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# Where Does Value-Added Flow in Gross Exports, Mr. Newton? Global Supply Chains and New Regionalization's Effects in the Asia-Pacific

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**Abstract** The New Trade Theory proposes that participating in global supply chains (GVCs) enhances productivity and economies of scale. However, recent events like the COVID-19 pandemic and Ukraine crisis have exposed the vulnerabilities of GVCs to global risks. This study investigates the relationship between gross exports and the domestic value-added content of such exports, considering various factors, including labor productivity, especially in Belt and Road Initiative countries (A-P Belt and Road Initiative [BRI]). We analyze the role of GVCs using cross-sectional and panel data from the 2021 OECD Trade in Value-Added. Over the period from 2009 to 2018, we observed that countries with increasing productivity exported goods, services, and value-added to other countries experiencing similar productivity. Our findings indicate that export concentration contributes to increased value-added exports. However, we could not validate the effects of R&D spending, the real effective exchange rate, foreign direct investment inflows, and A-P BRI membership contributions using the difference-in-differences method.

**Keywords:** Global Supply Chains, GVCs, Gravity modeling, Poisson Pseudo-Maximum Likelihood, Trade in Value-Added, Belt and Road Initiative

*JEL Classifications: F14, R15, J25, O47*

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## I. Introduction

The New Trade Theory posits that efficiency increases due to economies of scale and economic concentration. In economic reality, this process is associated with involvement in global value or supply chains (GVCs). Participation in GVCs undeniably reduces costs and enhances productivity

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and efficiency. Conversely, severing these networks for internal or external reasons can lead to a significant decrease in global trade, as seen during the COVID-19 pandemic and the security crisis in Ukraine in 2022. Economies confronted declining demand and physical and legal obstacles to transportation and production during the pandemic (Steinhauser, 2021b). Following the Ukraine crisis, these issues grew worse. We included the shortage of rare gases required for manufacturing microchips, further jeopardizing the stability of the automotive supply chain and electrical engineering (Jucca, 2022). Economic crises can potentially stimulate processes and settings (Morvay, 2022), but this only occurs if the underlying problem's internal structure is well understood. In this context, gravity modeling has served as valuable tools and consists the motivation for this paper. While this article examines the years up to 2018, it also analyzes the forces that influence gross exports and exported value-added content.

Gravity models have found numerous applications and have become popular for analyzing the factors influencing international trade (Bubáková, 2013). Among these factors, we included traditional variables found in gravity models, such as distance, remoteness, and variables related to gross domestic product (e.g., labor productivity, final consumption). Hence, we incorporated variables related to GVCs, including foreign direct investments (FDIs) and export concentration indices. Exports, imports, and turnovers have conventionally been used to examine trade flows between countries. Modern economies are increasingly interconnected with global value chains, altering perceptions of conventional trade statistics (Zábojník, Čiderová, & Krajčík, 2020). Monitoring only the overall value that transcends national borders is no longer sufficient; evaluating the contribution of domestic and foreign production factors to the production and supply chain is also necessary. Counting intermediates multiple times in traditional trade statistics carries a risk of bias. The Trade in Value-Added indicator (TiVA) (OECD, 2021) or the use of conventional input-output tables (Koopman, Wang, & Wei, 2014) are useful tools for measuring participation in global supply chains.

In this study, we will specifically focus on the 14 available Belt and Road Initiative (BRI) members in the Asia-Pacific region (according to Sacks, 2021; the geographical division according to The Heritage Foundation, 2019 and processed by Steinhauser, 2021a). China, as the project's initiator, plays a prominent role among BRI nations. Examining this region allows us to test the impact of regional trade agreements on exports and exported value-added. Ayuso-Díaz and Gómez-Plana (2023) studied the intensity of trade between East and Southeast Asian countries. Simultaneously, they found that trade in the region is significantly influenced by flows of FDI and exhibits a high degree of trade complementarity. Further trade agreements may increase trade intensity. Another motivation is the dual perspective of this initiative from the European Union's (EU) point of view. This can be considered as either a threat or an opportunity for European competitiveness (Steinhauser, 2021a). We view the latter perception as healthier and more sustainable in the long term as it allows for international cooperation between EU members

and BRI countries. This study primarily aims to examine the relationship between certain factors affecting gross exports and the domestic value-added content of these exports, particularly labor productivity, with a focus on the countries participating in the Asia-Pacific Belt and Road Initiative (A-P BRI). For example, an increase in R&D expenditures or export diversification should lead to an increase in value-added in exports (e.g., Durongkaveroj, 2023). This article aims to provide empirical evidence for these assumptions. Additionally, the paper analyzes the latest 2021 release of the OECD TiVA edition using panel data analysis with the Poisson pseudo-maximum likelihood (PPML) estimator with fixed effects. Additionally, we also employed utilized the conventional cross-sectional method of average time-series values. The effects of R&D expenditures on gross domestic product, the inflow of FDI, and labor productivity on value-added will be of particular interest. For our purposes, we use labor productivity as the GDP per person employed. In this context, productivity can serve as an indicator of national competitiveness (Porter, 1990; Krugman, 1994).

# II. Literature Review

## A. Importance of global value chains for foreign trade and business

Krugman (1981) explained the paradoxes of international trade by developing a theoretical model of intraindustry specialization. The model suggests that the greatest volume of trade occurs among nations with comparable production factors, trading in similar goods. Krugman suggests that economies of scale drive countries to specialize, producing a subset of goods from specific commodity groups. Economies of scale play a significant role in the growth and participation of countries in global supply chains (GVCs). Another effect identified by Krugman (1980)—"the home market effect" explains the concentration of production. This suggests that increasing returns and transportation costs stimulate companies to locate production near a large group of their customers, simultaneously reducing transportation costs and achieving economies of scale.

Frensch, Hanousek, and Kočenda (2013) utilized gravity models to determine the influence of specialization on international trade between new and old member states of the EU. Heckscher-Ohlin's theory assumes that capital-rich old member states will specialize in capital-intensive goods, while capital-poor new member states will specialize in labor-intensive goods. However, involvement in GVCs has been shown to increase specialization in a quantitative sense. The level of development of an economy affects the quality of participation in GVCs. Kordalska and Olczyk (2023) explored the quality of involvement in GVCs in new member states of the EU. Some countries, such as the Czech Republic or Slovenia, participate in R&D

activities. Conversely, others like Slovakia or Poland participate in activities with lower value-added. Analyzing chain analysis can be particularly useful for these countries to increase the quality of participation in GVCs. For Slovakia, Steinhauser, and Boros (2022) analyzed domestic exports using gravity modeling and found that distance is a significant factor influencing total Slovak exports. They observed that domestically identified exports account for only 12% of total Slovak exports in 2021. The remainder is generated by foreign entities operating in Slovakia or unidentified flows. This indicates a strong involvement in GVCs and a need for export diversification.

Zábojník, Čiderová, and Krajčík (2020) addressed national competitiveness issues while considering GVC characteristics. They found that participation in GVCs causes production activities to be distributed across multiple countries within a single industrial sector, with countries specializing in specific tasks within GVCs rather than product groups. Durongkaveroj (2023) discussed policymakers' attempts to increase domestic value-added in exports. However, they could not verify the correlation between value-added and net export earnings and export-led income. Nonetheless, the author argues that efforts to increase value-added in exports may contrast with economic development interests, as development encourages GVC participation. Brenton, Ferrantino, and Maliszewska (2022) also support this conclusion, stating that integration into trade systems has accelerated recovery after the COVID-19 pandemic.

Abdmoulah (2022) analyzed the 2018 edition of TiVA to examine the sophistication of exports and economic performance and highlight the importance of manufacturing and the need for implementing modern industrial policies. The author also identified the potential threats of involvement in GVCs. Without a learning process in participating economies, reliance on imported products may develop, hindering the improvement of participation in the chains. FDI requires science, training, and business promotion. The threats are also associated with the imitation of knowledge spillovers within the context of FDI. Javorcik (2004) found no evidence of intrasector knowledge spillovers. Newman et al. (2015) further explored this claim, indicating that spillovers occur in vertical rather than horizontal FDI, especially within joint venture schemes.

Gravity models are applicable to various nations, regions, and purposes. In this study, we compare the results for all available countries with those of the A-P BRI nations. The BRI, also known as One Belt One Road, can be interpreted differently from the perspective of the EU. We view the optimal BRI strategy as a challenge to increase EU competitiveness (Steinhauser, 2021a), leading to increased prosperity for EU member states and long-term cooperation with BRI countries. Jackson and Shepotylo (2021) analyzed the initiative's effect on welfare in China, the European Union, and the rest of the world, revealing that a 10% reduction in transport costs would increase China's standard of living by 1.57% and the EU's by 0.49%. Potential Free Trade Agreements (FTAs) between China and the EU could further enhance future benefits. However, China's massive investments in BRI projects create risks for the Chinese financial

market, while investments in the EU are exposed to lower levels of risk. The risks, including debt as a factor, were mentioned by van Twillert and Halleck Vega (2021) and the World Bank Group (World Bank, 2019). The World Bank Group's report highlighted benefits and risks associated with the initiative, such as the debt burden caused by costly infrastructure projects, corruption possibilities, lack of transparency, and potential environmental and social costs. Fang et al. (2021) analyzed the New Silk Road Railways, or China Railway Express, as a BRI project, finding that increased connectivity within the project has a real effect on the local European economy. However, potential project risks related to increased reliance on China were also identified (cf. Shepard, 2018).

## B. Domestic value-added in gross exports and determinants with the potential to affect exported value-added

Koopman, Wang, and Wei (2014) emphasize the importance of analyzing the value-added in exports to avoid double-counting trade flows within GVCs. Miroudot and Ye (2022) investigated the breakdown of value-added in gross exports. Vrh (2018) examined domestic value-added (DVA) as an indicator of competitiveness and found that insufficient investment in intangible capital in new EU member states hinders DVA growth and innovation development. Kersan-Škabić (2019) explored several factors influencing GVC participation intensity. Past involvement in GVCs, GDP percentage, and GDP growth rate positively impact. In contrast, the wage rate and profit tax rate have detrimental impact. FDI stocks also influence new EU member states. R&D expenditures enable these nations to participate at a more sophisticated level. Hermida, dos Santos, and Bittencourt (2022) examined GVCs' impact on long-term economic growth measured by GDP per capita. They found a positive effect of vertical specialization of production and GVC participation. These studies support not only the use of the indicator of exported DVA as a dependent variable but also the inclusion of GDP-related variables in the model specification. We chose the labor productivity indicator as productivity, in general, can be considered synonymous with national competitiveness (Porter, 1990; Krugman, 1994). Additionally, we also investigated the relationship between export competitiveness and value-added. Increasing productivity leads to an improved standard of living for the population.

Yotov (2022) presents 15 arguments to support of using domestic trade flows in gravity models. Domestic trade flows, defined as the difference between gross production and total exports are considered. However, in our gravity model, we adopt a different approach. We employ the total consumption share of GDP, which includes both household and government expenditures. Ružeková et al. (2020) found that export performance, measured as exports-value on GDP, is primarily determined by a country's consumption. This indicates that countries with larger economic scales engage less in international trade measured by export performance (share of exports to GDP).

We observe the importance of investigating the impact of the inflow of FDI as reasonable in the context of GVCs. Foreign affiliations can initiate involvement in the international division of labor. Traditionally, FDIs are used to assess development level within Dunning's investment development path theory. In Djokoto's study, the indicator of the net outflow of foreign direct investment is utilized, representing the difference between investments abroad and investments in the reported economy relative to the gross domestic product in a quadratic regression (Djokoto, 2021). We assume that countries with a significant influx of foreign investments are at lower levels of development and produce less value-added in gross exports. Empirical evidence suggests that many economies deviate from the conventional course of development. This primarily affects the nations of Eastern and Central European nations. The reason is the specific past of the previous experience with a centrally planned economy, the subsequent transformation, privatization, structural shocks, persistent informal ties, and the knowledge base from the past (Narula & Guimón, 2010).

Regarding the impact of expenditures on R&D, Kersan-Škabić (2019) revealed an improvement in the quality of involvement, particularly among new member states of the EU in GVCs. Additionally, research from manufacturing firms in Japan in 2006 and 2007 highlighted that offshore R&D activities are integrated into the main headquarters to access foreign markets and collaborate with local research entities. This suggests that countries with a higher R&D as a share of GDP tend to achieve greater levels of participation in the international division of labor (Banri et al., 2007). These findings were further corroborated by Altun et al. (2022), who investigated the impact of GVCs on high-tech exports. The intensity of this influence depends on the income level of the country, with higher-income economies exhibiting a stronger link between GVC participation and high-tech exports while this correlation is less significant for lower-income countries. Moreover, the involvement in GVCs also influences the import of high-tech products in low-income nations.

Our model specification includes the real effective exchange rate (REER) variable. The IMF (2022) defines REER as the weighted average currency exchange rate against selected foreign currencies, adjusted by price indices. We anticipate that a decrease in the REER value (currency depreciation or devaluation) will lead to more affordable exports from a foreign perspective. Conversely, appreciation will achieve the opposite result (Pavelka, Ružeková, & Zubaľová, 2021). Previous studies have explored the impact of exchange rates on international trade and export value-added (Choi & Lee, 2021). Notably, Cole and Nightingale (2016) demonstrated that the exchange rates impact on Australia's international trade is mitigated by intermediate goods trade mitigates this impact. Even intermediate imports do not show a correlation with the exchange rate change. However, the effect of exchange rates is remarkable in that it is mitigated with higher GVC involvement. Asymmetry in GVCs appears to mitigate the effects of currency misalignments, as suggested by Fišera and Horváth (2021). Moreover, they found

that overvaluation has a negative effect on the trade balance, but undervaluation does not affect it. Additionally, global value chain participation weakens the impact of currency misalignments on the balance of trade. Hence, our results suggest that globalization reduces the role of exchange rates in stimulating domestic economy (Fišera & Horváth, 2021). Moreover, Hung and Liu (2021) examined the impact of the U.S. dollar index value on the growth rates of developing countries. The depreciation of the dollar leads to increased supply, reducing borrowing costs and boosting FDI in developing nations.

Frohm from the European Central Bank (Frohm, 2021) found that export volume responds more positively to a depreciation of the exporter's currency against the U.S. dollar significantly more than a depreciation of the exporter's currency against the trading partner. Their study concludes that U.S. dollar dominates international trade. Additionally, the Herfindahl-Hirschman Index, measuring market concentration and specialization, was included in the equation specification. Moreover, it will be intriguing to observe the effect of the concentration index on domestic export value-added. The assumption is that countries with higher index values, concentrating their exports or imports on a small number of products, will export less DVA. This assumption is based on the author's of this study subjective empirical observation of the Central European region. However, Bighelli et al. (2023) demonstrate that significant growth in Europe's allocation effectiveness and productivity can be attributed to increasing specialization and market concentration.

Finally, gravity models were enriched with traditional variables used in this type of analysis, such as distance between capital cities in kilometers, remoteness, and participation in regional integration groups (Anderson, 1979; Nilsson, 2000; Bubáková, 2013; Yotov et al., 2016; Yotov, 2022).

## III. Methodology

The main aim of this study is to explore the connection between various factors affecting gross exports and the DVA content of such exports (e.g., labor productivity) with a focus on countries participating in the A-P BRI. For this purpose, we have employed quantitative econometric methods. Bubáková (2013) previously investigated the application of gravity models in international trade from both a historical and methodological perspective. These models have been utilized in economics since the 1960s and are based on the concept of gravity forces. They are commonly applied to exports, imports, and foreign trade turnovers, and can also be used for investment applications (Dudáš & Grančay, 2019) or studying international migration (Khan, Fatima & Fatima, 2022). Anderson (1979) proposed the fundamental gravity equation as follows:

$$M_{ijk} = \alpha_k Y_i^{\beta_k} Y_j^{\gamma_k} N_i^{\epsilon_k} N_j^{\epsilon_k} d_{ij}^{\mu_k} U_{ijk} \quad (1)$$

where $M_{ijk}$ is the dollar flow of goods or factor k from country or region i to country or region j, $Y_i$ and $Y_j$ are incomes and i and j, $N_i$ and $N_j$ are populations in i and j, and $d_{ij}$ is the distance between countries (regions) i and j. $U_{ijk}$ is a lognormally distributed error term with E(ln $U_{ijk}$) = 0" (Anderson, 1979). Gravity models have undergone considerable evolution. Incorporating the latest information from the scientific literature in their application is now essential. According to Yotov et al. (2016), Adam and Cobham (2007) and Shepherd (2019) suggest that including multilateral resistance terms is essential. This is because trade flows between two partners are influenced not only by their bilateral relations but also by their multilateral interactions. König (2021) discusses various practical applications of these multilateral terms. Baier and Bergstrand (2009) suggest the use of Taylor-series expansion, and Harrigan (1996) advocates employing fixed effects to account for unobserved effects like multilateral resistance terms. The primary advantage of panel data with fixed effects is that it captures the influence of variables not explicitly included in the model, such as multilateral resistance terms. However, panel data models have limitations; for instance, they cannot incorporate time-invariant variables like EU membership. Notably, fixed effects could not be included in the cross-sectional analyses. In this context, highlighting the uncovered multilateral resistance terms discovered in the cross-sectional data (Table 3) is essential. However, accepting this limitation is in our interest because cross-sectional data analysis is secondary to our approach that emphasizes panel data.

Egger (2002), Silva and Tenreyro (2006), and Fally (2015) who concentrated on selecting an appropriate estimator. We utilized in panel data a PPML estimator with time and fixed effects as a result. Grančay et al. (2015), the equation can be represented in log-linear form. Nilsson (2000) categorized gravity model variables into three groups: those characterizing the supply and demand sides of the evaluated countries and factors either supporting or opposing international trade.

We conducted two distinct types of evaluations. Models with cross-sectional data allow us to compare differences between nations, whereas analyses with panel data with fixed effects offer a dynamic advantage, focusing on changes over time (Fišera, 2022; Hsiao, 2014). PPML models were computed in RStudio using the Gravity 1.0, sandwich, and lmtest packages. Additionally, some calculations were performed using the software GRETL (Cottrell & Lucchetti, 2021; Adkins et al., 2015; Wölwer et al., 2022; Wölwer, Breßlein, & Burgard, 2018; Zeileis, Köll, & Graham, 2020; Zeileis, 2004; Zeileis & Hothorn, 2002; Zeileis, 2021). The general econometric equation for cross-sectional data analysis with a random component (e) is applied in the following form (own processing according to Lukáčik, Lukáčiková, & Szomolányi, 2011):

$$Avgt_y = b_0 + b_1 * Avgt\_x_1 + b_2 * Avgt\_x_2 + \cdots + b_n * Avgt\_x_n + e$$

The econometric equation for panel data analysis with fixed effects, which we divide into individual ($\alpha_{ij}$) and time-effects ($\lambda_t$) with an idiosyncratic error term ($u_{ijt}$), has the following format (own processing according to Lu & Su, 2020; Frohm, 2021; Lukáčiková, 2013):

$$y_{ij,t} = \alpha_{ij} + \lambda_t + \beta_1 x_{i/j,t\ 1} + \beta_2 x_{i/j,t\ 2} + \beta_k x_{i/j,t\ k} + u_{ij,t}$$

The equation specifications include dependent variable y (export of goods and services or DVA content of gross exports from countries i to countries j in nominal or time-series average expression), and x represents the independent variables of countries i or j in nominal or time-series average form. Table 1 presents the brief characteristics of the independent variables based on a literature review. We present the statistical probability of null hypothesis rejection concerning insignificant parameter estimates according to the numbers of an asterisk (* 90% probability; ** 95% and *** 99% probability).

In addition to the methods mentioned earlier, we incorporated the difference-in-differences (Dif-in-Dif) approach by adding the A-P BRIt interaction term to our specification (Fišera, 2022). We will closely monitor the significance of this variable to assess the impact of BRI membership on exports and exported value-added for 14 A-P BRI countries. Our expectation is that the value-added content of gross exports will decrease as distance, remoteness, final consumption, REER, and export concentration of exporting countries increase. The concentration index plays a critical role in our models. We hypothesize that as the concentration rate increases, participation in global supply chains will rise, while export value-added will decrease. We have optimistic expectations for labor productivity and expenditures on R&D. These factors are likely to boost exports and value-added in exporting countries. However, FDIs are not expected to have a significant effect. It should accelerate exports while increasing participation in GVCs. Concerning destinations, we anticipate mainly positive effects of REER and negative effects of import concentration.

**Table 1.** *Description of Variables*

| Variable | Description |
|---|---|
| EXGR | Gross export of goods and services in mill. USD (from countries i to countries j) from TiVA database - release 2021 [EXGR] |
| EXGR_DVA | Domestic value-added content of gross exports in mill. USD or exported domestic value-added (country trade relations i to j) from TiVA database - release 2021 [EXGR_DVA] |
| L_prod | GDP per person employed (constant, base year 2017, purchasing power parity, USD) from World Development Indicators updated 02/15/2022 [SL.GDP.PCAP.EM.KD] |
| FCons_sh | Final consumption expenditure (% of GDP) from World Development Indicators updated 02/15/2022 [NE.CON.TOTL.ZS] |
| REER | Real effective exchange rate (REER) index (2010 = 100) from World Development Indicators updated 02/15/2022 [PX.REX.REER] |
| FDI_inf_sh | Foreign direct investment (FDI), net inflows (% of GDP) from World Development Indicators updated 02/15/2022 [BX.KLT.DINV.WD.GD.ZS] |
| CI_EX | The concentration index (Herfindahl Index) as product concentration and diversification indices of exports (merchandise) from UNCTADStat database. Higher values mean a higher level of concentration. |
| CI_IM | The concentration index (Herfindahl Index) as product concentration and diversification indices of imports (merchandise) from UNCTADStat database. Higher values mean a higher level of concentration. |
| RandD_sh | R&D expenditure (% of GDP) from World Development Indicators updated 02/15/2022 [GB.XPD.RSDV.GD.ZS] |
| DistCap | Distance in kilometers between capital cities from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) database (CEPII, 2011; Mayer-Zignago, 2012) |
| Remot | The remoteness index (Head, 2003) is calculated as a product of distance between countries i and j and their GDP share of the world's GDP (LU Department of Econometrics, 2021). GDP value was evaluated using the variables population [SP.POP.TOTL] and GDP per capita at constant prices [NY.GDP.PCAP.KD] |
| A-P $BRI_t$ | Dummy variable, membership of Asian and Pacific countries in the BRI according to the year of entry and data availability (Brunei Darussalam, China, Indonesia, Kazakhstan, Cambodia, Korea, Lao PDR, Myanmar, Malaysia, New Zealand, Philippines, Singapore, Thailand, Vietnam). In cases where the year of BRI participation was unknown, 2018 was used. |
| EU | 28 EU-member states as of 2018 (EU, 2021) |
| FTA | "1 if the country pair is engaged in a regional trade agreement, source WTO [World Trade Organisation] supplemented by Thierry Mayer, bilateral." (CEPII, 2022; Conte-Cotterlaz-Mayer, 2022) |

(Source) Own processing by OECD (2021); World Bank (2022); UNCTAD (2022); CEPII (2011); CEPII (2022); Conte-Cotterlaz-Mayer (2022); Sacks (2021).

Table 2 provides a summary of statistics for our variables in specifications for all 65 available countries (Pacáková et al., 2009). Most indicator values for countries i (exporters) and j (destinations) are identical. This is because the OECD evaluates only 65 countries in the TiVA database, providing sufficient observations compared to other databases. Although we do not face significant issues with zero values in our dependent variable, our models are affected by the decrease in observations due to missing values of other independent variables, particularly the proportion of spending on R&D and the REER variable. Nevertheless, given the total number of observations (n = 41,600), we can still accept this for all country specifications. A positive side effect may be the higher sample homogeneity.

**Table 2.** *Summary Statistics, Using 1:01-4160:10 (n = 41,600)*

| Variable | Mean | Min. | Max. | Std. Dev. | Skew. | Miss. obs. |
|---|---|---|---|---|---|---|
| $EXGR_{ijt}$ | 3,681.20 | 0.00 | 490,470.00 | 15,065.00 | 13.61 | 0 |
| $EXGR\_DVA_{ijt}$ | 2,846.40 | 0.00 | 405,480.00 | 12,045.00 | 13.77 | 0 |
| $DistCap_{ij}$ | 7,054.20 | 59.62 | 19,812 | 4,912,10 | 0.45 | 0 |
| $Remot_{i}$ | 109.49 | 0.02 | 4254.3 | 331.77 | 6.76 | 0 |
| $Remot_{j}$ | 109.49 | 0.02 | 4254.3 | 331.77 | 6.76 | 0 |
| $L\_prod_{it}$ | 73,037.00 | 4831.50 | 251,600.00 | 42,477.00 | 0.99 | 0 |
| $L\_prod_{jt}$ | 73,037.00 | 4,831.50 | 251,600.00 | 42,477.00 | 0.99 | 0 |
| $FCons\_sh_{it}$ | 73.53 | 31.50 | 92.48 | 10.00 | -1.34 | 128 |
| $FCons\_sh_{jt}$ | 73.53 | 31.50 | 92.48 | 10.00 | -1.34 | 128 |
| $FDI\_inf\_sh_{it}$ | 7.27 | -40.08 | 280.13 | 22.39 | 7.56 | 0 |
| $FDI\_inf\_sh_{jt}$ | 7.27 | -40.08 | 280.13 | 22.39 | 7.56 | 0 |
| $RandD\_sh_{it}$ | 1.46 | 0.03 | 4.94 | 1.03 | 0.90 | 6,400 |
| $RandD\_sh_{jt}$ | 1.46 | 0.03 | 4.94 | 1.03 | 0.90 | 6,400 |
| $REER_{it}$ | 98.89 | 69.42 | 152.97 | 9.91 | 0.92 | 9,600 |
| $REER_{jt}$ | 98.89 | 69.42 | 152.97 | 9.91 | 0.92 | 9,600 |
| $CI\_EX_{it}$ | 0.20 | 0.05 | 0.77 | 0.14 | 1.70 | 0 |
| $CI\_EX_{jt}$ | 0.20 | 0.05 | 0.77 | 0.14 | 1.70 | 0 |
| $CI\_IM_{it}$ | 0.11 | 0.05 | 0.39 | 0.06 | 1.91 | 0 |
| $CI\_IM_{jt}$ | 0.11 | 0.05 | 0.39 | 0.06 | 1.91 | 0 |

(Source) Own calculation from software GRETL by OECD (2021); World Bank (2022); UNCTAD (2022); CEPII (2011).

# IV. Results and Discussion

As indicated in the methodology, we will use two types of samples: cross-sectional and panel data. Initially, the model was evaluated using an average time series of cross-sectional values from 2009 to 2018 (models 1 through 4 in Table 3). Panel data analysis using the "Between" method. Because of the insufficient number of observations for the REER variable for all countries, significantly affecting the evaluation of our A-P BRI members, we defined two specifications of independent variables. Additionally, we created b-labeled specifications as robustness checks, including bilateral FTAs with variable terms instead of membership in the EU. To assess the likelihood of multicollinearity in OLS, we used the Variance Inflation Factors (VIF) test. Since the highest VIF values are less than the threshold of 10, we can interpret the estimated parameters. All statistically significant approximated PPML-estimation parameters are interpreted with 99% probabilities, occasionally 95% (rejecting the null hypothesis of statistical insignificance). We can also interpret estimates with a 90% probability, but we acknowledge this as a limitation of our research. This applies only to one estimate

of FDI inflows and two concentration indices. Notably, the polarity of the mathematical signs is remarkable. The distance between pairs is estimated with a logical negative sign, indicating that more distant nations engage in less reciprocal trade. Interestingly, the variable remoteness shows a positive correlation, with bilateral trade increasing with increasing remoteness. This result can be interpreted considering China's unique position not only in the BRI but also in global trade. Moreover, most OECD members are geographically concentrated in Europe, making the United States and Canada more distant from Europe.

**Table 3.** *Between Analyses, PPML, Average Time-Series 2009-2018*

| Dep. variable | Model 1 | Model 2A | Model 2B (rob. check) | Model 3 | Model 4A | Model 4B (rob. check) |
|---|---|---|---|---|---|---|
| | $Avg\_EXGR_{ij}$ | | | $Avg\_EXGR\_DVA_{ij}$ | | |
| const | 22.064*** | 17.971*** | 19.614*** | 21.728*** | 18.410*** | 20.038*** |
| $Avg\_DistCap_{ij}$ (log) | -2.355*** | -2.354*** | -2.343*** | -2.404*** | -2.408*** | -2.403*** |
| $l\_Avg\_Remot_i$ | 0.813*** | 0.796*** | 0.852*** | 0.882*** | 0.873*** | 0.933*** |
| $l\_Avg\_Remot_j$ | 0.811*** | 0.807*** | 0.881*** | 0.813*** | 0.806*** | 0.876*** |
| $l\_Avg\_L\_prod_i$ | 0.341*** | 0.229*** | 0.172*** | 0.253*** | 0.179*** | 0.121** |
| $l\_Avg\_L\_prod_j$ | 0.359*** | 0.229*** | 0.152*** | 0.376*** | 0.236*** | 0.162*** |
| $l\_Avg\_REER_i$ | -0.833** | | | -0.480 | | |
| $l\_Avg\_REER_j$ | -0.507 | | | -0.649 | | |
| $Avg\_FCons\_sh_i$ | -0.020*** | -0.016*** | -0.018*** | -0.017*** | -0.014*** | -0.015*** |
| $Avg\_FCons\_sh_j$ | -0.009** | -0.005 | -0.006 | -0.010*** | -0.006* | -0.007** |
| $Avg\_FDI\_inf\_sh_i$ | 0.005* | 0.007*** | 0.006*** | 0.004 | 0.005** | 0.004* |
| $Avg\_FDI\_inf\_sh_j$ | 0.007*** | 0.008*** | 0.006*** | 0.007*** | 0.008*** | 0.006*** |
| $Avg\_RandD\_sh_i$ | -0.091** | -0.055 | -0.059* | -0.084** | -0.059* | -0.062* |
| $Avg\_RandD\_sh_j$ | -0.133*** | -0.086** | -0.084** | -0.129*** | -0.081** | -0.080** |
| $l\_Avg\_CI\_EX_i$ | -0.076 | -0.048 | 0.086** | 0.044 | 0.080 | 0.227*** |
| $l\_Avg\_CI\_EX_j$ | -0.203*** | -0.151*** | 0.060 | -0.187** | -0.139** | 0.051 |
| $l\_Avg\_CI\_IM_i$ | -0.024 | -0.075 | -0.043 | -0.112 | -0.157** | -0.122* |
| $l\_Avg\_CI\_IM_j$ | 0.030 | 0.021 | 0.128** | 0.066 | 0.049 | 0.142** |
| A-P $BRI_i$ | 0.361** | 0.287*** | 0.245** | 0.189 | 0.191* | 0.148 |
| A-P $BRI_j$ | 0.273* | 0.190* | 0.153 | 0.314* | 0.187* | 0.146 |
| $EU_i$ | -0.173 | -0.195** | | -0.187* | -0.203*** | |
| $EU_j$ | -0.397*** | -0.359*** | | -0.362*** | -0.326*** | |
| $FTA\_2018i_j$ | | | 0.423*** | | | 0.410*** |
| n | 2,450 | 4,032 | 4,032 | 2,450 | 4,032 | 4,032 |
| HAC standard errors | Yes | Yes | Yes | Yes | Yes | Yes |
| The highest VIF (OLS) | 3.982 | 3.376 | 3.561 | 3,982 | 3.376 | 3.561 |

(Source) Own calculation.

Estimation of labor productivity parameters was expected for both parties i and j. Essentially,

nations with higher labor productivity export more. These exports and value-added flow to nations with higher labor productivity. With a 1% increase in labor productivity, exports, and exports of value-added increase by approximately from 0.179 to 0.341%. For REER, we anticipated exporting countries to have a negative parameter estimate and positive destinations. Both estimated parameters in each specification, to our surprise, were estimated negatively. However, the REER of exporters based on a smaller sample of observations is estimated with a probability of at least 95%. Consequently, this result is in line with the theory that countries with depreciated currencies have supported exports. Notably, according to literature review, in countries with greater involvement in GVCs, exchange rate determination is losing significance.

Based on the theoretical premise that domestic consumption reduces the need for countries to engage in international trade, we found that the parameter estimate for final consumption is negative. FDI inflows have limited positive impact on exports and value-added content of gross exports, particularly to destinations that are also targets for foreign investment. Based on a literature review, R&D costs play a crucial role in exports with value-added. Surprisingly, we discovered that the R&D expenditure parameters for both groups of specifications are negative. One plausible explanation in which is that if a country joins the GVCs, R&D are conducted at the center. Nevertheless, this may explain the nature of the exports but not the exported DVA. We leave this phenomenon to be explained by further research.

Regarding concentration indices, we expected countries with more concentrated exports to be involved in GVCs. Here, the export concentration index rises, exports increase, but their value-added in exports falls. However, we found unexpected results in these indicators, with the connection between the export concentration index and exports being statistically limited and with a negative polarity. Examining the data in future releases of TiVA to see if the results diverge from our hypotheses would be very interesting. As for destinations, they have diversified their exports, while exporters of mainly DVA have a diversified import structure.

Finally, we can explore the impact of regional organizations on export flows and value-addition. In this instance, we can rely on estimates from models 2 and 4. Membership in the BRI by fourteen Asian and Pacific nations correlates with an increase in exports and exports' domestic value added (with only a 90% probability of null hypothesis rejection). Several results from our analyses have been unusual and unexpected, with the negative coefficient for the variable EU membership being one of the largest. Not only have we failed to demonstrate that EU membership increases exports or export value, but these flows do not even lead to the EU. We have proved that the BRI countries generate this trade. However, judgments about the BRI's impact on foreign trade can only be formed after examining panel gravity models. The cross-sectional analysis has only shown that the countries involved in the BRI project export more goods and services or have higher nominal value added without considering the nations' economic size. The same is true for BRI countries that serve as destinations for these

flows. Given that BRI members include large economies like China, these outcomes are to be expected. Only in the panel data specifications will the influence of economies joining the BRI project on the increase or decline of trade flows be measured.

Models 5-8 in Table 4 represent 10-year panel data analyses with fixed and time effects. Unlike Models 1-4, they allow us to examine dynamics over time. The term "remoteness" has a specific explanation in fixed-effect models as distance does not change over time, while the variable that does change is the gross domestic product share of the world's gross domestic product. Therefore, in this instance, interpreting the proportion of gross domestic product to the global GDP is necessary. As the share of exporting countries on the world's GDP increases, the value of exports and value-added in exports decrease. We have rejected the null hypothesis that the parameter estimate was insignificant with a 99% probability. Moreover, remoteness for destinations is insignificant, and this has multiple possible explanations. We assume that our sample countries' share of global gross domestic product is decreasing because of the growth of economies such as China and India. Labor productivity for both groups of countries was estimated with a positive polarity and with a 99% probability. With a 1% increase in this variable, we estimate a 1.5% increase in exports/exported DVA.

The dynamics of REER in our specification were statistically significant, with the null hypothesis rejected at a 99% confidence level. Exchange rates rose during the period under review, which is expected if we examine the time period after the 2008 financial crisis and prior to the onset of the COVID-19 pandemic. However, even in a dynamic form, we were unable to confirm the theoretical basis for the positive effect of the depreciated currency on export growth. The final consumption is expected to have a negative impact, and we disregard the interpretation of FDI inflows because the evaluations in the PPML models were not significant. Similarly, as in previous analyses, R&D expenditures did not yield positive results, and our p-values, according to robust standard errors, are higher than 0.05. We cannot reject the null hypothesis about the statistically insignificant estimation of R&D parameters. As mentioned earlier, we can suggest an explanation of the R&D effect insignificance on the dependent variable for further study, but it may be the same reason that diminishes the significance of exchange rate levels for international trade in the context of globalization and GVCs. With deep involvement in GVCs, the headquarters make R&D decisions rather than individual subsidiaries (e.g. Habrman, Habodászová, Šrámková, 2022).

Regarding the results of our alternative model robustness checks, most variables showed only cosmetic differences (except for some concentration indices and BRI). However, the variable of bilateral FTAs is statistically significant and positively related to gross exports and exported added value. This means that regional trade agreements intensify trade, which aligns with theory and empirical evidence (Ayuso-Díaz and Gómez-Plana, 2023).

**Table 4.** *Panel Data Analyses, PPML, Time-Series 2009-2018*

| Dep. var. | Model 5 | Model 6A | Model 6B (rob. check) | Model 7 | Model 8A | Model 8B (rob. check) |
|---|---|---|---|---|---|---|
| | | $EXGR_{ijt}$ | | | $EXGR\_DVA_{ijt}$ | |
| const | -22.240*** | -17.220*** | -16.811*** | -23.030*** | -18.360*** | -17.919*** |
| $l\_Remoi_{jt}$ (log) | -0.712*** | -0.714*** | -0.663*** | -0.735*** | -0.688*** | -0.626*** |
| $l\_Remot_{jt}$ | -0.100 | -0.109 | -0.067 | -0.061 | -0.120 | -0.083 |
| $l\_L\_prod_{it}$ | 1.575*** | 1.614*** | 1.575*** | 1.608*** | 1.120*** | 1.662*** |
| $l\_L\_prod_{jt}$ | 1.172*** | 1.110*** | 1.070*** | 1.153*** | 1.718*** | 1.092*** |
| $l\_REER_{it}$ | 0.468*** | | | 0.614*** | | |
| $l\_REER_{jt}$ | 0.494*** | | | 0.496*** | | |
| $FCons\_sh_{it}$ | -0.016*** | -0.018*** | -0.018*** | -0.019*** | -0.022*** | -0.022*** |
| $FCons\_sh_{jt}$ | -0.005 | -0.007 | -0.007 | -0.004 | -0.006 | -0.006 |
| $FDI\_sh_{it}$ | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| $FDI\_sh_{jt}$ | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| $RandD\_sh_{jt}$ | -0.070 | 0.011 | -0.029 | -0.054 | 0.044 | 0.007 |
| $RandD\_sh_{jt}$ | -0.109 | -0.042 | -0.072 | -0.117 | -0.050 | -0.084 |
| $l\_CI\_EX_{it}$ | 0.014 | 0.134* | 0.114 | 0.074 | 0.198** | 0.175** |
| $l\_CI\_EX_{jt}$ | -0.057 | 0.098 | 0.082 | -0.060 | 0.085 | 0.069 |
| $l\_CI\_IM_{it}$ | 0.038 | 0.044 | 0.047 | 0.037 | 0.004 | 0.007 |
| $l\_CI\_IM_{jt}$ | 0.018 | 0.024 | 0.024 | 0.033 | 0.040 | 0.040 |
| A-P $BRI_{it}$ | -0.105 | -0.027 | -0.066 | -0.077 | 0.000 | -0.035 |
| A-P $BRI_{jt}$ | -0.126 | -0.030 | -0.072 | -0.128 | -0.028 | -0.071 |
| $FTA_{ijt}$ | | | 0.374*** | | | 0.384*** |
| n | 20,202 | 29,774 | 29,774 | 20,202 | 29,774 | 29,774 |
| HAC standard errors | Yes | Yes | Yes | Yes | Yes | Yes |
| $Fixed\text{-}Effects_i$ | Yes | Yes | Yes | Yes | Yes | Yes |
| $Fixed\text{-}Effects_j$ | Yes | Yes | Yes | Yes | Yes | Yes |
| Time-Effects | Yes | Yes | Yes | Yes | Yes | Yes |
| The highest VIF (OLS) | 1.690 | 1.699 | 1.710 | 1.690 | 1.699 | 1.710 |

(Source) Own calculation.

Concentration indices determine participation in GVCs. The estimated parameter of the export concentration index of the exporting nation is the most notable. This parameter was statistically significant in the specification with a greater number of observations, but only with a limited 90% probability for gross exports and 95% probability for the DVA content of gross exports. Countries export 0.13% more goods and services for every 1% increase in export concentration and 0.20% more value-added.

This result contradicts our expectation that as the export concentration rate rises, participation in global supply chains would increase, export value would rise, and the DVA content of gross exports could decline. A panel analysis with fixed effects might reveal a structural change

in the analyzed countries due to their participation in global supply chains, where a gradual specialization process can be observed. From the perspective of the New Trade Theory, this result is not unexpected. According to Krugman (1980; 1981), the effort to achieve economies of scale, which includes transportation costs, is responsible for the specialization and concentration of production, as our models also captured. We cannot assess the benefits of BRI membership based on this panel data specification because A-P $BRI_t$ variables were insignificant in relevant models 6 and 8. From models 5 and 7, several A-P BRI members were omitted. This means that even though the examined BRI countries have more trade flows in real terms, including DVA, it is not known if trade has increased or decreased since they joined the initiative. It may also be because the effort has only been going on for a short time and has already led to numerous projects.

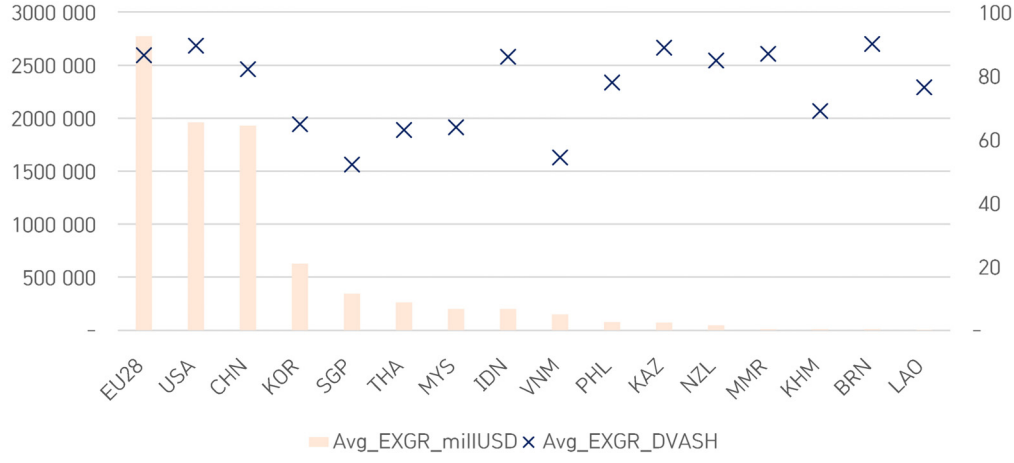
We discussed Krugman's (1981) "home market effect," which explains the concentration of production in larger markets because of economies of scale and decreased transport costs. Auer (2017) investigated the effects of trade liberalization. The BRI and the EU can be considered as efforts to eliminate transportation costs and promote integration and trade liberalization. However, shortly after the opening of economies, there may not be a significant increase in exports as businesses adapt to domestic demand and preferences: "*the volume of trade only grows sluggish after liberalization, since each country's industrial composition has to adapt to the demand structure of the open economy, which requires firm exit and entry and, therefore, time*" (Auer, 2017). This is also evident in the results of the fourteen A-P BRI countries. From this perspective, we can assume that certain A-P BRI countries will increase their involvement in global value chains in the future. Notably, Steinhauser (2021a) found that A-P BRI labor productivity members respond positively not only on the growth of the innovation index but also to the growth of human capital and economic freedom, unlike EU member states.

The robustness check for panel data, similar to Models 6 and 8, demonstrates that the variable FTAs is statistically significant and positive. This indicates that trade intensifies after engaging in regional trade agreements. However, to fully assess the impact of BRI membership, a longer period of time is needed.

Even within the group of 14 A-P BRI states, it is relatively heterogenous. While the method of panel data analysis with fixed effects adequately accounts for the heterogeneity, this can be seen in Figure 1. We can see the average values of gross exports (EXGR) and share of domestic value added in gross exports (EXGR_DVASH) for the period (2009-2018). The OECD (2021) reports that 28 EU member states generated the greatest volume of exports. According to the proportion of domestic value added to gross exports, the EU ranks 5th among the monitored nations (86.5%). Brunei ranks first with a 90.0% share, which is understandable given the importance of oil industry to Brunei's economy. However, they are followed by the United States (89.5%), Kazakhstan (88.8%), and Myanmar (86.9%). China, the world's third-

largest exporter, ranked eighth (82.1%) among the monitored nations in terms of domestic value added, while South Korea ranked twelfth (64.8%). Singapore is last among A-P BRI participants (52.1%). Two things are evident from this comparison: in a truly globalized economy with multilateral trade and production links. First, monitoring the volume of trade flows in the conventional manner is no longer sufficient. Second, monitoring value added will significantly alter outcomes. For instance, while Singapore is one of the world's largest exporters, it also produces a negligible amount of DVA. Second, identifying a potential competitiveness improvement gap for states like the EU, China, and South Korea is significant. In our opinion, increasing spending on R&D is one way to improve a company's value-added ranking. In our analysis, however, R&D expenditure were statistically insignificant. This is a consequence of globalization, which has enabled the formation of GVCs. Then, variables such as R&D expenditures cannot be empirically confirmed, in addition to the impact of exchange rates on international trade.

**Figure 1.** Caption: Comparison between A-P BRI, USA, and EU28




(Source) Own calculation, based on OECD (2021).

# V. Conclusions

In the past, international trade focused solely on analyzing and evaluating exports, imports, or their respective balances. However, participating in global supply chains (GVCs) necessitates a shift in perception and evaluation of these flows. It is essential to consider the value-added content of gross exports. Presently, our article is identifying and evaluating the impact of various determinants on export and DVA content. To achieve this, we utilized gravity models in conjunction with actual econometric tools, including a PPML estimator. We evaluated 65

countries using the OECD TiVA database from the most recent release (i.e., 2021). We concentrated on the Belt and Road Initiative nations in Asia and Pacific (A-P BRI), and we assessed the contribution of their membership using the difference-in-differences technique within the analysis of panel data. The primary objective of this study is to examine the relationship between certain factors influencing gross exports and the DVA content of gross exports, with a particular emphasis on labor productivity and its impact on the countries participating in the A-P BRI.

Our findings indicate that countries with higher or increasing labor productivity generate more exports and DVA in exports, and these flows are directed toward countries with similar labor productivity trends. Additionally, we validate prior research indicating that countries with higher domestic consumption tend to export fewer goods, services, or exported value-added.

Conversely, we were unable to demonstrate the positive effects of currency depreciation, R&D spending, and the rise in FDI inflows over time. Our findings align with the existing literature, suggesting that exchange rate optimization becomes irrelevant under the conditions of GVCs (Fišera-Horváth, 2021; Frohm, 2021). It is also possible that the importance of exchange rates is diminishing in the context of competitiveness, while aspects of cost competitiveness, including taxes or labor prices, are gaining significance (Dustmann et al., 2014; Albu, Joebges, and Zwiener, 2022). Further research in this area is recommended. The same factors that lessen the importance of exchange rates may also weaken the empirical significance of R&D expenditure in the context of globalization and global supply chains. Regardless of the lack of evidence in our empirical research, we strongly encourage decision-makers and private entities to advance R&D. To support this claim, we reference a review of the literature (Kersan-Škabić, 2019; Altun et al., 2022). Few studies examine the impact of R&D spending within GVCs. This may be based on the intuition of the positive impact of R&D on value-added growth. For this reason, we encourage other authors to address this question in their future works. Although it can aid in overcoming potential chain barriers, it also resolves other difficulties, such as environmental ones. As for direct foreign investment, we can study Dunning's development theory in this area, which has many unexplained aspects. For example, it cannot be applied to some groups of states (e.g., countries in Central and Eastern Europe). This is another area that warrants further research in the future.

The most intriguing empirical findings were derived from the export concentration indices, which can be interpreted as a measure of participation in GVCs. As export concentration increases, we expected a corresponding rise in GVC participation, resulting in increased exports but decreased DVA in exports. However, we observed that countries with higher export concentration export fewer goods and services but generate more value-added content. In contrast, as concentration further increases, countries export more goods and services and generate even greater value-added content. We believe our study captures and quantifies the structural change

explained by the New Trade Theory, indicating a country's specialization driven by enhanced productivity, efficiency, and, crucially, economies of scale. Additionally, this is related to reduced transportation costs per unit of production, implying increased participation in GVCs.

Throughout the analysis period, we acknowledge the positive effects of GVCs; however, deeper involvement in these chains carries certain risks. Unforeseen external crises, such as the COVID-19 pandemic or geopolitical tensions, like the situation in Ukraine, pose significant threats to these networks, potentially leading to global repercussions. It remains uncertain whether these crises will prompt economic actors to reassess their participation in GVCs and initiate processes of production and export diversification.

One limitation of our research lies in using the most recent data available from the 2021 edition of the OECD TiVA database, which only extends until 2018. Additionally, we wish to emphasize that the problem of multilateral resistance terms has primarily been addressed in panel data models with fixed effects. Moreover, the cross-sectional data may contain a possible distortion. Future research should investigate the level of participation in global value chains during and after the aforementioned crises, as well as explore the relationship between R&D spending and the DVA content of gross exports.

## Declaration of Interest

The author reports there are no competing interests to declare.

## References

Abdmoulah, W. (2022). Export sophistication and economic performance, new evidence using TiVA database. *International Review of Applied Economics, 37*(1), 113-137. https://doi.org/10.1080/02692171.2022.2026299

Adam, C., & Cobham, D. (2007). Modelling multilateral trade resistance in a gravity model with exchange rate regimes. *CDMA Conference Paper Series. Centre for Dynamic Macroeconomic Analysis*. Retrieved from https://www.st-andrews.ac.uk/~wwwecon/CDMA/papers/cp0702.pdf

Adkins, L., Waters, M., & Hill, C. (2015). *Collinearity Diagnostics in gretl*. Retrieved from https://learneconometrics.com/pdf/Collin/collin_gretl.pdf

Albu, N., Joebges, H., & Zwiener, R. (2022). An input-output analysis of unit labour cost developments of the German manufacturing sector since the mid-1990s. *Journal for Labour Market Research, 56*, 1. https://doi.org/10.1186/s12651-022-00306-7

Altun, A., Avsar, I. I., Turan, T., & Yanikkaya, H. (2022). Does global value chain participation boost high technology exports? *Journal of International Development, 35*(5), 820-837. https://doi.org/10.100

2/jid.3708

Anderson, J. (1979). A theoretical foundation for gravity equation. *American Economic Review, 69*(1), 106-116. Retrieved from https://www.jstor.org/stable/1802501

Auer, R. A. (2017). Product heterogeneity, cross-country taste differences, and the growth of world trade. *European Economic Review, 100*, 1-27. https://doi.org/10.1016/j.euroecorev.2017.05.010

Ayuso-Díaz, A., & Gómez-Plana, A. G. (2023). More integrated than ever? Long-term market and policy drivers of intra-asian trade. *Journal of Economic Integration, 38*(1), 32-58. https://doi.org/10.11130/jei.2023.38.1.32

Baier, S. L., & Bergstrand, J. H. (2009). Bonus vetus OLS: A simple method for approximating international trade-cost effects using the gravity equation. *Journal of International Economics, 77*(1), 77-85. https://doi.org/10.1016/j.jinteco.2008.10.004

Banri, I., Eiichi, T. & Ryuhei, W. (2007). *Dissecting offshore outsourcing and R&D: A Survey of japanese manufacturing firms* (RIETI Discussion Paper Series 07-E-060). Retrieved from https://www.researchgate.net/publication/5020669_Dissecting_Offshore_Outsourcing_and_RD_A_Survey_of_Japanese_Manufacturing_Firms

Bighelli, T., di Mauro, F., Melitz, M. J., & Mertens, M. (2023). European firm concentration and aggregate productivity. *Journal of the European Economic Association, 21*(2), 455-483. https://doi.org/10.1093/jeea/jvac040

Brenton, P., Ferrantino, M. J., & Maliszewska, M. (2022). *Reshaping Global Value Chains in Light of COVID-19: Implications for Trade and Poverty Reduction in Developing Countries*. Retrieved from: https://www.ceintelligence.com/files/documents/9781464818219.pdf

Bubáková, P. (2013). Gravitační model mezinárodní směny, jeho proměnné, předpoklady, problémy a aplikace. *Acta Oeconomica Pragensia, 21*(2), 3-24. https://doi.org/10.18267/j.aop.396

CEPII. (2011). *GeoDist* [Data set]. Retrieved from http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=6

CEPII. (2022). *Gravity* [Data set]. Retrieved from http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=8

Choi, M. S., & Lee, H. D. (2021). The value-added effects of exchange rates on global trade. *Academic Journal of Interdisciplinary Studies, 10*(1), 184-192. https://doi.org/10.36941/ajis-2021-0016

Cole, D., & Nightingale, S. (2016). Sensitivity of Australian trade to the exchange rate. *Reserve Bank of Australia, Bulletin September Quarter*, 13-20. Retrieved from https://www.rba.gov.au/publications/bulletin/2016/sep/bu-0916-2a.html

Conte, M., Cotterlaz P., & Mayer T. (2022). *The CEPII Gravity database* (Working Paper No. 2022-05). CEPII. Retrieved from http://www.cepii.fr/DATA_DOWNLOAD/gravity/doc/Gravity_documentation.pdf

Cottrell, A., & Lucchetti, R. (2021). *Gretl user's guide*. Retrieved from http://gretl.sourceforge.net/gretl-help/gretl-guide.pdf

Djokoto, J. G. (2021). The investment development path theory and small states. *Research in Globalization, 3*, 100048. https://doi.org/10.1016/j.resglo.2021.100048

Dudáš, T., & Grančay, M. (2019). Regional structure of foreign direct investment in slovakia - A

district-level gravity-type model 2009 - 2016. *Ekonomický časopis/Journal of Economics, 67*(8), 811-836.

Durongkaveroj, W. (2023). Emphasis on domestic value added in export in the era of global value chain: Evidence from Thailand. *Journal of Industrial and Business Economics, 50*, 703-729. https://doi.org/10.1007/s40812-022-00239-9

Dustmann, C., Fitzenberger, B., Schönberg, U., & Spitz-Oener, A. (2014). From sick man of europe to economic superstar: Germany's resurgent economy. *Journal of Economic Perspectives, 28*(1), 167-188. https://doi.org/10.1257/jep.28.1.167

Egger, P. (2002). An econometric view on the estimation of gravity models and the calculation of trade potentials. *The World Economy, 25*(2), 297-312. https://doi.org/10.1111/1467-9701.00432

EU. (2021). *Country profiles SK*. Retrieved from https://european-union.europa.eu/principles-countries-history/country-profiles_sk

Fally, T. (2015). Structural gravity and fixed effects. *Journal of International Economics, 97*(1), 76-85. https://doi.org/10.1016/j.jinteco.2015.05.005

Fang, L., Kleimann, M., Li, Y., & Schmerer, H. J. (2021). The implications of the new silk road railways on local development. *Journal of Asian Economics, 75*, 101326. https://doi.org/10.1016/j.asieco.2021.101326

Fišera, B. (2022). *Panel regressions: Examples* (Unpublished lecture by Ing. Boris Fišera, Ph.D.). Slovak Academy of Sciences, Slovakia; Charles University, Czech Republic.

Fišera, B., & Horváth, R. (2022). Are exchange rates less important for trade in a more globalized world? Evidence for the new EU members. *Economic Systems, 46*(1), 100868. https://doi.org/10.1016/j.ecosys.2021.100868

Frensch, R., Hanousek, J., & Kočenda, E. (2013). Trade with final goods in european union: A gravity model approach. *Politická Ekonomie, 61*(6), 715-734. https://doi.org/10.18267/j.polek.927

Frohm, E. (2021). *Dominant currencies and the export supply channel* (ECB Working Papers Series No. 2580). Retrieved from https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2580~f3ec872727.en.pdf

Grančay, M., Grančay, N., Drutarovská, J., & Mura, L. (2015). Gravity model of trade of the Czech and Slovak republics 1995-2012: How have determinants of trade changed? *Politická Ekonomie, 63*(6), 759-777. https://doi.org/10.18267/j.polek.1025

Habrman, M., Habodászová, Ľ. & Šrámková, L. (2022). *Reformný kompas slovenskej ekonomiky* (Analysis of Institute for Financial Policy, Ministry of Finance of the Slovak Republic). Retrieved from https://www.mfsr.sk/files/archiv/25/Reformny-kompas.pdf

Harrigan, J. (1996). Openness to trade in manufactures in the OECD. *Journal of International Economics, 40*(1-2), 23-39. https://doi.org/10.1016/0022-1996(95)01395-4

Head, K. (2003). *Gravity for beginners*. Retrieved from https://vi.unctad.org/tda/background/Introduction%20to%20Gravity%20Models/gravity.pdf

Hermida, C. do C., dos Santos, A. M. A., & Bittencourt, M. V. L. (2022). Does international fragmentation of production and global value chains participation affect the long-run economic growth? *Foreign Trade Review, 57*(4), 367-389. https://doi.org/10.1177/00157325211050448

Hsiao, C. (2014). *Analysis of Panel Data* (3rd ed.). Econometric Society Monographs. Retrieved from

https://rodorigo.files.wordpress.com/2020/02/cheng-hsiao-analysis-of-panel-dataz-lib.org_.pdf

Hung, Hf., & Liu, M. (2021). The Dollar Cycle of International Development, 1973-2017. *Studies in Comparative International Development, 57*, 1-35. https://doi.org/10.1007/s12116-021-09346-5

IMF. (2022). *What is real effective exchange rate (REER)*? Retrieved from https://datahelp.imf.org/knowledgebase/articles/537472-what-is-real-effective-exchange-rate-reer

Jackson, K., & Shepotylo, O. (2021). Belt and road: The China dream? *China Economic Review, 67*, 101604. https://doi.org/10.1016/j.chieco.2021.101604

Javorcik, B. S. (2004). Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American Economic Review, 94*(3), 605-627. https://doi.org/10.1257/0002828041464605

Jucca, L. (2022). *Ukraine war flashes neon warning lights for chips*. Reuters. Retrieved from https://www.reuters.com/breakingviews/ukraine-war-flashes-neon-warning-lights-chips-2022-02-24/

Kersan-Škabić, I. (2019). The drivers of global value chain (GVC) participation in EU member states. *Economic Research-Ekonomska Istraživanja, 32*(1), 1204-1218. https://doi.org/10.1080/1331677X.2019.1629978

Khan, M. A., Fatima, Z., & Fatima, S. (2023) Revisiting the Gravity Model of Migration. *Foreign Trade Review, 58*(2), 329-349. https://doi.org/10.1177/00157325221088707

König, B. (2021). Selected Methods of Estimating Multilateral Resistances in the Gravity Model. *Nové Trendy v ekonometrii A Operačním Výzkumu: Mezinárodní Vědecký Seminář*, 82-87. Retrieved from http://fhi.sk/files/Netrinecop/Praha2021.pdf

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

Kordalska, A., & Olczyk, M. (2023) Upgrading low value-added activities in global value chains: A functional specialisation approach. *Economic Systems Research, 35*(2), 265-291. https://doi.org/10.1080/09535314.2022.2047011

Krugman, P. (1980). Scale economies, product differentiation, and the pattern of trade. *The American Economic Review, 70*(5), 950-959. https://www.jstor.org/stable/1805774

Krugman, P. (1981). Intraindustry specialization and the gains from trade. *Journal of Political Economy, 89*(5), 959-973. https://www.jstor.org/stable/1830815

Krugman, P. (1994). Competitiveness: A dangerous obsession. *Foreign Affairs, 73*(2), 28-44. https://doi.org/10.2307/20045917

LU Department of Econometrics. (2021). *Gravity model example*. Retrieved from https://www.youtube.com/watch?v=qZwFKK-V-zc

Lu, X., & Su, L. (2020). Determining individual or time effects in panel data models. *Journal of Econometrics, 215*(1), 60-83. https://doi.org/10.1016/j.jeconom.2019.07.008

Lukáčik, M., Lukáčiková, A., & Szomolányi, K. (2011). *Ekonometrické modelovanie v programoch EViews a Gretl*. Retrieved from https://sekarl.euba.sk/arl-eu/sk/detail-eu_un_cat-0145080-Ekonometricke-modelovanie-v-programoch-EViews-a-Gretl/

Lukáčiková, A. (2013). *GRETL vo výučbe panelových dát*. Retrieved from http://www.fhi.sk/files/katedry/kove/ssov/Cingov/Cingov-2013.pdf

Mayer, T., & Zignago, S. (2012). *Notes on CEPII's distances measures: The GeoDist database*. Retrieved from https://doi.org/10.2139/ssrn.1994531

Miroudot, S., & Ye, M. (2022). Decomposing value added in gross exports from a country and bilateral perspective. *Economics Letters, 212*, 110272. https://doi.org/10.1016/j.econlet.2022.110272

Morvay, K. (2022). *Ekonomické recesie na Slovensku: dramatické momenty aj blikajúce kontrolky nových príležitostí*. Vydavateľstvo EKONÓM. Retrieved from https://nhf.euba.sk/www_write/files/katedry/khp/oznamy/2023/ekonomicke%CC%81_recesie_na_slovensku_morvay.pdf

Narula, R. & Guimón, J. (2010). The investment development path in a globalised world: implications for Eastern Europe. *Eastern Journal of European Studies, 1*(2), 5-19. Retrieved from https://www.researchgate.net/publication/49599033_The_Investment_Development_Path_in_a_Globalised_World_Implications_for_Eastern_Europe

Newman, C., Rand, J., Talbot, T., & Tarp, F. (2015). Technology transfers, foreign investment and productivity spillovers. *European Economic Review, 76*, 168-187. https://doi.org/10.1016/j.euroecorev.2015.02.005

Nilsson, L. (2000). Trade integration and the EU economic membership criteria. *European Journal of Political Economy, 16*(4), 807-827. https://doi.org/10.1016/S0176-2680(99)00060-9

OECD. (2021). *Trade in Value Added (TiVA) 2021 ed: Principal Indicators* [Data set]. Retrieved from https://stats.oecd.org/DownloadFiles.aspx?HideTopMenu=yes&DatasetCode=TIVA_2021_C1; https://stats.oecd.org/Index.aspx?DataSetCode=TIVA_2021_C1

Pacáková, V., Labudová, V., Sipková, Ľ., Šoltés, E., & Vojtková, M. (2009). *Štatistické metódy pre ekonómov*. Bratislava: Iura Edition.

Pavelka, Ľ., Ružeková, V., & Zubaľová, Ľ. (2021). *Inštitucionálna podpora financovania exportu a zahraničných investícií vo vybraných krajinách EÚ*. Slovenská republika: Leges.

Porter, M. E. (1990). *The competitive advantage of nations*. Retrieved from http://www.economie.ens.fr/IMG/pdf/porter_1990_-_the_competitive_advantage_of_nations.pdf

R Core Team. (2022). *R: A language and environment for statistical computing*. Retrieved from https://www.R-project.org/

Ružeková, V., Kittová, Z., & Steinhauser, D. (2020). Export performance as a measurement of competitiveness. *Journal of Competitiveness, 12*(1), 145-160. https://doi.org/10.7441/joc.2020.01.09

Sacks, D. (2021). *Countries in China's belt and road initiative: Who's in and who's out*. Retrieved from https://www.cfr.org/blog/countries-chinas-belt-and-road-initiative-whos-and-whos-out

Shepard, W. (2018). *The hidden economic rationale of china-europe rail*. Retrieved from https://www.forbes.com/sites/wadeshepard/2018/03/22/the-hidden-economic-rationale-of-china-europe-rail/?sh=693a60140d11

Shepherd, B. (2019). *The gravity model of international trade: A user guide (R version)*. Retrieved from https://www.unescap.org/resources/gravity-model-international-trade-user-guide-r-version#

Silva, J. M. C. 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

Steinhauser, D., & Boros, K. (2022). *2022/12 Kam tečú slovenské exporty, pán Newton?* (Analysis of Institute for Economic Analysis, Ministry of Economy, Slovakia). Retrieved from https://www.mhsr.sk/ministerstvo/centrum-pre-hospodarske-otazky/publikacie/analyzy/kam-tecu-slovenske-exporty-pan-ne

wton?csrt=7376486130118269909

Steinhauser, D. (2021a). Labour productivity as indicator of national competitiveness in european union and in asian belt and road initiative countries. *RELIK 2021: Conference Proceedings*, 652-661. Retrieved from https://relik.vse.cz/2021/download/pdf/377-Steinhauser-Dusan-paper.pdf

Steinhauser, D. (2021b). *Vplyv pandémie ochorenia Covid-19 na medzinárodný obchod, podnikanie a operačné riziko vo firmách*. Retrieved from https://sekarl.euba.sk/arl-eu/sk/detail-eu_un_cat-0272808-Vplyv-pandemie-ochorenia-Covid19-na-medzinarodny-obchod-podnikanie-a-operacne-riziko-vo-firmach/

The Heritage Foundation. (2019). *The Heritage Index of Economic Freedom 2019*. Retrieved from https://www.heritage.org/index/excel/2019/index2019_data.xls

UNCTAD. (2022). *Merchandise: Product concentration and diversification indices of exports and imports, annual* [Data set]. Retrieved from https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx

van Twillert, N., & Halleck Vega, S. (2021). Risk or opportunity? The belt and road initiative and the role of debt in the China-Central Asia-West Asia economic corridor. *Eurasian Geography and Economics, 64*(3), 365-377. https://doi.org/10.1080/15387216.2021.2012816

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

World Bank. (2019). *Belt and Road Economics: Opportunities and Risks of Transport Corridors*. Retrieved from https://www.worldbank.org/en/topic/regional-integration/publication/belt-and-road-economics-opportunities-and-risks-of-transport-corridors

World Bank. (2022). *World Development Indicators* [Data set]. Retrieved from https://databank.worldbank.org/source/world-development-indicators#advancedDownloadOptions

Wölwer, A. L., Breßlein, M., & Burgard, J. P. (2018). Gravity models in R. *Austrian Journal of Statistics, 47*(4), 16-35. https://doi.org/10.17713/ajs.v47i4.688

Wölwer, A., Burgard, J. P., Kunst, J., & Vargas, M. (2022). *Gravity: Estimation methods for gravity models. R package version 1.0*. Retrieved from https://CRAN.R-project.org/package=gravity

Yotov, Y. V. (2022). On the role of domestic trade flows for estimating the gravity model of trade. *Contemporary Economic Policy, 40*(3), 526-540. https://doi.org/10.1111/coep.12567

Yotov, Y., Piermartini, R., Monteiro, J. A., & Larch, M. (2016). *An advanced guide to trade policy analysis: The structural gravity model*. Retrieved from https://www.wto.org/english/res_e/booksp_e/advancedwtounctad2016_e.pdf

Zábojník, S., Čiderová, D., & Krajčík, D. (2020). *Competitiveness in international business: Challenges for the EU economies*. Czech Republic: Wolters Kluwer ČR.

Zeileis, A. (2004). Econometric computing with HC and HAC covariance matrix estimators. *Journal of Statistical Software, 11*(10), 1-17. https://doi.org/10.18637/jss.v011.i10

Zeileis, A. (2021). *How to add robust error variances in glm Poisson model in R?* Retrieved from https://stats.stackexchange.com/questions/520662/how-to-add-robust-error-variances-in-glm-poisson-model-in-r

Zeileis, A., & Hothorn, T. (2002). Diagnostic checking in regression relationships. *R News, 2*(3), 7-10. https://cran.r-project.org/doc/Rnews/Rnews_2002-3.pdf

Zeileis, A., Köll, S., & Graham, N. (2020). Various versatile variances: an object-oriented implementation of clustered covariances in R. *Journal of Statistical Software, 95*(1), 1-36. https://doi.org/10.18637/jss.v095.i01