses on the effects of the pandemic on international trade, and the findings are very contradictory. Barichello (2021) who analysed agricultural export in Canada, find that Covid-19 had either limited, or no impact for trade. Other authors (e.g. Espitia et al., 2022; Vidya & Prabheesh, 2020) claim the opposite. Vidya and Prabheesh (2020) showed that pandemic could result in drastic decline of trade and broken trade

* Corresponding author. E-mail: *vaiva.petryle@evaf.vu.lt*

networks. Espitia et al. (2022) found that pandemic had mostly negative effects on trade and the least negative impact was for the sectors which rely more on remote work. Still, the latter finding is not supported by Arriola et al. (2021). They claim that trade in services dropped more than trade in goods and that the decrease of trade is not related to product complexity.

Although, according to the World Bank, Lithuania's GDP growth amounted to –0.1% in 2020, it was the lowest decline in the whole European Union (e.g. the economy of Italy decreased by 8.9%, the one of Greece by 9% and GDP of Spain declined by even 10.8%). Therefore, the question arises, what was the effect of the pandemic on Lithuania's export? Did it more or less stayed immune to the shock, as Lithuania's GDP had, or did it suffer more seriously?

This paper investigates short-term changes of Lithuania's export structure in 2020. Due to the limited data so far, the research focuses on the goods' export only. The author aims to examine Lithuania's goods' export and how it shifted between products and between export markets during the first pandemic year.

The main research questions are the following:

– How Lithuania's export structure changed in 2020 in terms of the product groups?
– How Lithuania's export structure changed in 2020 in terms of the destination markets?

I hypothesize that during 2020 Lithuania's export structure shifted significantly and adjusted to the shock made by Covid-19 pandemic.

The results show that during 2020 Lithuania experienced some shifts in its' export structure in terms of the product groups. Lithuania's export of aircraft, railway products, meat and preparations of cereals, flour, starch and milk decreased. Still, export of a number of higher complexity product groups, such as furniture, articles of wood, various electric appliances, food, fuels, vehicles, optical, medical and pharmaceutical products, beverages and tobacco, even increased. I find a small influence of Covid-19 pandemic on the shifts of Lithuania's export structure in terms of the destination markets. Results show a positive relationship between the changes in export values to different countries, and either the strength of business relations or economic complexity of these countries. Still, the distance between Lithuania and its' export partners do not seem to matter for the strength of the pandemic-related effects.

I hope that the results of this research could be useful for Lithuanian policy makers, businesses and provide a background for future research on the effects of the pandemic.

The setup of the paper is as follows: in Section 1 methodology and the data is presented. Section 2 gives the results of Lithuania's gravity model. Section 3 looks at the impact of pandemic for different product groups. Section 4 examines the impact of pandemic for different export destinations. Finally, the last section concludes.

1. Methodology and the data

I apply a two-step estimation procedure. First, Lithuania's gravity model with one country of origin (Lithuania), 157 destination countries, 96 product groups and a period between 2015 and 2019 is estimated. Second, coefficients' estimates of the gravity model are used to forecast Lithuania's export of each product (in Section 3), and Lithuania's export to each destination country (in Section 4) in 2020. If the difference between the actual and predicted export is large, it indicates untypical changes of Lithuania's export. The most probable reason for these changes could be the pandemic.

Endogenous variable in the gravity model is Lithuania's export of product i from Lithuania to country c in year t. Exogenous variables are: destinations' GDP, Lithuania's GDP, distance between Lithuania and the destination country, an index of common spoken language between Lithuania and the destination country and three dummy variables: contiguity, the EU membership and the WTO membership.

Descriptive statistics is given in Table 1. I have 1 country of origin, 157 destination countries, 96 product groups and 6 years. As Lithuania does not export every product to every destination country, there is an unbalanced panel of 39 138 non-missing observations.

Export data is annual and varies by product, destination country and year. I take products classified by the HS 2-digit classification, hence, there are 96 product groups. Lithuania exported its' products to 199 countries in 2020, however, after combining export data with GDP, language and destination data, only 157 countries are left. The data on export is taken from Statistics Lithuania (2022). Non-zero export makes 74% of all the data.

Annual data of GDP in constant prices is retrieved from the World Bank's database (World Bank, 2021).

Table 1. Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
Export, meur	52 848				
Non-missing	39 138	3.92	24.9	0	1 070
GDP_{dest}, beur	52 848	654	1 930	34.3	16 400
GDP_{LT}, meur	52 848	42 900	2 090	40 300	46 300
Distance	52 848	4 792	3 804	224.93	17 226
Language	52 848	0.19	0.22	0	0.87
EU	52 848	0.28	0.45	0	1
EU member countries			27 (17%)		
Non-EU countries			130 (83%)		
WTO	52 848	0.92	0.28	0	1
WTO member countries			141 (90%)		
Non-WTO countries			16 (10%)		
Contiguity	52 848	0.04	0.20	0	1
Contiguous countries			4 (3%)		
Non-contiguous countries			153 (97%)		

The data for distance, common spoken language, contiguity as well as the EU and the WTO membership is taken from the CEPII database. Distance is calculated in thousand kilometres and shows the distance between the two biggest cities of the countries, weighted by the city's share in country's population (Mayer & Zignago, 2011). An index for common spoken language is between 0 and 1 and shows, what is the probability that any two people taken from two countries could understand each other (Mélitz & Toubal, 2012).

Contiguity is a dummy variable and shows if Lithuania has a land border with destination countries. There are 4 countries contiguous to Lithuania: Latvia, Poland, Russia and Belarus. For these countries the dummy is equal to 1, for all the others it amounts to 0.

The dummies of the EU and the WTO membership show, if both Lithuania and the destination country belong to either the EU of the WTO. The dummy is time varying and equals to either 1 (if both countries were members) or 0 (if any of the countries was not a member) in year *t*. As Lithuania was a member of both these organisations during the analysed period, the value of the dummy depends solely on the destination country.

Correlations between log of export and non-dummy exogenous variables (log of destination's GDP, log of distance and an index of common spoken language) are given in Figure 1. Origin's GDP is not included in the graphs because it does not vary by country. For the visibility purpose, means of exogenous variables are calculated and export data is summed over products. As expected, export is positively related to destination's GDP and common spoken language. Relationship is negative between export and distance.

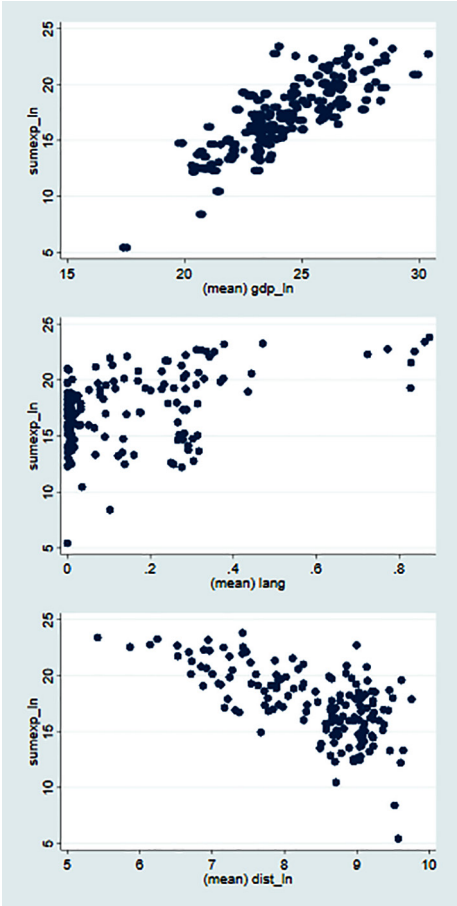

Figure 1. Correlations between endogenous and exogenous variables

2. Gravity model

In this section I present Lithuania's gravity model for the period of 2015–2019. The model takes only one country of origin (Lithuania), 157 destination countries and 96 products.

I construct gravity model for Lithuania following its' theoretical foundations presented by Anderson (1979), Anderson and van Wincoop (2003) and Anderson (2011). Based on Shepherd (2012), symmetric gravity models should be estimated including country fixed effects. The model I estimate has only one source country and a number of product groups. Usual fixed effect models also do not allow the estimation of time-invariant variables (i.e. distance, common spoken language, common border and the dummies for the EU and the WTO membership). Hence, to be in line with the theory and to avoid losing regressors, I follow Gaure (2011) and Guimarães and Portugal (2010) and estimate OLS model with product fixed effects. This method allows to estimate coefficients of country-specific explanatory variables, i.e. destination, language, contiguity, the EU membership and the WTO membership.

Based on Santos Silva and Tenreyro (2006), possible heteroscedasticity of the data makes OLS estimators biased and inconsistent. According to Martin (2020), although Poisson maximum likelihood (PPML) estimator is also biased, it is not so much biased as the OLS. Therefore, PPML estimator is a better choice for estimating gravity regressions. Based on that, I estimate Lithuania's gravity model under two specifications: OLS and PPML. Following Correia et al. (2020), I estimate gravity equation specified under PPML specification with product fixed effects.

Gravity equation for OLS specification is presented below. Following Shepherd (2012), I take logs of export, GDP and distance variables.

$$\log Export_{i,c,t} = \beta_0 + \beta_1 \log GDP_{LT,t} + \beta_2 \log GDP_{c,t} + \beta_3 \log Distance_c + \beta_4 Language_c + \beta_5 EU_{c,t} + \beta_6 Border_c + \beta_7 WTO_{c,t} + \varepsilon_{i,c,t} + u_{i,t}. \quad (1)$$

Gravity equation for PPML specification, where dependent variable is mean of export, is presented below. Following Santos Silva and Tenreyro (2006), I take logs of GDP and distance variables.

$$\overline{Export}_{i,c,t} = \exp(\beta_0 + \beta_1 \log GDP_{LT,t} + \beta_2 \log GDP_{c,t} + \beta_3 \log Distance_c + \beta_4 Language_c + \beta_5 EU_{c,t} + \beta_6 Border_c + \beta_7 WTO_{c,t}) + \varepsilon_{i,c,t} + u_{i,t}. \quad (2)$$

Estimation results of Lithuania's gravity model are given in Table 2. GDP of the destination, GDP of the origin, distance, common spoken language and WTO membership have expected signs and are highly significant in both models. The EU membership and contiguity are mostly insignificant.

The results presented in Table 2 are in line with the theory and similar to the mean results of the other structural gravity models. My estimates for destination's GDP and distance are very close to the average values of these variables, given by Head and Mayer (2014) (see: the last column of Table 2). The coefficient of origin's GDP is higher for Lithuania (around 1.6), than the average estimate which is 0.74. The reason could be purely Lithuania-specific, because I model just one country of origin.

Although the average estimate of common spoken language amounts to 0.39 (Head & Mayer, 2014), for Lithuania this estimate is between 3 and 4. Such high values for common spoken language may be specific to Lithuania and represent the influence of other cultural, historical and geographical factors for Lithuania's export. In Lithuania, Russian is the widest spoken foreign language (according to Statistics Lithuania, 63% of Lithuanians are able to speak it) and Lithuania indeed has developed strong trade relations with the former Soviet bloc countries. However, this factor could also include other, non-accounted factors as the knowledge of Russian work culture, historical trade relations, Lithuania's position as a gateway between the east and the west, etc.

My estimate of contiguity (0.3 in OLS model and negative and insignificant in PPML model) also differs from its' average value in other papers, which is around 0.66. Ambiguous results for contiguity could be also Lithuania-specific. Two of Lithuania's neighbours are the EU member states Latvia and Poland with which Lithuania expands its' trade relations. However, another two are authoritarian and aggressive countries of Russia and Belarus with which Lithuania tries to narrow its' trade relations.

Head and Mayer (2014) finds that the average value of the coefficient for free trade agreements is 0.36 and for NAFTA 0.76. My findings are in line with it, as the coefficient of WTO membership for Lithuania amounts to around 0.4 and this is close to the average value of FTA coefficient. Head and Mayer (2014) claims that on average the significance of the EU estimator is much lower than these of the other trade agreements and amounts to 0.16. I find it to be insignificant for Lithuania. The reason for insignificance could be that Lithuania is the member of the EU itself and the effect of the EU is already captured by the distance variable.

Overall, estimation results are robust and in line with the average results of the other gravity models.

Table 2. Results of the gravity equations

Variables	OLS	PPML	Mean
Dependent variable	Exporting	Exporting	Estimates[1]
GDP_{LT}	1.86511***	1.40508***	0.74
	(0.34072)	(0.23944)	
GDP_{dest}	0.67261***	0.62002***	0.58
	(0.02889)	(0.04290)	
Distance	–1.24760***	–0.96074***	-1.1
	(0.06024)	(0.12152)	
Language	4.36370***	3.07735***	0.39
	(0.27101)	(0.38469)	
EU	0.08897	0.01718	0.16
	(0.09507)	(0.13326)	
WTO	0.28186***	0.50888***	0.36 (FTA)
	(0.08841)	(0.19263)	0.76 (NAFTA)
Contiguity	0.29034*	–0.01780	0.66
	(0.15377)	(0.12867)	
Constant	yes	yes	
Fixed effects	product	product	
R-squared	54.33	73.70	
Obs	28 077	28 077	

Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

[1] Mean estimates of structural gravity models (Head & Mayer, 2014).

3. Changes of Lithuania's export structure by product group

In this section I use coefficients estimated by the gravity model in previous section to forecast Lithuania's export for the year 2020. For predictions I estimate OLS gravity model with product fixed effects for the period of 2015–2019. Next, estimated coefficients and product fixed effects are used to calculate predicted export values for each product group in 2020. The difference between the actual and predicted export values would be a rough estimation of the effect of the pandemic on Lithuania's goods export in 2020.

Table 3 lists product groups classified according to the HS 2-digit classification which in 2020 had much lower export values than the model predicts. The table also gives the quantile of product complexity, calculated by the Growth Lab at Harvard University (2019). Table 3 shows that the products which in 2020 had the greatest negative differences between the actual and predicted export values are: aircrafts, railway products, meat and preparations of cereals, flour, starch or milk.

The decrease of Lithuania's export of railway and aircraft industries could be a direct cause of the pandemic, because in the face of Covid-19 pandemic travelling decreased substantially. The decrease of the export of meat could be the result of the closure of restaurants.

Table 4 gives products for which Lithuania's export in 2020 was much higher than predicted. A quantile of product complexity is also listed. Product groups having the largest positive differences between their actual

Table 3. Products groups having the largest negative differences between their actual and predicted export values in 2020

Actual export was lower than predicted in 2020		
HS	Product description**	q*
11	Products of the milling industry; malt; starches; inulin; wheat gluten	2
19	Preparations of cereals, flour, starch or milk; pastrycooks' products	2
2	Meat and edible meat offal	3
88	Aircraft, spacecraft, and parts thereof	4
86	Railway or tramway locomotives, rolling-stock and parts thereof; railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signalling equipment of all kinds	5

Note: * q shows the quantile of product complexity (1 – the least complex, 5 – the most complex), given by the Growth Lab at Harvard University (2019).

and predicted export values are: leisure goods (beverages, spirits and tobacco), housing (furniture, articles of wood and electric appliances), optical, medical and pharmaceutical goods, food (fish, seeds and cereals), mineral fuels, oils and chemical products and vehicles.

Judging by the information presented in Table 4, export of products of higher complexity is more likely to be higher than predicted for 2020.

An increase of Lithuania's export of beverages and spirits together with a sharp increase of export of tobacco, ships and boats could be a direct consequence of the pandemic. Pandemic resulted in a shutdown of such traditional entertainment places as cafes, theatres and restaurants. Therefore, people most probably switched to other still available ways of entertaining and spent more on such leisure goods as alcohol and cigarettes. Lithuania's export of goods related to housing (i.e. furniture, wood products and electric appliances) also increased. This could also be the effect of Covid-19 pandemic. As people needed working space at home and could not spend money for their usual leisure activities, they could invest in more spacious apartments, new furniture and appliances. The increase of export of optical, medical and pharmaceutical products also directly associates to the pandemic.

The difference between Lithuania's actual and fitted export of vehicles, as well as of mineral fuels is high and positive. However, in the face of Covid-19 pandemic which resulted in decreased commuting and therefore lower usage of vehicles and fuels, I could expect quite the opposite. This result remains unclear and should be compared to the results of other model specifications.

Overall, the analysis shows that the influence of the pandemic was negative for Lithuania's export of aircrafts, railway products, meat and preparations of cereals, flour, starch or milk. OLS model predicts positive effects for the export of tobacco, beverages, furniture, electronics, articles of wood, food, fuels, vehicles and medical and pharmaceutical products.

Results suggest that pandemic-related export changes were mostly positive for the goods of higher complexity.

Table 4. Products groups having the largest positive differences between their actual and predicted export values in 2020

Actual export was higher than predicted in 2020		
HS	Product description**	q*
3	Fish and crustaceans, molluscs and other aquatic invertebrates	1
12	Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder	1
24	Tobacco and manufactured tobacco substitutes	1
31	Fertilisers	2
44	Wood and articles of wood; wood charcoal	2
10	Cereals	2
27	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	2
33	Essential oils and resinoids; perfumery, cosmetic or toilet preparations	3
22	Beverages, spirits and vinegar	3
72	Iron and steel	4
94	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings	4
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles	5
90	Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof	5
73	Articles of iron or steel	5
30	Pharmaceutical products	5
87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof	5
38	Miscellaneous chemical products	5
39	Plastics and articles thereof	5
84	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	5

Note: * q shows the quantile of product complexity (1 – the least complex, 5 – the most complex), given by the Growth Lab at Harvard University (2019).

4. Changes of Lithuania's export structure by destination country

This section examines the changes of Lithuania's export structure by destination country during 2020. I employ similar analysis method as in previous section. The only difference is that the coefficients and product fixed effects estimated by the OLS gravity model for the period of 2015–2019, are used to calculate predicted export values in 2020 for each destination country. The differences between actual and predicted export values show possible impact of the pandemic for Lithuania's export structure in terms of destination markets.

Table 5 lists Lithuania's export partners having the highest differences between their actual and predicted export values in 2020 (sorted by the magnitude of the difference, starting from the highest). In the left there are countries for which the difference between Lithuania's actual and predicted export was the largest negative. In the right there are countries which imported from Lithuania in 2020 much more than the fitted values, i.e. the difference between their actual and predicted export values was the largest positive. The shares of Lithuania's export to these countries in 2020 and countries' economic complexity indexes (ECI) as of 2018, calculated by the Growth Lab at Harvard University (2019) are also given in Table 5.

Judging by the findings given in Table 5, positive difference between the actual and predicted export values are more likely for countries having stronger relations with Lithuania, i. e. having larger share in Lithuania's export. Also, there may be a positive relationship between the above-mentioned difference and country's economic complexity. Countries of higher complexity are more likely to have actual export value higher than predicted. The relationship between the difference between actual and predicted export values and the distance between Lithuania and the destination country is ambiguous and requires further investigations. Almost all the countries in both sides of Table 5 are not very far away from Lithuania.

Table 5. Lithuanian export partners having the largest differences between the actual and predicted export values in 2020

Actual export was lower than predicted			Actual export was higher than predicted		
Country	Share[1]	ECI[2]	Country	Share[1]	ECI[2]
Belarus	2.15	0.89	Germany	8.19	2.09
Slovakia	0.35	1.41	Netherlands	5.31	0.98
Luxembourg	0.04	–	USA	4.49	1.55
Iran	0.01	–0.71	Sweden	4.61	1.70
			UK	4.25	1.51
			Russia	13.7	-0.04
			Estonia	4.60	0.96
			Norway	3.03	0.44
			France	2.54	1.37
			Ukraine	3.20	0.37
			Italy	2.18	1.44
			Belgium	2.15	1.18
			Denmark	2.61	1.09
			Finland	2.02	1.55
			Germany	8.19	2.09

Notes: [1] Share of Lithuania's export to the specific country in total Lithuania's export in 2020, %.

[2] Countries' economic complexity index as of 2018 (The Growth Lab at Harvard University, 2019).

I conclude that Covid-19 pandemic could have had a small impact for Lithuania's export structure in terms of export partners. I find no relationship between the effects of the pandemic and destination countries' closeness to Lithuania. However, the results show that stronger trade relations with Lithuania and higher economic complexity index of the destination country could result in positive pandemic-related effects on Lithuania's export.

Conclusions

The paper examines the shifts in Lithuania's export structure in 2020. I analyse how the changes of Lithuania's goods export reflected expected changes in consumers' demand during the Covid-19 pandemic in terms of products and export markets.

I find that pandemic negatively influenced Lithuania's export of aircraft, railway products, meat and preparations of cereals, flour, starch and milk. All these effects could be associated to "stay-home" requirements and the closure of cafes, bars and restaurants.

Pandemic had a positive impact on Lithuania's export of beverages, spirits, tobacco, furniture, articles of wood, various electric appliances, food, fuels, vehicles and optical, medical and pharmaceutical products. The increase of export of beverages, tobacco and ships could be explained by the shift of leisure activities when all the usual entertainment places were closed. Higher values of exported furniture, products made of wood and electric appliances could be associated to people working from home and the need of spending more money on their surroundings. Finally, medical and pharmaceutical products seem to be directly influenced by the pandemic. Still, the increase of export of fuels and vehicles is not very clear.

The findings suggest that products having higher complexity were more likely to be exported more during 2020.

I find that pandemic could have had a small impact for the export structure of Lithuania in terms of export partners. Larger export share and higher economic complexity of destination country resulted in the pandemic-related increase of export. Still, I find no clear relationship between the changes of export and destinations country's distance from Lithuania.

The findings of this preliminary research could serve as a background for future research on the possible

pandemic-related changes of Lithuania's and other countries' export structures. This research was made on a basis of an OLS model, however, PPML model has much higher determination coefficient. Therefore, checking if the results hold under PPML specification would give more robustness.

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