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Drivers of the Participation in Global Value Chains (GVCs):

The role of the national transportation system in reducing transportation costs

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Introduction

- **What drives GVCs participation? What separates** less successful countries from successful ones?
- This work aims to investigate the determinants of the integration in the international production network for both **emerging and developed economies** in a **transport perspective**.
- We propose an empirical model that jointly analyses:
  I. different **distance** dimensions (geographical, institutional, cultural and economic)
  II. the impact of the quality and efficiency of the **national transportation system**
  III. the negative effect of **physical distance** between trading partners **moderated** by the host country's national transportation system.
- Contribute to the recent literature on GVCs to develop a deeper **understanding of factors** that shape GVCs.
- Policy makers can make **better-informed decisions** on the role of national transportation systems within their countries for integration in GVCs

Literature review (1/2)

- Geographical distance
  - The level of fragmentation of production can be explained by the **costs incurred when the production is split in different locations** *(deBacker and Miroudot, 2014).*
  - **Trade costs due to geography and distance** can determine and shape a country's positioning in GVCs *(Buelens and Tirpak, 2017; Antràs and De Gortari, 2020)*
- Economic distance
  - Countries with **similar level of development** are involved in more trade relationships.
  - Activities motivated by resource and efficiency seeking (i.e., low-wage production) can **benefit from a weaker economic level** in the origin country (*Dunning and Lundan, 2008*).
  - For trade in parts and components, this relationship **is not clear** *(Kee, 2015).*
- Cultural distance
  - Persistence of **'transactional distance'** between countries (*Obstfeld and Rogoff, 2000)*
  - But, **the relationship between international trade and cultural differences is in fact non-linear**, so, international trade decreases with cultural distance, but only once it surpass a certain threshold *(Lankhuizen and Groot, 2016).*
- Institutional distance
  - The performance of a global production network is **conditioned to production delays**, **not sufficient law protection** of intangibles and **weak contract enforcement**.

H1. Distance dimensions, as geographical, economic, institutional quality and cultural, are negatively related to global value chain participation for both emerging and developed economies.

Literature review (2/4)

National transportation system

- The **stable supply of transportation network** is crucial when many nodes of the chain depend on each other for timely and reliable delivery *(Kowalski et al., 2015)*
- **Efficient logistics** for complex production processes that span across several borders *(Blyde, 2014).*
    - **A shipment delay incurs a tariff equivalent of 0.6% to 2.3%**, and the **most sensitive flows** are for trade in parts and components (*Hummels and Schaur, 2012)*.
    - **Each day of delay in inland transit** is equivalent to a country distancing itself from its trade partners by about **70 km on average** *(Djankov et al., 2010).*
    - The **quality of logistics and transport connectivity** has a significant effect on bilateral backward participation in emerging economies (*Kowalski et al., 2015)* .

The impact may vary based on the level of development of the host country

- **Differences in time and costs** are explained by the **quality** of transportation infrastructure in developing economies (*Memedovic et al., 2008)*
- Countries are **unable to reap the benefits of proximity** because of **transport inefficiency and high logistics costs** (Chakrabarty and Chanda, 2021).

H2. Better accessibility and quality of the transportation system is able to moderate the negative effect of geographical distance to participate in global value chains for emerging economies.

Data and Methodology

- **World input-output tables (WIOT)** provided by WIOD of WTO, released in 2016 to measures the integration in GVCs.
- 28 EU countries and 15 other major countries in the world, 56 sectors for the period from 2000 to 2014, which count for almost 85% of the global production.
- Two measures of GVCs integration:
  - **Backward links** expressed in value terms (i.e. the **foreign value added** of intermediates embodied in gross exports for each country pair or FVAT-CP)
  - **Forward links** expressed in value terms (i.e. the **domestic value added** destined for processing and exports by each country partner or DVX-CP)
- Following the exposition of Stehrer (2012) and Koopman et al. (2014), to calculate the foreign (and domestic) value added in trade flows for any country *r* and industry i three components are needed:
  I. the value-added requirements per unit of gross output, $\boldsymbol{v_{ri}}$;
  II. the Leontief inverse of the global input-output matrix, $\boldsymbol{L}$; and
  III. the export vector, $\boldsymbol{x_{ri}}$.

Data and Methodology - Measures of GVCs integration

- Using the three elements, the value added in trade matrix ($\boldsymbol{VAT_r}$) of dimension 2408 x 2408 (43 countries x 56 industries) is calculated as follow:

$$\boldsymbol{VAT_r} = \boldsymbol{diag}(\boldsymbol{v})_r \cdot \boldsymbol{L} \cdot \boldsymbol{diag}(\boldsymbol{x})_r$$

$$= \begin{bmatrix} v_1 & 0 & \cdots & 0 \\ 0 & v_2 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & v_r \end{bmatrix} \begin{bmatrix} l_{1,1} & l_{1,2} & \cdots & l_{1,r} \\ l_{2,1} & l_{2,2} & \dots & l_{2,r} \\ \vdots & \vdots & \ddots & \vdots \\ l_{r,1} & l_{r,2} & \cdots & l_{r,r} \end{bmatrix} \begin{bmatrix} x_1 & 0 & \cdots & 0 \\ 0 & x_2 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & x_r \end{bmatrix}$$

$$= \begin{bmatrix} v_1 l_{1,1} x_1 & v_1 l_{1,2} x_2 & \cdots & v_1 l_{1,r} x_r \\ v_2 l_{2,1} x_1 & v_2 l_{2,2} x_2 & \dots & v_2 l_{2,r} x_r \\ \vdots & \vdots & \ddots & \vdots \\ v_r l_{r,1} x_1 & v_n l_{r,2} x_2 & \cdots & v_n l_{r,r} x_r \end{bmatrix} \qquad (3)$$

- The total FVAT flow (and DVX flow) for each country pair is obtained by summing up over all FVATs (and DVXs) from all industries between two countries.

Data and Methodology - The gravity model

- We use augmented gravity equations in the multiplicative form following Santos Silva and Tenreyro (2006; 2011):

$$\boldsymbol{Y}_{ij,t} = {\beta_0}' \times {\boldsymbol{X}_{ij,t}}^{{\beta_1}'} \times {\boldsymbol{D}_{ij,t}}^{{\beta_2}'} \times {T_{i,t}}^{\beta_3} \times \varepsilon_{ij,t} \qquad (4)$$

- where $Y_{ij,t}$ represents the two measures of GVCs participation based on country-pair ij in year t.
- The matrix $\boldsymbol{X}_{ij,t}$ includes all distance measures T
- The matrix $\boldsymbol{D}_{ij,t}$ contains the dummy measures we use to control for common border and other trade related policies, year and host country effect.
- And, an addition to a set of national transportation system variables of country of origin (home country) i involved in the GVCs are used denoted as $T_{i,t}$ and the standard error term $\varepsilon_{ij,t}$.

- The dependent variables follow a Poisson distribution, the Pseudo Poisson Maximum Likelihood (PPML) estimator is used. *(Santos Silva and Tenreyro, 2006, 2011; Arvis and Shepherd, 2013; Fally, 2015; Correia et al., 2020).*

Data and Methodology - Explanatory variables (1/2)

Bilateral distances:

1. For geographic distance (dGEO) we used the distance between the capital cities of country pairs in kilometres according to CEPII database.

2. The institutional distance measure (dWGI) is based on the distance between the home and host country's World Governance Index (WGI) values. We calculated the Euclidean distance

3. For computing the cultural distance (dCULT) the Hofstede's data on national culture *(Beugelsdijk et al., 2015)* are used, following the modified formula proposed by *Halaszovich and Kinra (2018)* which includes all six dimensions:

4. Economic distance (dECO) is measured as Euclidean distance of the GDP per capita in constant US dollars for country pairs based on WB database information.

Transportation system:

- To measure the availability and quality of national transportation systems, data from the **World Economic Forum** (WEF, Global Competitiveness Report) for four main transport modes – **roads, rails, ports and airports.**
- To address the correlation issue, each of the quality of the transportation mode variables are regressed on the principal component after computing the factor analysis, and consider the idiosyncratic part of each measure (*Di Giacinto et al., 2012).*
- The transportation variables grouped in inland, maritime and air transportation.

Data and Methodology – Summary statistics

Table 2. Summary statistics

	Obs.	Mean	St. dev.	Min	Max	Units of measurement
Independent variables						
FVACP	27090	1024	3138	0	66894	Constant US $
DVXCP	27090	1024	3138	0	66894	Constant US $
Dependent variables						
dGEO	27090	4891	4390	60	18524	Kilometers
dWGI	27090	2.25	1.42	0.10	7.21	Equation (4)
dCULT	25830	2.00	1.22	0.03	6.69	Equation (5)
dECO	25830	25404	20826	1.14	110795	Constant US $
Border	27090	0.06	0.24	0	1	0/1
Pop origin	27735	99.73	260.46	0.38	1364.27	Total in million
FTA	27606	0.51	0.50	0	1	0/1
Road	336	66.66	18.54	27.25	96.01	0-100
Rails	240	62.08	17.39	24.79	97.21	0-100
Ports	336	68.95	14.34	35.97	97.27	0-100
Airports	336	74.47	12.94	43.47	95.80	0-100

Econometric results (1/3)

Table 3. Econometric results - baseline model (all countries)

	FVT flows		DVX flows	
	Coef.		Coef.	
dGEO	-0.000157	***	-0.000017	***
	(0.000029)		(0.000003)	
dWGI	0.1724743	***	0.093405	***
	(0.057107)		(0.049389)	
dCULT	-0.0931822		-0.067978	
	(0.063561)		(0.051164)	
dECO	-0.000023	***	-0.000169	***
	(0.000005)		(0.000033)	
Border	1.305285	***	0.975661	***
	(0.161804)		(0.127766)	
Pop origin	0.0022812	**	0.005776	**
	(0.001108)		(0.001472)	
FTA	-0.908040	***	0.081690	***
	(0.228557)		(0.181511)	
Constant	8.456723	***	7.415881	***
	(0.366006)		(0.369238)	
Year FE	Yes		Yes	
Regional FE	Yes		Yes	
Obs.	24600		24600	
Clusters country pair	1640		1640	
Pseudo R2	0.5344		0.6500	
Log pseudolikelihood	-18678850.7		-14040547.6	
Wald Chi2	208.71	***	280.71	***

Robust standard error in parenthesis, *** p<0.01, ** p<0.05, * p<0.10.
Standard error adjusted for clusters. Statistics robust to heteroskedasticity.

Table 4. Econometric results - baseline model (sub-samples of emerging and developed economies)

	Emerging economies				Developed economies			
	FVT flows		DVX flows		FVT flows		DVX flows	
	Coef.		Coef.		Coef.		Coef.	
dGEO	-0.000210	***	-0.000007		-0.000170	***	-0.000034	***
	(0.000056)		(0.000004)		(0.000022)		(0.000005)	
dWGI	0.215262	***	0.182944	*	0.228284	***	0.074633	
	(0.070839)		(0.095302)		(0.086029)		(0.066876)	
dCULT	0.016887		-0.074858		-0.174926	**	-0.147526	**
	(0.091225)		(0.083079)		(0.069881)		(0.059401)	
dECO	-0.000001		-0.000178	***	-0.000047	***	-0.000225	***
	(0.000004)		(0.000047)		(0.000007)		(0.000043)	
Border	1.387256	***	0.540344	**	1.207273	***	1.013842	***
	(0.254560)		(0.246635)		(0.165297)		(0.126103)	
Pop origin	-0.001362		0.003328	***	-0.056217	***	-0.005199	
	(0.001302)		(0.001197)		(0.017527)		(0.011859)	
FTA	-0.692114	***	0.486706	**	-1.281115	***	-0.480381	**
	(0.226617)		(0.236989)		(0.275946)		(0.228075)	
Constant	8.265673	***	7.134726	***	12.192330	***	9.583113	***
	(0.721840)		(0.606962)		(0.744352)		(0.671164)	
Year FE	Yes		Yes		Yes		Yes	
Regional FE	Yes		Yes		Yes		Yes	
Obs.	13,200		13,200		11,400		11,400	
Clusters country pair	880		880		760		760	
Pseudo R2	0.5436		0.5436		0.5729		0.5729	
Log pseudolikelihood	-6809627		-6809627		-9642471		-9642471	
Wald Chi2	94.28	***	214.21	***	228.39	***	228.39	***

Robust standard error in parenthesis, *** p<0.01, ** p<0.05, * p<0.10. Standard error adjusted for clusters. Statistics robust to heteroskedasticity.

Econometric results (1/3)

- **Geographic distance** between trading partners acts as a barrier to the integration in international production networks (*Cheng et al., 2015; Stöllinger & Stehrer, 2015)*
- Positive relationship of the **institutional distance** independently of the level of development of the country involved in GVCs, mostly in an import perspective (Kuncic, 2013; Buckley et al., 2009). Countries with bad institutions do not necessarily have to improve their quality in order to attract investors (Darby et al., 2009; Cuervo-Cazurra, 2006).
- **Cultural distance** it becomes statistically significative and negative only for developed economies both from an import and an export perspective (Lankhuizen and Groot, 2016).
- Negative effect of the **economic distance** (Linder and Heckscher-Ohlin effects), large magnitude in an export perspective.
- **Adjacent countries** trade substantially more foreign and domestic value added in intermediate inputs, while the presence of **free trade agreements** between two countries seems to have a controversial effect on GVCs participation. The negative relationship can be interpreted more as a global rather than a regional feature of production networks, thus overcoming the barriers of trade agreements. Metter most for developing countries when backward integration is considered.
- **Population** positively affect export and negatively affect import GVC-related trade flows of emerging and developed countries respectively (Kowalsky et al.,2015).

Econometric results (2/3)

Table 5. Econometric results – national transportation system variables (all countries)

	FVT flows	DVX flows
	Coef.	Coef.
dGEO	-0.000156***	-0.0001737***
	(0.000027)	(0.000034)
dWGI	0.1795923***	0.093434*
	(0.058814)	(0.050743)
dCULT	-0.0723601	-0.061927
	(0.063115)	(0.052556)
dECO	-0.0000216***	-0.000015***
	(0.000005)	(0.000003)
Border	1.307663***	0.950765***
	(0.156476)	(0.133542)
Pop origin	-0.0021123	0.005997***
	(0.001560)	(0.001433)
FTA	-1.078083***	-0.008170
	(0.226618)	(0.194515)
Land transport	1.261882*	-0.650353
	(0.717770)	(0.733107)
Maritime transport	0.7473384**	-0.516639
	(0.379604)	(0.504560)
Air transport	1.142532**	-0.518408
	(0.506525)	(0.394317)
Constant	9.347928***	7.470615***
	(0.404861)	(0.415228)
Year FE	Yes	Yes
Regional FE	Yes	Yes
Obs.	9600	9600
Country pair clusters	1600	1600
Pseudo R2	0.5134	0.6142
Log pseudolikelihood	-9516327	-7519604.7
Wald Chi2	224.38***	267.13***

Robust standard error in parenthesis, *** p<0.01, ** p<0.05, * p<0.10. Standard error adjusted for clusters. Statistics robust to heteroskedasticity.

Table 6. Econometric results - national transportation system variables (sub-samples of emerging and developed economies)

	Emerging economies		Developed economies	
	FVT flows	DVX flows	FVT flows	DVX flows
	Coef.	Coef.	Coef.	Coef.
dGEO	-0.000189***	-0.000165***	-0.000173***	-0.000239***
	(0.000052)	(0.000049)	(0.000024)	(0.000042)
dWGI	0.234068***	0.175943*	0.246467***	0.103744
	(0.074161)	(0.096061)	(0.089370)	(0.069520)
dCULT	0.031267	-0.076378	-0.169787**	-0.145552**
	(0.089584)	(0.079696)	(0.069816)	(0.061856)
dECO	-0.000002	-0.000005	-0.000044***	-0.000032***
	(0.000004)	(0.000004)	(0.000007)	(0.000006)
Border	1.455961***	0.539355**	1.188504***	1.022609***
	(0.244704)	(0.254013)	(0.161375)	(0.129491)
Pop origin	-0.005656***	0.005238***	-0.009503	0.025979*
	(0.001822)	(0.001588)	(0.017710)	(0.013892)
FTA	-0.781106***	0.363876	-1.440196***	-0.520982**
	(0.235277)	(0.262004)	(0.283803)	(0.237808)
Land transport	0.907649	1.703224*	1.390083	-3.077623***
	(0.641647)	(0.942245)	(1.074645)	(1.043836)
Maritime transport	0.676335**	0.988847	0.984758*	-2.199013***
	(0.337747)	(0.664417)	(0.567834)	(0.720141)
Air transport	1.044655**	0.719559	1.026489	-1.811492***
	(0.476011)	(0.481239)	(0.736558)	(0.580265)
Constant	9.986281***	6.352293***	10.438320***	8.229254*
	(0.810584)	(0.817823)	(0.892985)	(0.771635)
Year FE	Yes	Yes	Yes	Yes
Regional FE	Yes	Yes	Yes	Yes
Obs.	5,040	5,040	4,560	4,560
Countrypair clusters	840	840	760	760
Pseudo R2	0.5193	0.6463	0.5547	0.6398
Log pseudolikelihood	-3632905	-3641950	-4869966	-3225180
Wald Chi2	132.15***	183.55***	224.26***	299.11***

Econometric results (1/3)

- Findings provide different nuanced answer whether the national transport systems stimulate GVC-related trade volumes:
- **Whole sample:** all transportation systems are significant and positive for GVC-related to imports that embed foreign value-added re-exported in other countries. Negative but not significant effect of the quality of all infrastructures on GVC-related to export of domestic value-added that are re-exported in other countries' exports. (Francois and Manchin, 2013).
- Different level of development:
  - **Emerging countries:** The quality of maritime and air transportation system seems to be related more with the backward integration, while the quality of the inland transportation system shows a positive and significative coefficient for the forward production integration.
  - **Developed countries:** only the quality of the maritime transportation system shows a positive and significative coefficient from the demand side, while we found a reversed effect for all the transportation modes that show highly significative but negative coefficients from the supply side of value chains (domestic value-added flows).

Econometric results (3/3)

Table 7. Econometric results of the effect of the national transportation system in moderating the geographic distance (all, emerging and developed economies)

	All economies		Emerging economies		Developed economies	
	FVT flows	**DVX flows**	**FVT flows**	**DVX flows**	**FVT flows**	**DVX flows**
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
[results are shortened]						
dGEO x Land	0.0009 *	0.0005	0.0009 *	0.0008 *	0.0005	0.0002
	(0.0006)	(0.0005)	(0.0005)	(0.0004)	(0.0006)	(0.0006)
dGEO x Maritime	0.0007 *	0.0004	0.0007 *	0.0006	0.0004	0.0001
	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0005)
dGEO x Air	0.0005 *	0.0002	0.0005 *	0.0004	0.0003	0.0001
	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Obs.	9600	9600	5,040	5,040	4560	4560
Country pair clusters	1600	1600	840	840	760	760
Pseudo R2	0.5176	0.6151	0.5239	0.6499	0.5561	0.6403
Log pseudolikelihood	-9435499	-7501197.4	-3597924	-3604808	-4854880	-3221278
Wald Chi2	251.85***	288.96***	156.4***	191.11***	249.28***	341.68***

Robust standard error in parenthesis, *** p<0.01, ** p<0.05, * p<0.10. Standard error adjusted for clusters. Statistics robust to heteroskedasticity.

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Econometric results (1/3)

- **The ability of the transportation systems to reduce the cost of distances for emerging economies:**

  - **The national inland transportation system** (the quality of road and rail network) reduces the negative effect of the geographical distance for both backward and forward integration and increases GVCs trade flows.

  - **The quality of maritime and air transport** (infrastructure nodes) are found to be significant when the emerging countries are involved mainly in the backward production integration

Conclusions

- Confirm that the participation on GVCs is exposed to gravity.
- Also the quality of national transportation systems is determinant of the ability of countries to participate in GVC networks.
- For the emerging economies, the quality and efficiency of the transportation system is capable to reduce the “remoteness” and bring them closer to country partners by reducing the physical distance and decreasing costs of trade.
- Speeding up the pace of integration within the global trading system will depend also by improving the quantity and efficiency of support transport infrastructures.
- Investments in transport infrastructures are required to overcome the obstacle of the national transportation system as a limitation for involvement in GVCs of emerging economies.

Thank you for your attention

Any question?