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Estimating gravity equations for trade in value added: A structural perspective

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ABSTRACT

A large number of recent papers employ value-added trade data alongside traditional gross measures of trade to estimate the impact of various trade costs on bilateral trade. Value-added gravity equations are typically justified by referencing the theoretical and empirical merits of traditional gravity equations for gross trade. Contradicting this notion, we use theory and simulations to show that value-added gravity equations are misspecified when the gross trade gravity equation is correct. Consequently, estimates from value-added gravity equations are difficult to interpret and prone to omitted variables bias.

1. Introduction

Many recent papers employ value-added (VA) trade data alongside with traditional gross measures of trade to estimate the impact of various trade costs on bilateral trade.[1] VA gravity equations are typically justified by citing the theoretical and empirical merits of traditional gravity equations for gross trade. Contradicting this view, we demonstrate that if bilateral gross trade follows gravity, the bilateral VA trade gravity equations are misspecified.

We employ a simple model of gross trade and VA trade to pinpoint the origin of the misspecification and conduct simulation exercises to assess the importance of the issues in a controlled setting. Our results indicate that both the external and internal validity of partial trade cost elasticities estimated with reduced-form VA gravity equations are limited.

Specifically, we point out three issues. We use indicators for regional trade agreements (RTAs) to illustrate them, but our findings apply to any trade cost variable. First, the theoretical general gravity equation for VA trade, which we derive from a structural gravity model for gross trade[2], implies that the partial effects of RTAs are not comparable across samples, agreements, and time periods, and are not informative for future agreements.

Second, the theory implies that trade cost changes have heterogeneous effects on bilateral VA trade between third countries. This implies that the estimated partial elasticities of RTAs for member countries are confounded by indirect effects on non-member countries.

Third, changes in other determinants of trade between third countries happening elsewhere in the world will bias the RTA estimate unless both members' and non-members' GVCs are equally exposed to the third-country shock. Given that countries' GVCs are very different, such biases are generally likely and ambiguous in direction.

We are not the first to point out that trade cost elasticities obtained from reduced-form VA gravity equations are problematic from a structural point of view; Noguera (2012) derived a theory-grounded log-linear VA gravity equation with control terms for indirect trade cost effects. However, the majority of empirical studies have continued to use simple log-linear estimation models.[3] Moreover, we show that

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[1] Our search of the Web of Science and the OECD iLibrary returned 35 published academic papers and 4 policy reports (listed in the Appendix) that employ reduced-form gravity equations with measures of bilateral VA trade flows as the left-hand-side variable.

[2] Our definition of *general* and *structural* gravity equations follows Head and Mayer (2014).

[3] In several of these papers, the issue of third-country effects is discussed, though only a few papers attempt to tackle the misspecification problem, using either the methodology proposed by Noguera (2012) (see Laget et al., 2020; Kang and Gapay, 2024) or non-structurally motivated interaction terms (Mulabdic et al., 2017; Boffa et al., 2019; Sanguinet et al., 2022).

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the indirect effects of a potentially prohibitively large set of other third-country shocks – including country-specific ones like productivity growth and infrastructure development – also confound estimates of the partial effects of trade cost shocks on VA trade.

2. A general gravity equation for value added

2.1. The theoretical model

We set up a model of bilateral trade between N countries, indexed by i, j, k, n, h. Our analysis rests on two core assumptions.

(A1). Final goods trade C_{in} and intermediate goods trade A_{in} from country i to country n follow general gravity equations, respectively given by

$$C_{in} = \pi_{in} C_n \quad \text{and} \quad A_{in} = \pi_{in} A_n \quad \text{with}$$
$$\pi_{in} = \frac{\tau_{in}^{-\varepsilon}}{\Psi_i \Phi_n}$$
$$\Phi_n = \sum_{h=1}^{N} \frac{\tau_{hn}^{-\varepsilon}}{\Psi_h},$$

where $A_n = \sum_i A_{in}$ and $C_n = \sum_i C_{in}$.[4]

A1 stipulates that trade shares π_{in} are identical for final and intermediate goods, implying that total trade also follows a general gravity equation:

$$X_{in} = \tau_{in}^{-\varepsilon} \frac{X_n}{\Psi_i \Phi_n}, \tag{1}$$

where $X_n = A_n + C_n$.

(A2). For every country n, the ratio of VA to output, denoted by v_n, is constant.

A2 implies that the ratio of expenses for intermediates to country n's output is $(1 - v_n)$ and A1 and A2 together imply that the share of intermediates sourced directly from i in output of n is $a_{in} = \pi_{in}(1 - v_n)$. We use $\mathbf{a}$ to denote the $N \times N$ matrix of direct input coefficients a_{in} and $\mathbf{B} = (\mathbf{I} - \mathbf{a})^{-1}$ to denote the corresponding Leontief inverse with typical element b_{in}.

Definition 1. VA exports from i to n, VA_{in}, are defined as VA that originates in i and is consumed in n.

This definition follows Johnson and Noguera (2012) and leads us to the following result:

Proposition 1. *Under A1 and A2, bilateral VA exports are given by*

$$VA_{in} = \frac{v_i C_n}{\Phi_n} \left(\sum_h^N \frac{b_{ih} \tau_{hn}^{-\varepsilon}}{\Psi_h} \right), \tag{2}$$

where $b_{ih} = f\left[\left\{\tau_{jk}, \Psi_j, \Phi_k, v_k\right\}_{j,k=1}^{N}, \varepsilon\right]$.

Proof. It follows from $A2$ and Definition 1 that $VA_{in} = v_i \left(\sum_h^N b_{ih} C_{hn}\right)$. Substituting C_{hn} and π_{hn} from A1 yields (2). The dependency of b_{ih} on the trade cost, multilateral resistance terms, and value added coefficients of other countries is due to the fact that b_{ih} is a function of *all* input coefficients in $\mathbf{a}$.

Proposition 1 has two important implications. First, VA_{in} is not log-proportional to τ_{in}. Second, VA_{in} depends in a non-trivial way on the determinants of trade between third countries. Intuitively, this is because VA from i reaches n embodied in goods processed elsewhere. The indirect nature of VA flows is, of course, well known and variants of (2) have been employed to quantify the impact of trade cost changes on VA trade in computable general equilibrium models.[5] The purpose of deriving (2) is to enable a structural interpretation of the coefficients that are estimated by ad-hoc VA gravity equations. This allows us to pinpoint a set of problematic issues that arise under the commonly employed reduced-form approach.[6]

2.2. Estimating the impact of RTAs on (VA) trade

To map our setup directly into commonly used panel estimation frameworks, we add a time dimension indexed by t and employ two additional assumptions:

(A3). Bilateral trade costs depend on RTAs and a vector of other observable trade barriers Z_{int} according to

$$\tau_{int} = \exp\left\{\delta RTA_{int} + \nu Z_{int}\right\}. \tag{3}$$

Combining (4) and (3), we derive the empirical gravity equation for gross trade

$$\ln X_{int} = \beta^X RTA_{int} + \nu Z_{int} + \gamma_{it} + \gamma_{nt} + \gamma_{in} + u_{int}. \tag{4}$$

where $\gamma_{it}, \gamma_{nt}, \gamma_{in}$ are fixed effects. Henceforth, we use $\boldsymbol{\zeta}_{int}$ to denote the vector of covariates in (4).

(A4). Exogeneity of the covariates

$$\mathrm{E}\left[u_{ins} | \zeta_{int}\right] = 0 \quad \text{for } s, t = 1, \ldots, T.$$

Under A4, (1) and (4) imply that the elasticity of gross trade to a trade cost change that is due to a change in RTA membership is

$$\beta^X = \frac{\partial \mathrm{E}\left[\ln X_{int} | \boldsymbol{\zeta}_{int}\right]}{\partial RTA_{int}} = -\varepsilon\delta. \tag{5}$$

In analogy to (4), VA gravity equations employ (variants of) the empirical model

$$\ln VA_{int} = \beta^{VA} RTA_{int} + \nu^{VA} Z_{int} + \gamma_{it} + \gamma_{nt} + \gamma_{in} + \epsilon_{int} \tag{6}$$

to estimate $\beta^{VA} = \frac{\partial \mathrm{E}[\ln VA_{int} | \boldsymbol{\zeta}_{int}]}{\partial RTA_{int}}$. However, the theoretical VA gravity Eq. (2) implies several issues that complicate the estimation of (6).

Issue (1): Coefficient heterogeneity. According to (2) and (3), the elasticity of VA trade to a change in RTA membership is

$$\frac{\partial \ln VA_{int}}{\partial RTA_{int}} = \frac{\partial \ln VA_{int}}{\partial (\ln \tau_{int}^{-\varepsilon})} (-\varepsilon\delta) \tag{7}$$

where

$$\frac{\partial \ln VA_{int}}{\partial (\ln \tau_{int}^{-\varepsilon})} = \frac{\partial (\ln C_{nt}/\Phi_{nt})}{\partial (\ln \tau_{int}^{-\varepsilon})} + \omega_{iint} + \sum_h \omega_{ihnt} \left(\frac{\partial \ln b_{iht}}{\partial (\ln \tau_{int}^{-\varepsilon})} - \frac{\partial \ln \Psi_{ht}}{\partial (\ln \tau_{int}^{-\varepsilon})} \right)$$

and $\omega_{ihnt} = \frac{b_{iht} \tau_{hnt}^{-\varepsilon} \Psi_{ht}^{-1}}{\sum_j b_{ijt} \tau_{jnt}^{-\varepsilon} \Psi_{jt}^{-1}}$. Note that $\frac{\partial \ln VA_{int}}{\partial RTA_{int}}$ depends on characteristics of the pair i, n. Thus, the best we can aim for by estimating (6) is the sample average of $\frac{\partial \mathrm{E}[\ln VA_{int} | \zeta_{int}]}{\partial RTA_{int}}$ for the pairs whose RTA status changes.

The magnitude of this average effect, which we denote with $\beta^{VA,treated}$, will depend on the set of country pairs and the time period included in the estimation, even if the actual data were generated by a process consistent with A1–A4. In contrast, $\hat{\beta}^{X,treated}$ estimates $-\varepsilon\delta$ under A1–A4, independent of the sample composition.

[4] Trade shares π of this form are implied, e.g., by the model of Eaton and Kortum (2002) or the Armington model of Anderson and Van Wincoop (2003)

[5] E.g., Johnson and Noguera (2017) and Felbermayr et al. (2022) employ quantitative trade models featuring gravity in intermediate and final goods trade to structurally estimate the partial effect of RTAs on gross trade and then calculate the corresponding changes in the world input–output matrix and the new VA trade flows.

[6] While our focus is on VA exports, the logic we outline extends to related measures such as the domestic VA content of exports or imports or the carbon content of trade.

Issue (2): Lack of control group. Under A2, VA exports from j reach k via every possible route. This implies that a reduction in τ_{in}, e.g., due to a bilateral RTA between i and n also benefits VA trade from j to k that travels via i and n. Formally, except for knife-edge cases,

$$\frac{\partial \ln VA_{jkt}}{\partial \ln(\tau_{int}^{-\epsilon})} \neq 0 \qquad \forall\, i, n, j, k. \tag{8}$$

For example, for two countries j, k, which are not part of the RTA, the effect is

$$\frac{\partial \ln VA_{jkt}}{\partial (\ln \tau_{int}^{-\epsilon})} = \frac{\partial \ln(C_{kt}/\Phi_{kt})}{\partial (\ln \tau_{int}^{-\epsilon})} + \sum_h \omega_{jhkt} \left(\frac{\partial \ln b_{jht}}{\partial (\ln \tau_{int}^{-\epsilon})} - \frac{\partial \ln \Psi_{ht}}{\partial (\ln \tau_{int}^{-\epsilon})} \right)$$

Like the partial effect on the "treated" country pairs, the effect on "untreated" pairs is heterogeneous. Issue 2 implies that, under A1–A4, we will never be able to recover the (sample-dependent) $\beta^{VA,treated}$. Hence, we will at best be able to identify the difference between the average effect of the RTA on members' VA trade with each other and the average effect on all other, indirectly affected pairs:

$$\hat{\beta}^{VA} = \hat{\beta}^{VA,treated} - \hat{\beta}^{VA,untreated}. \tag{9}$$

Issue (3): Omitted variables bias. The non-zero cross derivatives in (8) imply more generally that the effect of a given RTA cannot be identified separately from any trade cost change happening elsewhere in the world. Since $\frac{\partial \ln VA_{int}}{\partial \ln(\tau_{jkt}^{-\epsilon})}$ is non-zero and pair specific, i.e., not absorbed by exporter and importer fixed effects, any trade cost change across the world that coincides with the change in RTA_{in} will bias the coefficient $\hat{\beta}^{VA}$, except in special cases. Moreover, omitted variables bias is not limited to trade cost. In fact, even changes in the country-specific parameters Ψ_h and υ_h, that influence VA_{int} through the Leontief coefficients in (2), will bias the coefficient if they coincide with the formation of the RTA.

3. Quantification of heterogeneity and bias

3.1. Methodology

In this section, we demonstrate the quantitative importance of the abovementioned issues in a controlled simulation setting where A1–A4 hold. We use a variant of the model of Aichele and Heiland (2018) to simulate the exact partial and general equilibrium effects of a hypothetical RTA on gross trade and VA trade.[7] The model satisfies A1 and A2, and we simulate trade cost shocks that satisfy A3 and A4. Specifically, we assume that the set of countries $B \subset N$ forms an RTA that reduces trade cost among members by 10% ($\delta = .9$) and a trade elasticity $\epsilon = -5$. The model yields counterfactual changes $\hat{X}_{in} = X'_{in}/X^0_{in}$, where X^0_{in} (X'_{in}) is gross bilateral trade in the baseline (counterfactual) equilibrium, and, analogously, counterfactual changes in VA trade, $\widehat{VA}_{in} = VA'_{in}/VA^0_{in}$ for $i, n \in N$. Our assumptions imply that we can recover the partial effect of the RTA on gross trade from the regression

$$\ln \hat{X}_{in} = \beta^X RTA_{in} + \mu_i + \mu_n + u_{in}, \tag{10}$$

where RTA_{in} equals one for $n, i \in B, n \neq i$ and zero otherwise. β^X observes $e^{\beta^X} = \delta^{\epsilon}$.

In analogy to (10), we set up the ad-hoc log linear estimation equation

$$\ln \widehat{VA}_{in} = \beta^{VA} RTA_{in} + \mu_i + \mu_n + \varepsilon_{in} \tag{11}$$

to study the properties of $\hat{\beta}^{VA}$.

[7] The model baseline is calibrated to match production and bilateral trade of 65 countries and the rest of the world in the OECD ICIO database in 2018.

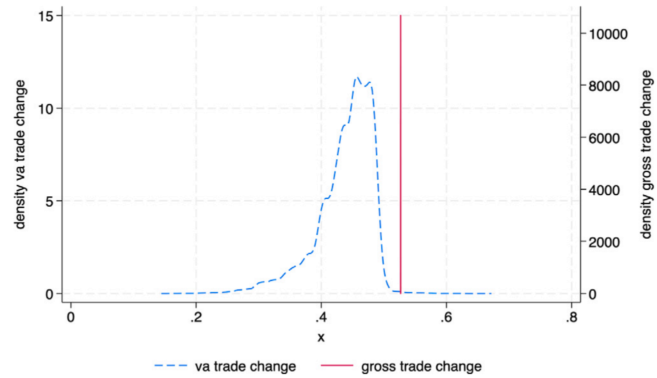

Fig. 1. BRICS, effects on RTA-members vs. Non-members.

3.2. Results

First, we focus on the extent of heterogeneity that is concealed by the average partial effect (issue 1). To that end, we simulate the following scenario:

Scenario 1 ("$BRICS$"). We assume that the BRICS countries (Brazil, Russia, India, China, and South Africa) form an RTA that reduces trade costs between RTA members by 10%.

To quantify the heterogeneity, we calculate the distribution of the partial VA trade effects of the RTA across all possible quadruples with one treated pair. Starting with gross trade as a reference point, A1 implies

$$\ln\left(\frac{\hat{X}_{in}/\hat{X}_{ij}}{\hat{X}_{kn}/\hat{X}_{kj}}\right) = \beta^X \qquad \text{if} \qquad RTA_{in} = 1, RTA_{ij}, RTA_{kn}, RTA_{kj} \neq 1. \tag{12}$$

The partial trade effect is constant across members of the RTA and independent of the composition of the control group. In contrast, every RTA member experiences a different partial VA trade effect, and so does every non-member. Hence, the distribution of

$$\ln\left(\frac{\widehat{VA}_{in}/\widehat{VA}_{ij}}{\widehat{VA}_{kn}/\widehat{VA}_{kj}}\right) \qquad \text{for} \qquad RTA_{in} = 1, RTA_{ij}, RTA_{kn}, RTA_{kj} \neq 1 \tag{13}$$

is non-degenerate. Fig. 1 (dashed blue line) shows the distribution of the RTA effects across quadruples. The partial VA effects are smaller than the partial effect on gross trade on average, but span a wide range.

Fig. 2 plots the distribution of the RTA effects on the control groups, calculated as

$$\ln\left(\frac{\widehat{VA}_{in}/\widehat{VA}_{ij}}{\widehat{VA}_{kn}/\widehat{VA}_{kj}}\right) \qquad \text{for} \qquad RTA_{in}, RTA_{ij}, RTA_{kn}, RTA_{kj} \neq 1. \tag{14}$$

As implied by (8), the effects are non-zero and heterogeneous across pairs.

Table 1 shows the estimate of β^{VA} from (11) in column 1. The implied average partial VA trade change is $(e^{\beta^{VA}} - 1) * 100\% = 54.97\%$.

To illustrate that the estimate of the VA trade cost elasticity depends on the composition of the estimation sample, we analyze two additional scenarios:

Scenario 2: "$BRICS + TTIP$". In parallel with the formation of the $BRICS$ agreement as defined in Scenario 1, another RTA (called "TTIP") is formed between the U.S. and all EU27 members, which also reduces trade costs between members by 10%.

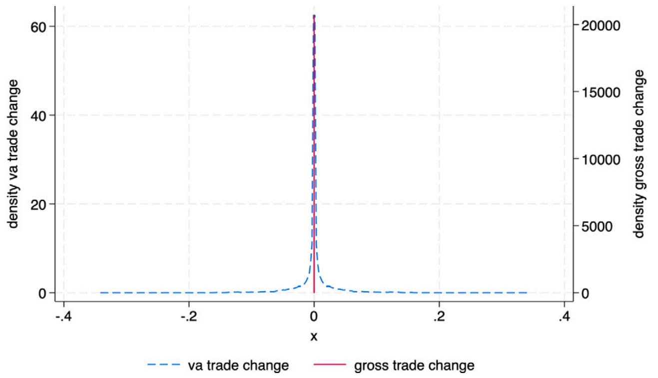

Fig. 2. BRICS, effects on Non-members.

Table 1
Partial VA trade effects under different scenarios.

	1.$BRICS$	2.$BRICS+TTIP$	3.$BRICS_{2001}$	4.$BRICS+US$
β^{VA}	0.4381	0.4474	0.4476	0.4402

Note: In all four scenarios, the partial trade effect on gross trade is $\beta^X = 0.5268$.

Scenario 3: "$BRICS_{2001}$". Like in Scenario 1, the BRICS countries form an RTA, but now we calibrate the model baseline with data from 2001 instead of 2018.

In both new scenarios, we find partial average VA effects that are approximately 1.5 percentage points larger than in the baseline scenario (see columns 2, 3). By construction, the partial effect on gross trade are identical.

To demonstrate the issue of omitted variables bias, we study the following scenario:

Scenario 4: "$BRICS + US$". In addition to the BRICS agreement as in Scenario 1, a positive infrastructure shock occurs in the USA which reduces trade costs between the U.S. and all destinations (including the U.S. itself) by 50%.

Column 4 shows that the estimated partial VA trade effect of $BRICS$ is affected by the infrastructure shock occurring elsewhere in the world. This occurs despite the fact that the direct effect on BRICS countries' and non-BRICS countries' VA trade with the US is absorbed by the country fixed effects in (11). In contrast, in the gross trade regression, the country fixed effects perfectly control for the infrastructure shock.

4. Discussion and conclusions

Before concluding, we would like to discuss the assumptions underlying our framework. A3 is a widespread and fairly harmless log-linearity assumption. A4, in contrast, is likely to fail when confronted with real-world data. However, we adopt it for practical purposes only, because we want to demonstrate the challenges associated with VA gravity estimates for variables whose effects on gross trade can be cleanly identified using OLS with fixed effects.

A1 and A2 warrant more discussion. A2 implies that the VA composition of exported goods is identical across destinations, effectively ruling out the possibility that different inputs are used for different destination markets. If we had real data on value added content, we could more accurately measure country-pair specific exposure to the treatment or confounding shocks. The empirical issues caused by heterogeneous exposure, however, would persist. The same holds for relaxing A1 by allowing for differences between trade shares of final and intermediate goods or multiple sectors.

Finally, we do not intend for our analysis to suggest that gross trade gravity equations are correct. Instead, we want to point out that the use of reduced-form VA gravity equations should not be justified by referencing the theoretical and empirical merits of gravity equations for gross trade. We think the misspecification issues outlined here are relevant beyond our stylized framework because they arise from the multilateral nature of VA trade and the uniqueness of each country's GVC, which is an empirical fact. Consequently, we believe that the effects of trade cost changes on VA trade are better studied using a structural model of trade in final and intermediate goods.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT-4 to improve the language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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Appendix

List of academic papers and policy reports estimating gravity equations with value added trade flows

Academic papers

Blind et al. (2018)
Boffa et al. (2019)
Böhmecke-Schwafert and Blind (2023)
Chen et al. (2022)
Díaz-Mora et al. (2022)
Doan and Le (2021)
Fertő et al. (2024)
Hayakawa and Mukunoki (2023)
Johnson and Noguera (2017)
Kang and Gapay (2024)
Laget et al. (2020)
Le et al. (2022)
Lee (2019)
Lu and Wolszczak-Derlacz (2024)
Mulabdic et al. (2017)
Njike (2021)
Olczyk and Kordalska (2017)
Pahl and Timmer (2019)
Sanguinet et al. (2022)
Sharma et al. (2023)
Sharma et al. (2024)
Thang et al. (2021)
Tokas (2021)
Tokas (2022)
Wang and Thangavelu (2021)
Wolszczak-Derlacz and Lu (2022)
Yang (2022)
Yang (2023)
Yang and Liu (2024)
Zaninović (2022)
Zaninović and Bugarčić (2023)
Zaninović et al. (2024)
Zhang et al. (2024)
Zhao (2022)
Zhong et al. (2022)

Policy reports

Cadestin et al. (2016)
Jouanjean et al. (2017)
Moïsé and Sorescu (2015)
OECD (2021)

Data availability

I have shared the link to my data/code at the Attach File step

replication package (Original data) (Github)

References

Aichele, R., Heiland, I., 2018. Where is the value added? Trade liberalization and production networks. J. Int. Econ. 115, 130–144.
Anderson, J.E., Van Wincoop, E., 2003. Gravity with gravitas: A solution to the border puzzle. Am. Econ. Rev. 93 (1), 170–192.
Blind, K., Mangelsdorf, A., Niebel, C., Ramel, F., 2018. Standards in the global value chains of the European single market. Rev. Int. Political Econ. 25 (1), 28–48.
Boffa, M., Jansen, M., Solleder, O., 2019. Do we need deeper trade agreements for GVCs or just a BIT? World Econ. 42 (6), 1713–1739.
Böhmecke-Schwafert, M., Blind, K., 2023. The trade effects of product market regulation in global value chains: evidence from OECD and BRICS countries between 2000 and 2015. Empirica 50 (2), 441–479.
Cadestin, C., Gourdon, J., Kowalski, P., 2016. Participation in Global Value Chains in Latin America: Implications for Trade and Trade-Related Policy. Technical Report, OECD, Paris.
Chen, H., Luo, C., Renard, M.-F., Sun, S., 2022. EU-China trade and intra-EU trade: Substitute or complementary? J. Econ. Surv. 36 (3), 558–585.
Díaz-Mora, C., García-López, E., González-Díaz, B., 2022. Bilateral servicification in global value chains and deep trade agreements. World Econ. 45 (8), 2510–2531.
Doan, T.N., Le, H.T., 2021. Upgrading the global value chain with regime-wide rules of origin. Appl. Econ. Lett. 28 (2), 143–147.
Eaton, J., Kortum, S., 2002. Technology, geography, and trade. Econom. 70 (5), 1741–1779.
Felbermayr, G., Groeschl, J., Heiland, I., 2022. Complex Europe: Quantifying the cost of disintegration. J. Int. Econ. 138, 103647.
Fertő, I., Kheyirkhabarli, M., Sass, M., 2024. Gravity models with TiVA data: do they bring new results? Appl. Econ. Lett. 31 (8), 702–705.
Hayakawa, K., Mukunoki, H., 2023. The magnification effect in global value chains. Rev. Int. Econ. 31 (1), 141–157.
Head, K., Mayer, T., 2014. Chapter 3 - Gravity equations: Workhorse, toolkit, and cookbook. In: Gopinath, G., Helpman, E., Rogoff, K. (Eds.), Handbook of International Economics. In: Handbook of International Economics, vol. 4, Elsevier, pp. 131–195.
Johnson, R.C., Noguera, G., 2012. Accounting for intermediates: Production sharing and trade in value added. J. Int. Econ. 86 (2), 224–236.
Johnson, R.C., Noguera, G., 2017. A portrait of trade in value-added over four decades. Rev. Econ. Stat. 99 (5), 896–911.
Jouanjean, M.-A., Gourdon, J., Korinek, J., 2017. GVC Participation and Economic Transformation: Lessons From Three Sectors. Technical Report, OECD, Paris.
Kang, J.W., Gapay, J.A.O., 2024. Indirect channel of trade agreements in deepening global value chains. World Econ. 47 (8), 3511–3550.
Laget, E., Osnago, A., Rocha, N., Ruta, M., 2020. Deep trade agreements and global value chains. Rev. Ind. Organ. 57 (2), 379–410.
Le, H.T., Hoang, D.P., Doan, T.N., Pham, C.H., To, T.T., 2022. Global economic sanctions, global value chains and institutional quality: Empirical evidence from cross-country data. J. Int. Trade Econ. Dev. 31 (3), 427–449.
Lee, W., 2019. Services liberalization and global value chain participation: New evidence for heterogeneous effects by income level and provisions. Rev. Int. Econ. 27 (3), 888–915.
Lu, Y., Wolszczak-Derlacz, J., 2024. The impact of China's one-belt one-road initiative on international trade and global value chains. Asia Pac. J. Account. Econ. 1–18.
Moïsé, E., Sorescu, S., 2015. Contribution of Trade Facilitation Measures to the Operation of Supply Chains. Technical Report, OECD, Paris.
Mulabdic, A., Osnago, A., Ruta, M., 2017. Deep integration and UK-EU trade relations. World Bank Policy Res. Work. Pap. (7947), 24.
Njike, A., 2021. Are African exports that weak? A trade in value added approach. World Econ. 44 (3), 733–755.
Noguera, G., 2012. Trade costs and gravity for gross and value added trade. In: Job Market Paper. Vol. 4, Columbia University.
OECD, 2021. Global Value Chains, Environmental Policies, and the Pollution Haven Hypothesis. Technical Report, OECD, Paris.
Olczyk, M., Kordalska, A., 2017. Gross exports versus value-added exports: Determinants and policy implications for manufacturing sectors in selected CEE countries. East. Eur. Econ. 55 (1), 91–109.
Pahl, S., Timmer, M.P., 2019. Patterns of vertical specialisation in trade: long-run evidence for 91 countries. Rev. World Econ. 155 (3), 459–486.
Sanguinet, E., Alvim, A., Atienza, M., 2022. Trade agreements and participation in global value chains: Empirical evidence from Latin America. World Econ. 45 (3), 702–738.
Sharma, S., Arora, R., Gupta, P., 2024. Servicification of GVCs through deep service provisions: Uncovering new insights from structural gravity and machine learning. World Econ. 47 (10), 4277–4303.
Sharma, S., Mundhada, Y.P., Arora, R., 2023. Which combination of trade provisions promotes trade in value-added An application of machine learning to cross-country data. Econ. Pap. J. Appl. Econ. Policy 42 (4), 332–346.
Thang, D.N., Ha, L.T., Dung, H.P., Long, T.Q., 2021. On the relationship between rules of origin and global value chains. J. Int. Trade Econ. Dev. 30 (4), 549–573.
Tokas, K., 2021. 'New-Age' preferential trade agreements and global value chains: An empirical analysis. Glob. Bus. Rev..
Tokas, K., 2022. 'New-Age' preferential trade agreements and global value chains: A comparative sectoral analysis. Glob. Bus. Rev..
Wang, W., Thangavelu, S., 2021. Trade and human capital in global value chain in developed and developing countries. Asian Econ. Pap. 20 (3), 1–15.
Wolszczak-Derlacz, J., Lu, Y., 2022. The role of the one-belt one-road initiative in China?s exports and global value chains. Equilib. Q. J. Econ. Econ. Policy 17 (2), 317–341.
Yang, X., 2022. Value-added share and elasticity of trade to barriers. Appl. Econ. Lett. 29 (17), 1599–1604.
Yang, L., 2023. Fields of harmony: trade standards and China's value-added exports in global value chains. Econ. Res. Èkon. Istraživanja 36 (2), 2140304.
Yang, Y., Liu, W., 2024. Free trade agreements and domestic value added in exports: An analysis from the network perspective. Econ. Model. 132, 106656.
Zaninović, P.A., 2022. The determinants of value added trade in the EU (EU-15 vs. CEE). Èkon. Misao I Praksa Econ. Thought Pr. 31 (1), 211–236.
Zaninović, P.A., Bugarčić, F.ž., 2023. The effects of international logistics in global value chain trade. J. Bus. Econ. Manag. 24 (5), 841–856.
Zaninović, P.A., Zajc Kejžar, K., Pavlić Skender, H., 2024. Assessing the effects of hard and soft infrastructure on traditional vs supply-chain trade: the case of Central and Eastern EU member states (CEMS). Appl. Econ. 56 (3), 249–264.
Zhang, B., Kong, L., Xu, Z., Sun, C., 2024. Evolution of China's role in the structure of global carbon emission transfers: An empirical analysis based on network governance. China World Econ. 32 (1), 130–166.
Zhao, T., 2022. Economic policy uncertainty and manufacturing value-added exports. Eng. Econ. 33 (1), 103–114.
Zhong, S., Goh, T., Su, B., 2022. Patterns and drivers of embodied carbon intensity in international exports: The role of trade and environmental policies. Energy Econ. 114, 106313.