

THE EFFECTS OF INTERNATIONAL LOGISTICS IN GLOBAL VALUE CHAIN TRADE

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Abstract. The current empirical literature shows that logistics plays a vital role in increasing the total volume of international trade. However, there is scarce literature on the impact of logistics performance on global value chain trade. Therefore, the objective of this paper is to investigate the effect of logistics performance on global value chain trade, measured by the value-added exports. The empirical specification of this paper is based on the structural gravity model of international trade. The analysis is based on biennial panel data on bilateral trade flows for the EU-15, CEE, and the Western Balkans and covers the period from 2010 to 2018. The model is estimated with a Poisson Pseudo Maximum Likelihood Estimator. The results show that logistics performance appears to have significant positive effects on global value chain trade and that the logistics performance of the partner country plays a more critical role than the logistics performance of the reporting country. Institutional quality matters greatly for global value chain trade. Individual differences in the observed variables were found between selected groups of countries. The need to improve logistics performance and invest in knowledge and technology will help countries improve in value chains, along with adequate institutional support.

Keywords: logistics performance, global value chains, value-added trade, gravity model, PPML, international logistics.

JEL Classification: F13, F14, O24.

Introduction

Ubiquitous globalization, fragmentation of the production process and relocation of economic activities, as well as the constant desire of countries to become more involved in international trade, make it necessary to quantify their success in this process. Integration into global value chains (hereinafter GVC) and the amount of value added (hereinafter VA) in the structure of exports created within an individual economy can serve as an appropriate means of measuring countries' performance in international markets. Koopman et al.

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(2010) provided a conceptual framework and propose VA in trade rather than total exports to measure the success of countries in the global economy. In this context, instead of trying to identify the level of total exports, which may include significant value added in other economies, an important task is to identify the determinants that contribute to VA within the national economy and thus realize the benefits of international integration. Domestic value added (DVA) in the structure of export is an important component of the efficiency and productivity of domestic industry and the direction of future development policy (Caraballo & Jiang, 2016), which must strive to increase the domestic contribution in the structure of total export.

Total export includes VA of domestic industry, domestic content in exports of semi-finished products that will ultimately be re-imported, as well as foreign content in domestic export (Koopman et al., 2014). Better information on countries' participation in GVCs can improve the assessment of their performance, while analyses that include this component can provide more realistic results and guidance for economic policy makers. For this reason, there is an enviable tendency to change the future patterns in the world economy that shape countries' participation by taking into account their position in GVC (Antràs, 2020). The consequences of increasing the share of DVA in total exports have been seen in the initiation of higher revenues in relation to the growth of total international trade, allowing countries to benefit from comparative advantages, both their own and those of other countries. The GVC concept is the main driver of globalisation and strongly coincides with GDP growth in all cyclical economic trends (Wang et al., 2017). The positive effects and motives are reflected in the benefits derived from the various aspects of economic openness, through the adoption of new technologies, the mobility of factors of production and labour, the optimal exchange rate, and the positive effects of higher VA products on the balance of payments and reindustrialization, especially in less developed economies. By lowering the cost of production inputs and through economies of scale, greater participation in GVC can also make a positive contribution to individual firms as they seek to grow their productivity (Antràs, 2020). Country participation in GVCs can also have a significant long-term impact on reducing inequalities in developing countries (Carpa & Martínez-Zarzoso, 2022), providing additional motivation to find ways to create domestic value added (hereinafter DVA) and more active country participation in DVA exports.

In today's circumstances, various factors play a role in the specialization of countries, thus affecting the domestic value of exports and the position of countries in GVCs, which may affect the level of economic growth and development. Some of the identified macro-economic determinants that initiate more active participation in GVC are FDI inflows, institutional quality, political stability, resource quality, and technology (Antràs, 2020). These determinants can influence the disparity between total trade and trade in VA. The size of the economy can also affect the structure of exports, positively, since it is assumed that larger economies have more inputs, which reduces import dependence, but also negatively, if we assume that these countries, due to their size, are closer to certain markets where they often buy products (Antràs & De Gortari, 2020). The cost of international trade is one of the main negative impacts of all trade flows, which can be due to various causes, such as geographical distance, underdeveloped infrastructure, regulatory barriers in the form of quotas and tariffs,

and inaccurate customs procedures. One way to reduce certain types of costs is through trade agreements, as evidenced by the increase in GVC activity within the EU and ASEAN (Ruta, 2017). In addition to distance, transportation costs can also be affected by the level of exports between two countries, where the trading partners who trade more often have lower transport prices (Hafner et al., 2022). However, in the context of GVC, the existing literature does not provide empirical evidence on the impact of international trade logistics. It includes various physical “hard” and “soft” service components (Arvis et al., 2018) that have great potential to reduce trade costs and facilitate international trade flows.

The identified gap in the literature is the subject of this research. This paper examines the impact of logistics system quality and performance on GVC trade. The aim of this paper is to empirically identify the potential contribution of logistics performance to increasing the domestic value-added share in exports. The motive for this assumption can be derived from previous findings that point to the positive impact of logistics on various segments of economic development, especially in terms of initiating overall international trade (Hausman et al., 2013; Gani, 2017; Çelebi, 2019; Bugarčić et al., 2020; Host et al., 2019), but also its contribution to improving global competitiveness and initiating economic growth and development (D'Aleo & Sergi, 2017), and as a factor of business development (Aćimović et al., 2022). For this reason, it is necessary to study the impact of logistics on the success of countries in participating in GVCs and creating DVA and initiating VA exports, since the flows of international trade depend significantly on different segments of international logistics. Considering other assumptions affecting the volume of international trade, a structural gravity model was applied as an adequate approach for trade analysis. We chose to base our analysis on the gravity model because it is considered the workhorse of bilateral trade analysis (Anderson & van Wincoop, 2004; Baier & Bergstrand, 2007; Head & Mayer, 2014). However, we extended the gravity model based on the main literature on GVC trade, i.e., Koopman et al. (2010, 2014), Noguera (2015), Antràs (2020), and Antràs and de Gortari (2020). We estimate our augmented gravity equation using the Poisson Pseudo Maximum Likelihood (Silva & Tenreyro, 2006) estimator to deal with the most common econometric problem in the analysis of international trade. According to the findings, logistics performance appears to have a considerable beneficial impact on international trade, and partner country logistics performance is more important than reporting country logistics performance. In the global value chain trade, institutional quality is crucial and along with proper institutional support, improving logistics performance and making investments in knowledge and technology can help countries advance in global value chain trade. The remainder of the paper is organized as follows. Section 1 reviews the literature on the determinants of GVC and value-added trade. Section 2 explains the structural gravity model and the data and variables used in the analysis. Sections 3 and 4 presents and discusses the regression results, while the last Section concludes the paper.

1. Literature review

Pomfret and Sourdin (2018) point to the strong growth of activities within GVC over the last two decades, with clear differences between countries, some of which occupy a dominant

position. Existing literature provides some evidence on various factors that influence the creation of VA in exports and the performance of countries in GVCs. The motive for looking at these determinants is to find valid patterns for increasing VA within an economy's borders. Economies with higher DVA could derive greater benefits from export orientation with the goal of increasing the level of aggregate economic development. In this process, there is a constant desire to find new ways to increase the performance of countries in the international environment, which would allow a more efficient implementation of industrial policies with the aim of increasing participation in GVCs (Gomes Nogueira et al., 2017).

Certain studies (Kowalski et al., 2015; Stehrer & Stöllinger, 2014) have found a positive relationship between the openness of the economy to FDI inflows and the foreign share of domestic exports (FVA). This is because FDI inflows are associated with an increase in imports of semi-finished goods that are later used as intermediate inputs for production destined for export. In some cases, FDI inflows may be the reason for lower demand for domestic intermediate inputs, which ultimately leads to a lower level of DVA in exports (Vrh, 2018). However, Damijan et al. (2018) used the example of Central and Eastern European countries (CEECs) to demonstrate, based on industry-level data, that FDI inflows contribute significantly to export restructuring. The authors find that the difference between countries in the success of export incentives with higher VA is related to the level of technology applied, with which industry receives FDI inflows and with which level of technology being crucial for countries' export potential.

In the process of adding value and increasing the quality of export potential, the role of innovation and patents within the economy plays an important role (Caraballo & Jiang, 2016), as well as R&D (Lasinio et al., 2016), based on which it is possible to create new VA that affect the structure of total exports.

Manova and Yu (2016) emphasise that the capital market is an important prerequisite for strengthening the role of countries in GVCs. Strengthening the financial sector of the economy provides a better development prospect for export enterprises to avoid the situation where they are forced to produce and export products with low VA due to credit constraints. The development of the financial sector could make a special contribution to the promotion of DVA in developing countries (OECD, 2013), so it can be mentioned as an important factor for stimulating VA export in this case.

Ambroziak (2017) has attempted to identify differences in factors affecting trade flows based on the panel data gravity model. The results of this research suggest that the size of the economy, as measured by GDP, has a greater impact on VA exports than on total exports, while geographic distance is a smaller constraint on VA exports. The paper also shows the positive impact of the common border and the free trade agreement in both cases analysed. Zaninović (2022) analyses the determinants of the global supply chain from the perspective of ICT and technology. The methodology was based on the structural gravity model estimated with the PPML estimator. The results show that ICT and technology are significant determinants of GVC trade, enabling countries to produce more sophisticated products with higher DVA.

In the context of global trade flows, efficiency, and cost of international trade, it is necessary to consider the role of international logistics, which can be an important determinant

of VA export incentives through different dimensions. Previous research emphasizes the importance of logistics in facilitating overall international trade (Zaninović et al., 2021) as well as in reducing the impact of distances between trading partners in bilateral trade flows (Bugarčić et al., 2020), which directly reduces overall trade costs. In the area of logistics systems, the importance of physical infrastructure stands out as one of the most important factors of trade facilitation (Rezaei et al., 2018), as well as components of the quality of logistics services and customs procedures (Hausman et al., 2013). An important determinant of competitiveness and efficiency in international markets and potentially within GVCs is the ability to track shipments (Korinek & Sourdin, 2011) and on-time delivery (Hummels & Schaur, 2013). In this sense, the quality of logistics performance has a significant impact on FDI inflows (Luttermann et al., 2020; Bugarčić & Skvarciany, 2023), increases comparative advantages through infrastructure development (Park, 2020), and has a positive long-term impact on the intensity of an increasingly important segment of cross-border e-commerce (He et al., 2021). Logistics is an integral part of all activities within and between the GVCs which underscores the need for empirical analysis of its impact on GVC trade. So far, the empirical literature was focus on the relationship between the logistics performance and gross trade but often underestimated the role of logistics in GVCs and in exports of higher value added. This research aims to fill the current gap and to evaluate the logistics performance in higher value-added content in exports. Our main research hypothesis is that it is expected that logistics performance has a significant impact on global value chain trade, and that the better the logistics performance, the higher the value-added trade.

2. Methodology and data

2.1. Model specification

Our empirical model specification is based on the gravity model, which is considered the workhorse of bilateral trade analysis and one of the most successful models in empirical application in the field of international economics. In the absence of a common approach to value-added trade modelling, we mainly base our analysis on the standard gravity model developed by Anderson and van Wincoop (2004), Baier and Bergstrand (2007), Head and Mayer (2014), and extended based on the methodology of Koopman et al. (2010, 2014), Noguera (2015), Antràs (2020), and Antràs and de Gortari (2020).

The standard gravity model relates bilateral trade flows to GDP and distance, and usually considers other trade-related, political, social, and cultural indicators that could have an impact on bilateral trade. Since the objective of this paper is to examine the impact of logistics on value-added trade, i.e., value-added in exports, along with the standard gravity variables, we include in our model the logistics performance index (LPI) as a proxy variable for logistics performance and the variables quality of institutions and position in global value chains as important variables for the analysis of value-added trade. The more detailed description of the independent and dependent variables is explained in the Data description section. Our gravity model equation has the following form:

$$DVAFX_{ijt} = \exp(\alpha + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln distw_{ij} + \beta_4 RTA_{ijt} + \beta_5 LPI_{it} + \beta_6 LPI_{jt} + \beta_7 institution_{it} + \beta_8 institution_{jt} + \beta_9 GVCposition_{ijt} + \lambda_t + \varepsilon_i + \tau_j + \omega_{ij} + \mu_{ijt}), \quad (1)$$

where $DVAFX_{ijt}$ represents domestic value-added embodied in gross foreign exports (expressed in US dollars) between reporting country i and partner country j in year t while $\ln GDP_{it}$ and $\ln GDP_{jt}$ are gross domestic products of reporting i and partner country j in time t . The variable $\ln distw_{ij}$ is the weighted distance between the capital cities of the trading partners. To obtain more precise estimates, we performed a logarithmic transformation of GDPs and distance variables. Dummy variable RTA_{ijt} represents the regional (free) trade agreement and has a value of one if the trading partners have a trade agreement in force and zero if they do not.

Since we do not have data for the entire observed period, as the Logistics Performance Index is published every two years, we estimate our model based on biennial panel data (t stands for 2010, 2012, 2014, 2016, and 2018), where delta is two. The LPI was published every two years until 2018, but due to the Covid 19 pandemic, there was no survey or publication of LPI data in 2020 or either 2022, and at the time of this study, the last available data were from 2018. The variables LPI_{it} and LPI_{jt} represents the logistics performance index of reporting country i and partner country j in year t . Variables $institution_{it}$ and $institution_{jt}$ are factor variable that represents the quality of the institutions of the reporter country i and partner country j in year t . The variable $GVCposition_{ijt}$ represents the bilateral value chain position of the countries, that is used as the logarithmic ratio of a country's forward and backward participation. The variable position in global value chain is important to control for in value-added trade estimations (see Koopman et al., 2010; Antràs, 2020).

To deal with the potential endogeneity problem because the omitted variable and/or reverse causality leads to biased estimation results, we follow the approach suggested by Baier and Bergstrand (2007) and include fixed effects variables in our equation. The term λ_t stands for the time fixed effects. The terms $\varepsilon_i + \tau_j$ stand for the reporter and partner country fixed effects, while the term ω_{ij} stands for the country-pair fixed effects. To account for the correlation of error terms within country-pairs, we use country-pair clusters in our estimation. Country-pair, reporter and partner fixed effects are proposed to control for multilateral trade resistance terms (MRT) (Hummels, 2001). All independent variables are also lagged by one year, to avoid potential endogeneity issues. Data description is provided in Table 1.

In regression analysis of panel data, the most commonly used estimators are Pooled Ordinary Least Square (POLS) estimator, which in most cases lead to biased estimates, then Fixed Effects (FE) estimator, Poisson Pseudo Maximum Likelihood (PPML) estimator, and Generalized Method of Moments (GMM). The PPML estimator (Silva & Tenreiro, 2006) has been shown to be robust in the presence of zero trade values and heteroscedasticity (Saslavsky & Shepherd, 2014; Kejžar et al., 2022; Zaninović, 2023), so we chose to estimate our model using the PPML estimator, however to compare results for both, POLS and PPML regression results (Table 2).

2.2. Data description

Table 1. Summary statistics (source: author's calculations)

VarName	Obs	Mean	SD	Min	Median	Max
DVAFX	69 337	194 262.92	1.99e+06	0	463.6584	1.08e+08
lnGDP _i	148 312	17.93	2.229	11.92126	17.80513	23.74511
lnGDP _j	133 990	17.56	2.308	10.368	17.49863	23.74511
Indistw	145 799	8.70	0.797	2.418322	8.893925	9.885839
RTA	152 669	0.20	0.400	0	0	1
LPI _i	129 510	3.02	0.565	1.338373	2.881649	4.225967
LPI _j	114 918	2.91	0.579	1.338373	2.774072	4.225967
institution _i	149 980	-0.03	1.083	-3.088517	-.1105957	2.950658
institution _j	140 076	-0.02	1.086	-3.229724	-.1017111	2.812912
GVCposition	69 337	0.00	0.000	-.0009062	-3.99e-10	.0041776

Our panel data include value-added trade data between 181 reporting countries and 237 partner countries, covering the period from 2000 to 2019. We use Eora MRIO trade indicators, mainly domestic value-added (DVAFX) included in gross foreign exports, as the equivalent of exports obtained from the Eora MRIO (2020) Global Value Chain (GVC) database. Gross domestic product (GDP), distance, and regional (free trade) agreement data are from the CEPII (2019) database. The LPI was created based on a global survey of more than 5,000 international freight forwarders and logistics companies. Each respondent rates their trade logistics experience (across six dimensions/sub-indices: customs, infrastructure, shipping prices, logistics service, tracking, and on-time shipping) with the eight countries with which they trade the most (Arvis et al., 2018).

The variable institutions that represent the quality of the institutions is a factor variable created with the confirmatory factor analysis that includes Worldwide Governance Indicators data from 2020 (namely Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption).

The variable GVC position, i.e. bilateral position in the global value chain is calculated based on the Koopman et al. (2010) approach. First, we calculate forward (FP) and backward (BP) of the countries in the GVCs and then we calculate bilateral GVC position. Forward participation means that the country is positioned more downstream, while backward participation means that the country is positioned more upstream. More upstream position means more domestic value-added in exports. Forward participation can be measured as domestic value-added embodied in foreign exports (DVAFX). Backward participation can be measured as foreign value-added (FVA) embodied in domestic exports (Kejzar et al., 2022).

The backward and forward participation is calculated as follows:

$$FP_{ijt} = \left(\frac{DVAFX}{\text{gross export}} \right) \times 100; \quad (2)$$

$$BP_{ijt} = \left(\frac{FVA}{\text{gross export}} \right) \times 100. \quad (3)$$

The bilateral GVC position is calculated as follows:

$$\text{GVC position} = \ln\left(\frac{1+FP}{100}\right) - \ln\left(\frac{1+BP}{100}\right). \quad (4)$$

The upstream position of a country in the GVC increases with the ratio's value. Using the bilateral participation indices that we stated in Equations (2) and (3), the GVC position is modified to be country-pair specific. This results in a bilateral GVC participation index (Eq. (4)).

We also create three dummy variables: EU15, CEE, and WBALKAN, representing EU15 countries, CEE countries, and Western Balkan countries, respectively. The details of the countries covered can be found in Appendix. In the second stage of the analysis, we run three separate regressions in each of which we include country dummy variables; EU15, CEE or WBALKAN if the reporting countries belong to one of the country groups. In this way, we aim to investigate whether logistics performance in terms of value-added exports matters more for EU15 countries, CEE countries or Western Balkan countries (Table 3).

3. Results

The results of the panel data regression analysis are shown in Table 2. The first column presents the results of estimation with the POLS estimator, while the second column presents the results of estimation with the PPML estimator. As we mentioned before, all independent variables are lagged by one year (period), except for the LPI index, since the LPI survey is conducted the year before and it is actually the opinion of the past and not the current year. The analysis refers to all countries included in the analysis. Considering that POLS usually provides over-estimated results, we focus only on the PPML estimation results in the discussion. The results suggest that the size of the reporting country's economy, represented by GDP, has significant positive effects on domestic value-added in exports, which is consistent with gravity theory and the assumption that higher income countries attract more foreign investment, have higher value-added production, and consequently have higher value-added exports. However, partner country GDP shows a negative impact on value-added exports, which may seem counterintuitive at first glance, but may also be related to the fact that lower income countries tend to be more backward involved in GVCs and tend to have more foreign content in their imports, while higher income countries tend to be more forward involved and have more domestic value-added in their exports rather than foreign value-added. Therefore, high-income partner countries have a negative sign for domestic value-added in exports.

The distance variable is omitted from the estimation in the case of PPML because we included country-pair fixed effects in the estimation while the RTA variable for value-added exports turns out not to be significant. The reason could be that most of the RTAs entered into force before the period we observe and therefore we do not find any variation. Our main variable of interest, country logistics performance, appears to have significant positive effects on value-added exports only in the case of partner country logistics performance, while it is not significant in the case of reporting country logistics performance. This could be explained by the fact that not all DVA in the country depends on the quality of logistics performance

due to the participation of the service sector as a value-added factor that does not require the active use of logistics capacities. On the other hand, the quality of institutions of both the reporting country and the partner country has significant and positive effects on value-added exports. Global value chains are a complex network involving a variety of roles and actors, and institutional support plays an important role in the activities of GVCs. Position in global value chains also has significant positive effects on value-added exports, i.e., the higher the country is positioned in global value chains, the higher the share of domestic value-added in its exports. The explanation for this is that more developed countries tend to occupy an upstream position because they have the resources and technology to produce higher value-added products and therefore have a higher share of domestic value-added in their exports.

Table 2. Results of the POLS vs. PPML regression (source: author's calculations)

VARIABLES	(1) POLS	(2) PPML
	lnDVAFX	DVAFX
lnGDP _i	0.641*** (0.0265)	0.552*** (0.106)
lnGDP _j	-0.406*** (0.0274)	-0.352*** (0.0881)
Indistw	-0.697*** (0.0199)	- -
RTA	0.315*** (0.0266)	0.0867 (0.0591)
LPI _i	0.139*** (0.0169)	0.00866 (0.0356)
LPI _j	0.0374*** (0.0139)	0.175*** (0.0625)
institution _i	0.0644*** (0.0140)	0.0927*** (0.0248)
institution _j	0.0167 (0.0172)	0.0848** (0.0369)
GVCposition	36,407*** (4,570)	10,350*** (2,887)
Constant	5.127*** (0.655)	10.53*** (2.408)
Time FE	YES	YES
Reporter FE	YES	YES
Partner FE	YES	YES
Pair FE	NO	YES
Observations	45,754	45,328
R-squared	0.916	

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

To investigate whether there is a significant difference in the effect of logistics performance on value-added exports for different groups of countries, we included dummy variables for three groups of countries: EU15 or old EU member countries, Central and Eastern European member countries – CEE and Western Balkan countries, of which Croatia is a member of the EU, while the rest of the countries are not. Based on the LPI index, the old EU member states, i.e. EU15, are among the countries with the best logistics performance, while CEE and some of the Western Balkan countries are average. Some Western Balkan countries are even below average. For details on the LPI index results, see the Logistics Performance Index Report (Arvis et al., 2018). Table 3 shows the PPML regression results, with the first column (1) containing the report results when the reporting countries are only one of the EU15 countries. The second column (2) gives the regression results for the case when

Table 3. Results of the PPML regression with country group dummy (source: author's calculations)

VARIABLES	(1) Dummy EU15	(2) Dummy CEE	(3) Dummy WBALKAN
	DVAFX	DVAFX	DVAFX
$\ln GDP_i$	0.535*** (0.138)	0.370*** (0.112)	-2.200*** (0.840)
$\ln GDP_j$	-0.195** (0.0774)	-0.281*** (0.101)	0.235 (0.210)
$\ln distw$	-	-	-
RTA	0.149* (0.0896)	0.0684** (0.0348)	0.326*** (0.108)
LPI_i	0.0339 (0.0800)	0.00139 (0.0262)	-0.468*** (0.178)
LPI_j	0.0861* (0.0485)	-0.0798 (0.0668)	0.0459 (0.116)
$institution_i$	-0.0572 (0.0436)	0.0245 (0.0551)	0.504** (0.229)
$institution_j$	0.118** (0.0458)	0.0652** (0.0329)	0.227* (0.117)
GVCposition	2,558 (2,493)	1,827 (4,038)	29,364*** (8,981)
Constant	8.312** (3.607)	13.73*** (2.998)	43.58*** (16.08)
Time FE	YES	YES	YES
Reporter FE	YES	YES	YES
Partner FE	YES	YES	YES
Pair FE	YES	YES	YES
Observations	4,578	4,057	1,938

Note: Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

the reporting countries are from the CEE group, while the third column (3) gives the results for the case when the reporting countries are from the Western Balkans group. Croatia is classified into two groups: CEE and Western Balkans, while the other countries belong to only one group. Details on the countries belonging to one of the three groups can be found in Appendix.

The estimation results show that the GDP of the reporting countries has a significant positive impact on value-added exports in the case of EU15 and CEE countries exports, while in the case of Western Balkan countries the impact is significant and negative, which means that for these countries the increase in GDP has a negative impact on value-added exports, which is counterintuitive. However, we must acknowledge the limitation of this study that we have a small sample, only 1,938 observations in the case of the Western Balkan countries, which could also affect our results and lead to incorrect conclusions. Also, the results may differ for GDP per capita, as the right measure of economic development. The distance variable is omitted from the estimation because we included country pair fixed effects. In case of variable free trade agreement (RTA) the results are in line with our expectations and show positive and significant effects on trade, with the strongest effects on the Western Balkan countries, which makes sense since, for example, Croatia became an EU member state from CEFTA integration in the observed period. The LPI of the reporting country is not significant for EU15 value-added exports and CEE, while it is significant and negative for Western Balkan value-added exports. These results are again counterintuitive, as we would expect that an improvement in logistics performance would lead to a higher level of value-added exports. In part, we can explain the negative sign by the only five time periods for which we have the LPI, and in part by noting that the Western Balkan countries are more involved in backward participation in GVCs and therefore have more foreign value-added in their exports than domestic value added. In the case of the EU15 partner countries, the LPI shows positive and significant effects on value-added exports. This means that improving logistics performance is important for partner countries because of the great amount of foreign value-added content incorporated in their production. Institutions show significant positive impacts on value-added exports, especially in the Western Balkans, as institutional support is important for GVC functioning. Finally, the importance of GVC position, i.e., the more the Western Balkan countries occupy an upstream position in GVCs, the higher their value-added share in exports. This leads us to conclude that the Western Balkan countries should invest in an institutional environment as well as in technology and knowledge that will ensure them an upstream position in GVCs, and thus more domestic value-added to their exports.

4. Discussion

Overall, our results are generally consistent with our expectations. The results of the regression analysis show that the size of the trading partner's economy, especially the exporting country, positively affects domestic value-added in the country's exports. Our main variable of interest, logistical performance of trading partners, is an important determinant of trade in value-added, especially in the case of the total sample size, not specifically for a particular group of countries. These results are consistent with the previous findings of Zaninović et al.

(2021), Marti et al. (2014), Behar and Manners (2008), and Saslavsky and Shepherd (2014), whose results show that logistics performance plays an important role in international trade, but they analysed the impact on gross trade and not on trade with value-added, which is the scientific contribution of this study.

In our analysis, we also wanted to investigate whether there are significant differences in the impact of logistics performance on value-added trade between different groups of countries, namely the old Member States (EU-15), the new Member States (CEE) and the Western Balkan countries. However, due to the relatively small sample size and number of observations, we cannot determine whether there are significant differences in the impact of logistics performance on trade in value-added, but the results suggest that the CEE and the Western Balkan countries have free trade agreements between trading partners, good and reliable institutions, and an upstream position in global value chains. The results for logistics performance are inconclusive, as logistics performance seems to be positively significant only for the EU-15 countries. These economies certainly have a high level of value-added in exports. Part of the credit apparently goes to logistics, as those countries are the best performers regarding LPI. This is also one of the motivations for further research. Institutional quality and position in a global value chain have been shown to be important determinants of value chain trade. Our results suggest that more developed/stronger economies with good institutional backgrounds have higher domestic value added in their exports and that the further up the value chain they are, the higher the domestic value-added in their exports.

When we compare our results with previous findings, the important role of upstream position in global value chains is consistent with the findings of Caraballo and Jiang (2016) that innovation and patents increase the quality of export potential because one of the upstream activities in GVCs are R&D, innovation, and design, and the most developed economies participate in GVCs with these activities, while developing countries participate with assembly activities, for example. The results of Zaninović (2023) show that trade in value-added is most responsive to improvements in institutional efficiency and are consistent with our findings that institutional quality is an important determinant of domestic value-added in exports.

Based on the presented evidence, logistics performance can also be accepted as a value-added trade facilitation factor, together with FDI (Damijan et al., 2018) and the quality of the financial sector (Manova & Yu, 2016). Among these elements, we can now include logistics performance as one of the factors, which means that the logistics system can be treated as an important component in the success of the value creation process and participation in GVC. Also, focusing on value-added exports, targeted policies could gain better export-oriented strategies and more significant contributions to the economy.

The smaller contribution of logistics influence to value-added export compared to total export in previous studies (Marti et al., 2014; Gani, 2017; Bugarčić et al., 2020) indicates the complexity of modern trade flows within GVC and the fact that the improvement of logistics represents one link in the chain towards increasing the participation of countries in GVC.

Conclusions

The objective of this paper was to estimate the impact of logistics performance on GVC trade. The value-added share of exports was used as a proxy measure for GVC trade. We aimed to investigate whether the impact of logistics performance differs across the three country groups EU15, CEE and Western Balkan countries. Our analysis was based on the gravity model of international trade extended to the analysis of value-added in trade. Panel data regression analysis with the PPML estimator shows that logistics performance in general, together with institutional quality and upstream position in the GVC, has significant positive effects on domestic value-added in exports. However, when we perform the analysis separately for the different country groups, the results still confirm the importance of institutions and upstream position but show an insignificant and negative effect in terms of logistics performance. We acknowledge that our analysis is also subject to some limitations as our panel data only covers five periods, 2010, 2012, 2014, 2016, and 2018, for which we have LPI data, and thus we cannot draw precise conclusions with this small sample and number of observations. Future research should focus more on an industry rather than country level because GVCs are different in each industry and the results could provide more information on the role of logistics performance in value chain trade. In addition, logistics performance can be decomposed into several elements, such as transportation, customs, on-time delivery of shipment, etc. Future research should focus on each element individually, rather than analysing it in its entirety and how each of these components contributes to domestic value-added in exports. Since one of our main research limitations is the short time period, we believe that future research could benefit from a longer time period, e.g., data for at least 10 years. Nevertheless, this paper contributes to the current knowledge on the relationship between logistics performance and GVC trade. The findings of this research show that upstream movements in GVCs are an important determinant of GVC trade, especially the share of domestic value-added in the country's exports. From a policy perspective, firms and countries that want to increase their value-added share of exports should consider investing in knowledge and technology that will help them upgrade in GVCs, while the government should provide institutional support to these firms.

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References

- Aćimović, S., Mijušković, V., & Bugarčić, F. Ž. (2022). Logistics system as a factor of business development: The case of the Republic of Serbia, *Ekonomika preduzeća*, 70(5–6), 325–334. <https://doi.org/10.5937/EKOPRE2206325A>
- Ambroziak, U. (2017). Determinants of trade in value added: the case of the Central and Eastern European Countries. *International Journal of Business & Technology*, 6(1), 1–7. <https://doi.org/10.33107/ijbte.2017.6.1.10>

- Anderson, J. E., & van Wincoop, E. (2004). Trade costs. *Journal of Economic Literature*, 42(3), 691–751. <https://doi.org/10.1257/0022051042177649>
- Antràs, P. (2020). Conceptual aspects of global value chains. *The World Bank Economic Review*, 34(3), 551–574. <https://doi.org/10.1093/wber/lhaa006>
- Antràs, P., & Gortari, A. (2020). On the geography of global value chains. *Econometrica*, 88(4), 1553–1598. <https://doi.org/10.3982/ECTA15362>
- Arvis, J. F., Ojala, L., Wiederer, C., Shepherd, B., Raj, A., Dairabayeva, K., & Kiiski, T. (2018). *Connecting to compete 2018*. <https://doi.org/10.1596/29971>
- Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade? *Journal of International Economics*, 71(1), 72–95. <https://doi.org/10.1016/j.jinteco.2006.02.005>
- Behar, A. & Manners, P. (2008). *Logistics and export* (CSAE Working paper series 2008-13). Centre for the Study of African Economies, University of Oxford.
- Bugarčić, F. Ž., & Skvarciany, V. (2023). Logistics Influence on FDI: “hard” versus “soft” Infrastructure Components. *European Journal of International Management*. <https://doi.org/10.1504/EJIM.2022.10051618>
- Bugarčić, F., Skvarciany, V., & Stanišić, N. (2020). Logistics performance index in international trade: case of Central and Eastern European and Western Balkans countries. *Business: Theory and Practice*, 21(2), 452–459. <https://doi.org/10.3846/btp.2020.12802>
- Caraballo, J. G., & Jiang, X. (2016). Value-added erosion in global value chains: An empirical assessment. *Journal of Economic Issues*, 50(1), 288–296. <https://doi.org/10.1080/00213624.2016.1148991>
- Carpa, N., & Martínez-Zarzoso, I. (2022). The impact of global value chain participation on income inequality. *International Economics*, 169, 269–290. <https://doi.org/10.1016/j.inteco.2022.02.002>
- Çelebi, D. (2017). The role of logistics performance in promoting trade. *Maritime Economics & Logistics*, 21(3), 307–323. <https://doi.org/10.1057/s41278-017-0094-4>
- D'Aleo, V., & Sergi, B. S. (2017). Does logistics influence economic growth? The European experience. *Management Decision*, 55(8), 1613–1628. <https://doi.org/10.1108/md-10-2016-0670>
- Damijan, J., Kostevc, R., & Rojec, M. (2018). global supply chains at work in Central and Eastern European countries: Impact of foreign direct investment on export restructuring and productivity growth. *Economic and Business Review*, 20(2). <https://doi.org/10.15458/85451.66>
- Gani, A. (2017). The logistics performance effect in international trade. *The Asian Journal of Shipping and Logistics*, 33(4), 279–288. <https://doi.org/10.1016/j.ajsl.2017.12.012>
- Hafner, K. A., Kleinert, J., & Spies, J. (2022). Endogenous transport costs and international trade. *The World Economy*, 46(3), 560–597. <https://doi.org/10.1111/twec.13337>
- Hausman, W. H., Lee, H. L., & Subramanian, U. (2013). The impact of logistics performance on trade. *Production and Operations Management*, 22(2), 236–252. <https://doi.org/10.1111/j.1937-5956.2011.01312.x>
- He, Y., Wu, R., & Choi, Y. J. (2021). International logistics and cross-border e-commerce trade: Who matters whom? *Sustainability*, 13(4), Article 1745. <https://doi.org/10.3390/su13041745>
- Head, K., & Mayer, T. (2014). Gravity equations: Workhorse, toolkit, and cookbook. In *Handbook of international economics*, (pp. 131–195). Elsevier. <https://doi.org/10.1016/b978-0-444-54314-1.00003-3>
- Host, A., Pavlič Skender, H., & Zaninović, P. A. (2019). Trade logistics – the gravity model approach. *Zbornik Radova Ekonomskog Fakulteta U Rijeci: Časopis Za Ekonomsku Teoriju I Praksu/Proceedings of Rijeka Faculty of Economics: Journal of Economics and Business*, 37(1), 327–342. <https://doi.org/10.18045/zbfri.2019.1.327>
- Hummels, D. (2001). *Time as a trade barrier* (GTAP Working Papers). Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, United States. <https://doi.org/10.21642/GTAP.WP18>

- Hummels, D. L., & Schaur, G. (2013). Time as a trade barrier. *American Economic Review*, 103(7), 2935–2959. <https://doi.org/10.1257/aer.103.7.2935>
- Lasinio, C. J., Manzcocchi, S., & Meliciani, V. (2016, January 1). *Intangible assets and participation in global value chains: An analysis on a sample of European Countries*. <https://econpapers.repec.org/RePEc:lu:llee/wp:16129>
- Koopman, R., Powers, W., Wang, Z., & Wei, S. J. (2010). *Give credit where credit is due: Tracing value added in global production chains*. <https://doi.org/10.3386/w16426>
- Koopman, R., Wang, Z., & Wei, S. J. (2014). Tracing value-added and double counting in gross exports. *American Economic Review*, 104(2), 459–494. <https://doi.org/10.1257/aer.104.2.459>
- Korinek, J. & Sourdin, P. (2011). *To what extent are high-quality logistics services trade facilitating?* (OECD Trade Policy Papers, No. 108). OECD Publishing, Paris. <https://doi.org/10.1787/5kggdthrlzn-en>
- Kowalski, P., Lopez Gonzalez, J., Ragoussis, A., & Ugarte, C. (2015). *Participation of developing countries in global value chains* (OECD Trade Policy Papers No. 179). OECD Publishing, Paris.
- Luttermann, S., Kotzab, H., & Halaszovich, T. (2020). The impact of logistics performance on exports, imports and foreign direct investment. *World Review of Intermodal Transportation Research*, 9(1), 27. <https://doi.org/10.1504/WRITR.2020.106444>
- Manova, K., & Yu, Z. (2016). How firms export: Processing vs. ordinary trade with financial frictions. *Journal of International Economics*, 100, 120–137. <https://doi.org/10.1016/j.jinteco.2016.02.005>
- Gomes Nogueira, C., Padilla-Pérez, R., & Villarreal, F. G. (2017). *Value chain selection and industrial policy*. <https://doi.org/10.18356/55424b04-en>
- Marti, L., Puertas, R., & Garcia, L. (2014). Relevance of trade facilitation in emerging countries' exports. *The Journal of International Trade & Economic Development*, 23(2), 202–222. <https://doi.org/10.1080/09638199.2012.698639>
- Noguera, G. (2015, January 1). *Trade costs and gravity for gross and value added trade*. <https://www.semanticscholar.org/paper/Trade-Costs-and-Gravity-for-Gross-and-Value-Added-Noguera/72214dcb638cb4299b85840333ce707594a7f88f>
- OECD. (2013). Knowledge-based capital and upgrading in global value chains. In *Supporting investment in knowledge capital, growth and innovation* (pp. 215–252). <https://doi.org/10.1787/9789264193307-9-en>
- Park, S. (2020). Quality of transport infrastructure and logistics as source of comparative advantage. *Transport Policy*, 99, 54–62. <https://doi.org/10.1016/j.tranpol.2020.07.016>
- Pomfret, R., & Sourdin, P. (2018). Value chains in Europe and Asia: Which countries participate? *International Economics*, 153, 34–41. <https://doi.org/10.1016/j.inteco.2016.11.002>
- Rezaei, J., van Roekel, W. S., & Tavasszy, L. (2018). Measuring the relative importance of the logistics performance index indicators using Best Worst Method. *Transport Policy*, 68, 158–169. <https://doi.org/10.1016/j.tranpol.2018.05.007>
- Ruta, M. (2017, September 13). *Preferential trade agreements and global value chains: Theory, evidence, and open questions*. SSRN. <https://doi.org/10.1596/1813-9450-8190>
- Saslavsky, D., & Shepherd, B. (2014). Facilitating international production networks: The role of trade logistics. *The Journal of International Trade & Economic Development*, 23(7), 979–999. <https://doi.org/10.1080/09638199.2013.811534>
- Stehrer, R., & Stöllinger, R. (2014, February 15). *The Central European manufacturing core: What is driving regional production sharing?* (FIW-Research Reports No. 2014/15-02). <http://hdl.handle.net/10419/121234>
- Vrh, N. (2018). What drives the differences in domestic value added in exports between old and new E.U. member states? *Economic Research-Ekonomska Istraživanja*, 31(1), 645–663. <https://doi.org/10.1080/1331677X.2018.1438910>

- Wang, Z., Wei, S. J., Yu, X., & Zhu, K. (2017). *Measures of participation in global value chains and global business cycles* (NBER Working paper 23222). <https://doi.org/10.3386/w23222>
- Kejžar, K. Z., Velić, A., & Damijan, J. P. (2022). COVID-19, trade collapse and GVC linkages: European experience. *The World Economy*, 45(11), 3475–3506. <https://doi.org/10.1111/twec.13314>
- Silva, J. S., & Tenreyro, S. (2006). The log of gravity. *The Review of Economics and statistics*, 88(4), 641–658. <https://doi.org/10.1162/rest.88.4.641>
- Zaninović, P. A., Zaninović, V., & Skender, H. P. (2021). The effects of logistics performance on international trade: EU15 vs CEMS. *Economic Research-Ekonomska Istraživanja*, 34(1), 1566–1582. <https://doi.org/10.1080/1331677X.2020.1844582>
- Zaninović, P. A. (2022). Do ICT and technological development facilitate supply chain trade?. *Zbornik Radova Ekonomskog Fakulteta U Rijeci: Časopis Za Ekonomsku Teoriju I Praksu/Proceedings of Rijeka Faculty of Economics: Journal of Economics and Business*, 40(2), 313–327. <https://doi.org/10.18045/zbefri.2022.2.313>
- Zaninović, P. A. (2023). Assessing the effects of hard and soft infrastructure on traditional vs supply-chain trade: the case of Central and Eastern EU member states (CEMS). *Applied Economics*. <https://doi.org/10.1080/00036846.2023.2167918>

APPENDIX

Table A1. ISO codes of the country dummy variables

ISO EU15	ISO CEE	ISO WBALKAN
AUT	BGR	ALB
BEL	CYP	BIH
DEU	CZE	MKD
DNK	EST	MNE
ESP	HRV	HRV
FRA	HUN	SRB
GBR	LTU	
GRC	LVA	
IRL	MLT	
ITA	POL	
LUX	ROU	
NLD	SVK	
PRT	SVN	
SWE		
FIN		