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NEREUS
Núcleo de Economia Regional e Urbana da Universidade de São Paulo
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Geographical Proximity and Technological Similarity

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Background

Estimation of regional (subnational) input-output systems

Practical matter: how to generate input-output estimates for countries where no previous information is available?

MINERVA Project: neighboring countries similarities (is Iraq similar to Kuwait and Saudi Arabia?)

Last resource approach: countries' overall structural (sectoral mix) similarities (is Peru similar to Mozambique?)

Average structure of neighbors: does it make any sense?

Ex-post rationale

Roadmap

Working hypothesis: spatial spillovers generate more similar economic structures across countries

Empirical approach: comparative analysis of input-output technology matrices using spatial analysis techniques

Data: national tables extracted from the OECD IRIO database, which provides for each of the 66 countries in the sample a reconciled common sectoral classification

Results: (i) closer economies tend to be more similar than distant ones; (ii) over time, closer economies are becoming structurally more similar

Issues

Can we identify proximity dimensions associated with countries' technological similarity?

Can we observe a pattern of technological convergence over time?

Does geographical proximity matter for the technological similarity between countries?

Do the patterns of holistic similarity prevail at the sector level?

Can we find evidence of localized spillovers at the sector level?

Is there any theoretical and empirical support?

There are at least **three hierarchical dimensions** for which space matters for knowledge spillovers and, consequently, potential technological convergence

How does geographical proximity between **individuals** influence interactive learning and innovation? (Boschma, 2005)

Knowledge spillovers also benefit from the geographical proximity of firms and workers at the **local** level (Caragliu and Nijkamp, 2016)

At the **country** level, technology transfer is also critical to technological convergence (UNCTAD, 2014)

General framework

Consider there are R countries, r = 1, ..., R, which exhaust the space of the world economy

There are C firms, c = 1, ..., C, allocated to J sectors, j = 1, ..., J

Firms are spatially distributed in the R countries and are characterized by a production set Y^c contained in the sectoral production set Y^j they belong

In each country r, the number of firms is given by $C_{(j)}^{(r)}$, so that $0 \leq C_{(j)}^{(r)} \ll C$ and $\sum_{j=1}^{J} \sum_{r=1}^{R} C_{(j)}^{(r)} = C$

Let $\mathbf{A^r} = \left(a_{ij}^{r}\right)$ be an nxn matrix of direct input coefficients for a country economy r, reflecting the sectoral-level technology obtained from the aggregation of firm-level production decisions on the use of inputs

General framework (cont.)

To compare the economic structures of two different countries, r and s, we define the coefficient of technological association, CTA_{rs}

Using a general metric to compute the holistic dissimilarity between two distributions (Isard, 1960), we transform the $\mathbf{A^r}$ and $\mathbf{A^s}$ matrices, normalizing the values of their coefficients to their respective total values, such that

$\widetilde{\mathbf{A}}^{\mathbf{r}} = \left(\tilde{a}_{ij}^{r} = \frac{a_{ij}^{r}}{\sum_{ij} a_{ij}^{r}}\right)$ and $\widetilde{\mathbf{A}}^{\mathbf{s}} = \left(\tilde{a}_{ij}^{s} = \frac{a_{ij}^{s}}{\sum_{ij} a_{ij}^{s}}\right)$ so that $\sum_{ij} \tilde{a}_{ij}^{r} = 1$ and $\sum_{ij} \tilde{a}_{ij}^{s} = 1$

General framework (cont.)

$$CTA_{rs} = \frac{\sum_{i=1}^{J}\sum_{j=1}^{J}\left|\tilde{a}_{ij}^{r} - \tilde{a}_{ij}^{s}\right|}{2}$$

Thus, if countries r and s share the same technology, i.e., input coefficients are distributed exactly the same way, the value for the CTA_{rs} will be 0

In contrast, the more distinct the distributions, its value will approach unity

We first use the CTA_{rs} to compare, pairwise, the economic structures of a subset of countries, $\bar{R}$, for which we know the respective $\mathbf{A^r}$s, for $r = 1, \ldots, \bar{R}$, and $\bar{R} \subset R$

General framework (cont.)

We then use **regression analysis** to understand some of the country-level determinants of technological (dis)similarities, focusing on different dimensions of proximity

We regress our estimates for the CTA_{rs} within our sample on a set of variables aimed to capture geographical and institutional proximity between each pair of countries (X_{rs}), and country-specific structural characteristics ($Y_{r,}\, Z_s$)

We estimate the following general model:

$CTA_{rs} = f\left(X_{rs}, Y_{r,} Z_s\right)$ for $r \neq s = 1, \ldots, \bar{R}$, and $\bar{R} \subset R$

General framework (cont.)

We are particularly interested in the results for geographical proximity, which will inform on the specification of the spatial weights matrix, **W**

We can then move to the next step, which is the calculation of the **spatial lag** of each country's $\widetilde{\mathbf{A}}^{\mathbf{r}}$, $\boldsymbol{W}^{\mathbf{r}}\widetilde{\mathbf{A}}^{\mathbf{r}}$, and compare a country's economic structure, given by its technical coefficients matrix, with that of its neighboring countries by calculating the CTA_{rs}, where s represents a set of nearby countries, so that

$$CTA_{rs} = \frac{\sum_{i=1}^{J}\sum_{j=1}^{J}\left|\tilde{a}_{ij}^{r} - w_{rs}\tilde{a}_{ij}^{s}\right|}{2}$$

with $s \in \bar{S}$ and $\bar{S} \subseteq \bar{R}$ is the subset of country r's neighboring countries

General framework (cont.)

We rely on a computational approach based on **permutation inference procedures** to determine whether a country's economic structure is more similar to its neighbor's

We build a reference distribution of the value for the CTA_{rs} under the null hypothesis of spatial randomness so that a pseudo-p-value can be calculated (Anselin, 1995)

Sectoral technology

We also compare the elements of a column vector of the $\mathbf{A^r}$ matrix for the different countries in the sample

For each sector j, we define column-standardized vectors, $\breve{\boldsymbol{A}}_{\boldsymbol{j}}^{\boldsymbol{r}}$, such that:

$\breve{\boldsymbol{A}}_{\boldsymbol{j}}^{\boldsymbol{r}} = \left(\breve{a}_{ij}^{r} = \frac{a_{ij}^{r}}{\sum_i a_{ij}^{r}}\right)$ and $\breve{\boldsymbol{A}}_{\boldsymbol{j}}^{\boldsymbol{s}} = \left(\breve{a}_{ij}^{s} = \frac{a_{ij}^{s}}{\sum_i a_{ij}^{s}}\right)$ so that $\sum_i \breve{a}_{ij}^{r} = 1$ and $\sum_i \breve{a}_{ij}^{s} = 1$, $\forall$ j = 1, ..., J

We can then assess similarities and dissimilarities between countries *r* and *s* in their sectoral mix of inputs using the coefficient of technological association calculated for a given sector *j*:

$$CTA_{rs}^{j} = \frac{\sum_{i=1}^{J} \left|\breve{a}_{ij}^{r} - \breve{a}_{ij}^{s}\right|}{2}$$

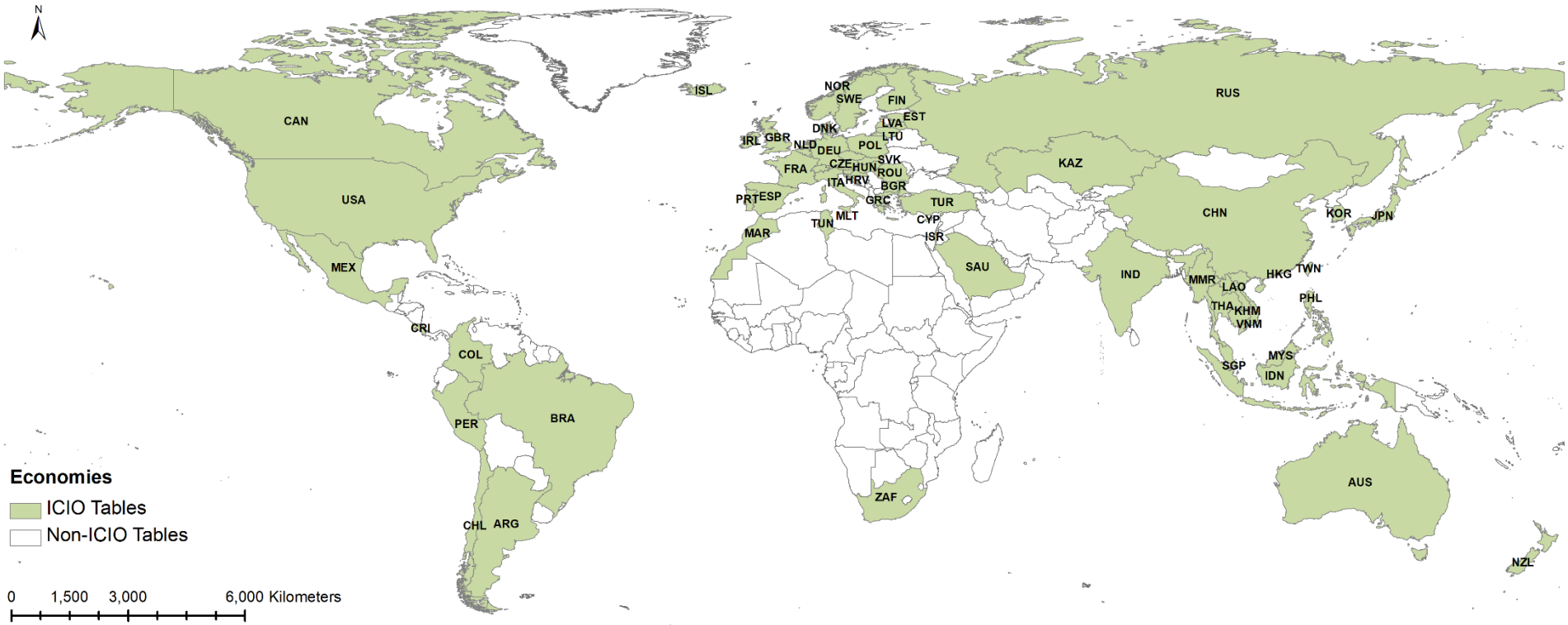
Data

We use information from the 2021 edition of OECD Inter-Country Input-Output (ICIO) tables which consolidates a common classification of **45 sectors** based on ISIC Revision 4

Tables are provided for **66 countries** for the years **1995 to 2018**

For each country and each year, we build a time series of $\mathbf{A}^{\mathbf{r}}$ matrices that provide the direct coefficient inputs consolidated across all different geographical sources, i.e. for each sector it provides the **technical recipe of inputs mix irrespective of the origin of the inputs**

Geographical coverage



1. Can we identify proximity dimensions associated with countries' technological similarity?

Table 1. Descriptive statistics for the Coefficient of Technological Association (CTA): 1995-2018

Variable	Mean	Std. Dev.	Min	Max
cta	0.4241	0.0764	0.2319	0.7488
ln_go_ecn_r	12.5975	1.7838	7.9924	17.3962
ln_go_ecn_s	12.9070	1.7428	7.9924	17.3962
ln_distance_km	8.5263	0.9661	4.9438	9.8922
contiguity	0.0359	0.1860	0.0000	1.0000
language	0.1268	0.3328	0.0000	1.0000
oecd	0.3277	0.4694	0.0000	1.0000

Note: *cta*: coefficient of technological association between countries r and s; *ln_go_ecn_r*: log of the gross output of country r; *ln_go_ecn_s*: log of the gross output of country s; *ln_distance_km*: log of the distance between countries r and s, in km; *contiguity*: dummy of contiguity between countries r and s (1 if contiguous, 0 otherwise); *language*: dummy of common language between r and s (1 if countries r and s share a common official language, 0 otherwise); *oecd*: dummy for membership at OECD (1 if countries r and s are OECD members, 0 otherwise).

1. Can we identify proximity dimensions associated with countries' technological similarity?

Table 2. Determinants of technological similarity: 1995-2018

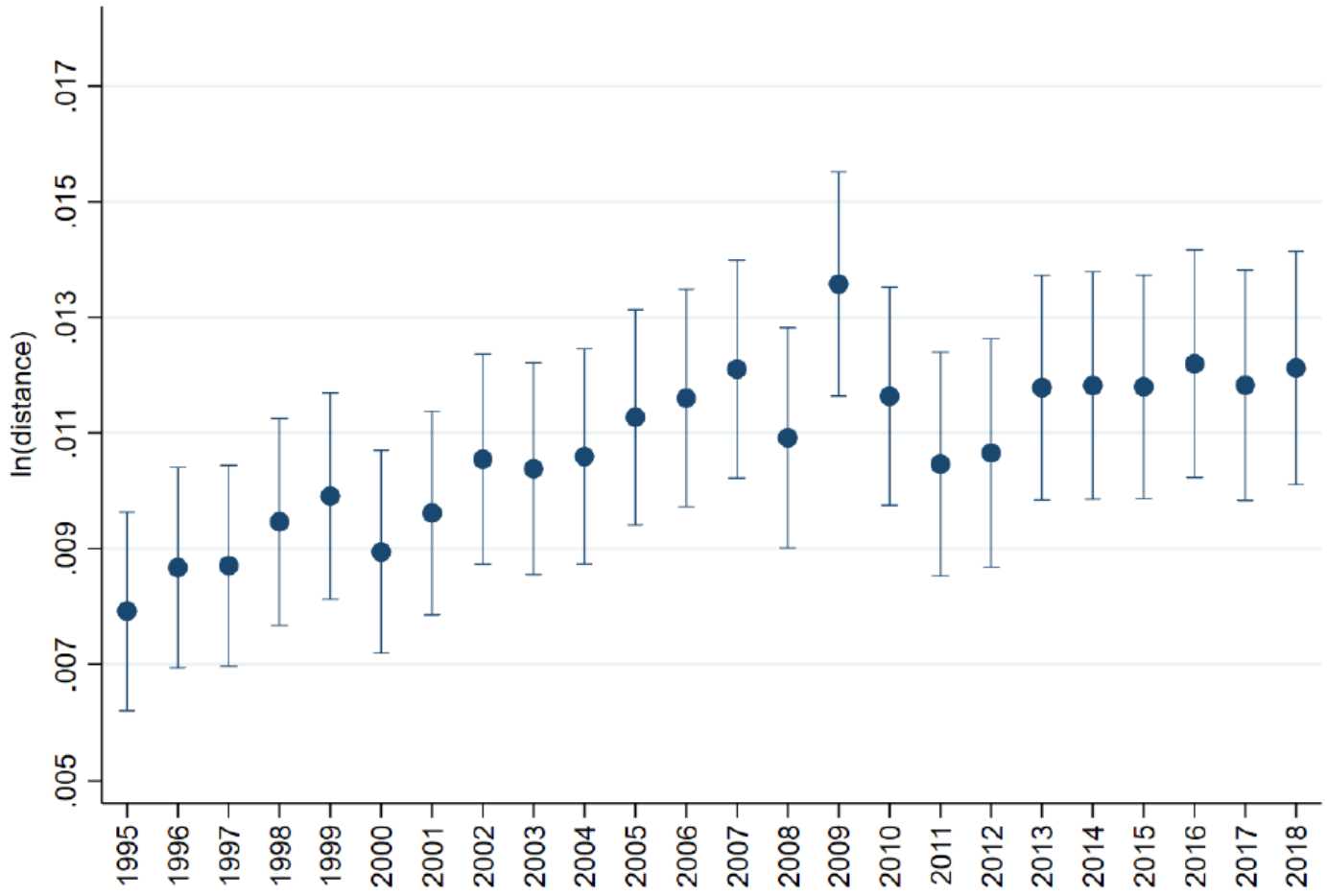
Dependent variable: Coefficient of Technological Association (cta)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
ln_go_ecn_r	−0.0117***	−0.0126***	−0.0145***	−0.0109***	−0.0105***	−0.0125***	−0.0157***	−0.0157***	−0.0148***	−0.0151***	−0.0151***	−0.0149***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0009)	(0.0008)	(0.0008)
ln_go_ecn_s	−0.0161***	−0.0161***	−0.0156***	−0.0160***	−0.0167***	−0.0149***	−0.0153***	−0.0152***	−0.0154***	−0.0170***	−0.0172***	−0.0185***
	(0.0009)	(0.0009)	(0.0008)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0010)	(0.0009)
ln_distance_km	0.0079***	0.0087***	0.0087***	0.0095***	0.0099***	0.0089***	0.0096***	0.0105***	0.0104***	0.0106***	0.0113***	0.0116***
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0010)
contiguity	−0.0129***	−0.0113***	−0.0112***	−0.0116***	−0.0111***	−0.0120***	−0.0110***	−0.0100***	−0.0108***	−0.0102***	−0.0100***	−0.0093***
	(0.0032)	(0.0032)	(0.0033)	(0.0033)	(0.0032)	(0.0033)	(0.0033)	(0.0033)	(0.0033)	(0.0033)	(0.0032)	(0.0033)
language	−0.0043**	−0.0045**	−0.0047**	−0.0039**	−0.0042**	−0.0034*	−0.0033*	−0.0035*	−0.0041**	−0.0044**	−0.0044**	−0.0042**
	(0.0018)	(0.0018)	(0.0018)	(0.0019)	(0.0019)	(0.0018)	(0.0018)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)
oecd	−0.1227***	−0.1244***	−0.1238***	−0.1292***	−0.1373***	−0.1412***	−0.1314***	−0.1329***	−0.1448***	−0.1486***	−0.1490***	−0.1370***
	(0.0038)	(0.0040)	(0.0039)	(0.0040)	(0.0040)	(0.0038)	(0.0039)	(0.0039)	(0.0039)	(0.0041)	(0.0040)	(0.0041)
constant	0.7997***	0.7952***	0.8161***	0.7799***	0.7871***	0.7949***	0.8282***	0.8222***	0.8242***	0.8500***	0.8467***	0.8539***
	(0.0188)	(0.0193)	(0.0174)	(0.0180)	(0.0182)	(0.0191)	(0.0188)	(0.0197)	(0.0192)	(0.0194)	(0.0202)	(0.0197)
Dummy *r*	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dummy *s*	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2.145	2.145	2.145	2.145	2.145	2.145	2.145	2.145	2.145	2.145	2.145	2.145
R-squared	0.9169	0.9165	0.9190	0.9226	0.9230	0.9240	0.9239	0.9204	0.9203	0.9217	0.9216	0.9147

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

1. Can we identify proximity dimensions associated with countries' technological similarity?

Figure 2. Effect of distance on technological similarity: 1995-2018



Dependent variable: Coefficient of Technological Association (CTA)

2. Can we observe a pattern of technological convergence over time?

We regress the average growth rate of the CTA_{rs} on the value of the CTA_{rs} at the first year of the period considered.

We first estimate a model for the whole period (1995-2018); we then define moving 10-year periods to verify the dynamics of the estimated β-coefficient.

$$log\left(\frac{CTA_{rs,t}}{CTA_{rs,t-1}}-1\right)=\alpha_{rs}-\beta\log\left(CTA_{rs,t-1}\right)+\delta_{rs}+\mu_r+\varphi_s+u_{rs,t}$$

where t is the time period, $=1,2,\ldots,T$; α_{rs} is the constant term; δ_{rs} measures the distance between r and s; μ_r and φ_s are country dummies; and $u_{rs,t}$ is the error term

2. Can we observe a pattern of technological convergence over time?

Table 3. β-convergence estimates, by period

Dependent variable: Coefficient of Technological Association (CTA) growth rate

	(1) 1995/2018	(2) 1995/2005	(3) 1996/2006	(4) 1997/2007	(5) 1998/2008	(6) 1999/2009	(7) 2000/2010	(8) 2001/2011	(9) 2002/2012	(10) 2003/2013	(11) 2004/2014	(12) 2005/2015	(13) 2006/2016	(14) 2007/2017	(15) 2008/2018
cta1995	−0.0466***	−0.0537***													
	(0.0024)	(0.0042)													
cta1996			−0.0547***												
			(0.0043)												
cta1997				−0.0593***											
				(0.0046)											
cta1998					−0.0730***										
					(0.0055)										
cta1999						−0.0623***									
						(0.0048)									
cta2000							−0.0636***								
							(0.0048)								
cta2001								−0.0642***							
								(0.0052)							
cta2002									−0.0700***						
									(0.0049)						
cta2003										−0.0676***					
										(0.0047)					
cta2004											−0.0685***				
											(0.0049)				
cta2005												−0.0667***			
												(0.0049)			
cta2006													−0.0681***		
													(0.0048)		
cta2007														−0.0634***	
														(0.0048)	
cta2008															−0.0626***
															(0.0046)
ln_distance_km	0.0009***	0.0015***	0.0015***	0.0016***	0.0013***	0.0016***	0.0014***	0.0010***	0.0011***	0.0012***	0.0011***	0.0010***	0.0010***	0.0008***	0.0010***
	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Constant	0.0052***	−0.0006	0.0032**	0.0047***	0.0116***	0.0054***	0.0047**	0.0085***	0.0080***	0.0105***	0.0106***	0.0070***	0.0111***	0.0104***	0.0085**
	(0.0019)	(0.0015)	(0.0015)	(0.0016)	(0.0018)	(0.0017)	(0.0020)	(0.0029)	(0.0026)	(0.0029)	(0.0023)	(0.0021)	(0.0033)	(0.0031)	(0.0042)
Dummy *r*	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Dummy *s*	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145
R-squared	0.7632	0.7746	0.7602	0.7645	0.7744	0.7299	0.7246	0.7219	0.7324	0.7600	0.7589	0.7604	0.7608	0.7833	0.7487

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

3. Does geographical proximity matter for the technological similarity between countries?

We test whether nearby countries are more technologically similar than distant ones

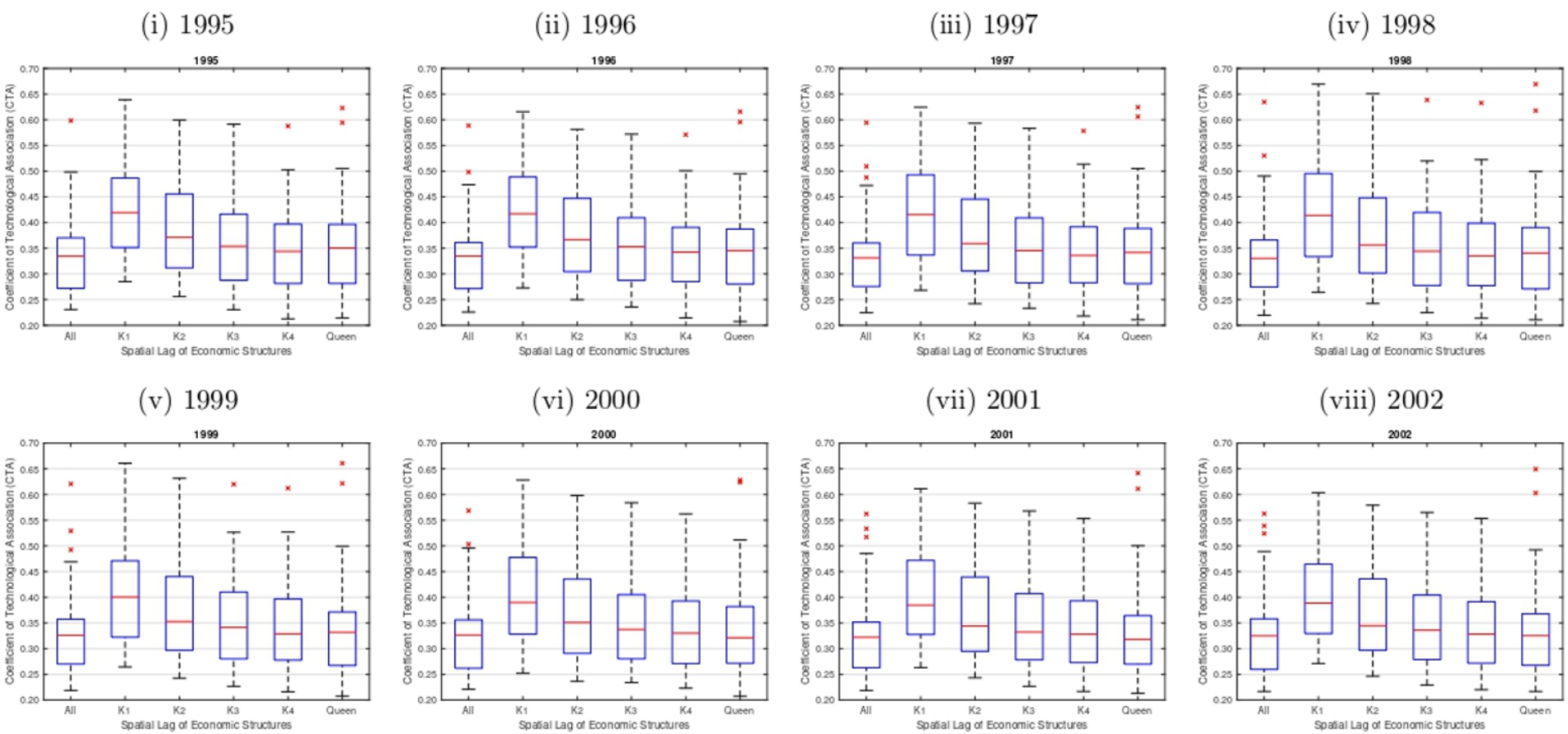
For different spatial weights matrices, $\mathbf{W}$, we calculate

$$CTA_{rs} = \frac{\sum_{i=1}^{J}\sum_{j=1}^{J}\left|\tilde{a}_{ij}^{r} - w_{rs}\tilde{a}_{ij}^{s}\right|}{2}$$

We then proceed with the conditional permutations to yield the empirical reference distributions that provide the basis for inference (for a given $\mathbf{W}$, we compare the "true" value with the randomly permuted values)

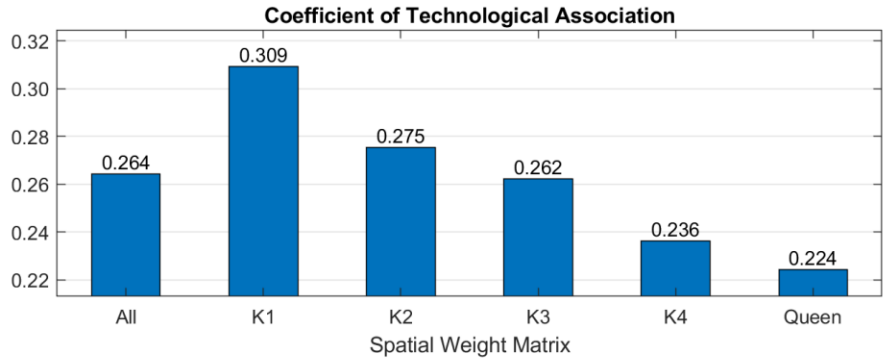
3. Does geographical proximity matter for the technological similarity between countries?

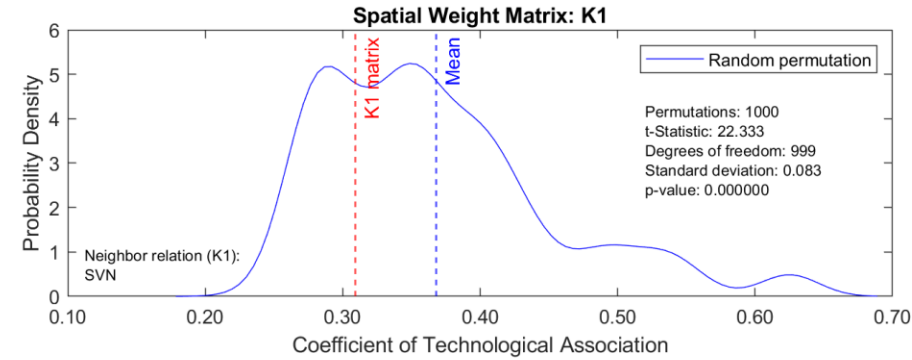
Figure 3. Distributions of the CTA_{rs} based on different neighborhood criteria for the calculation of the spatial lag of $\tilde{A}^r$

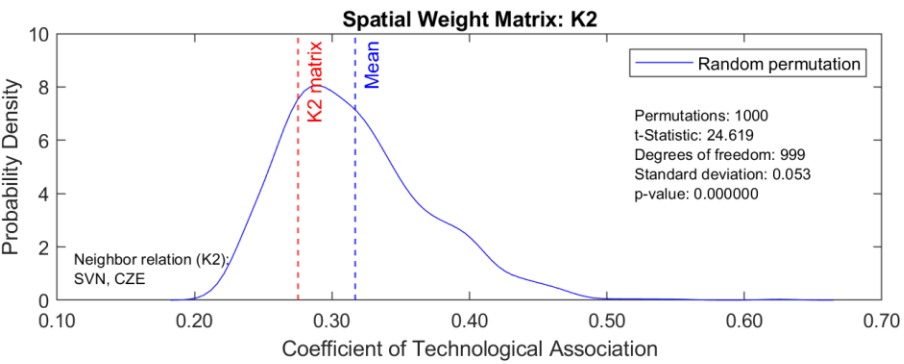


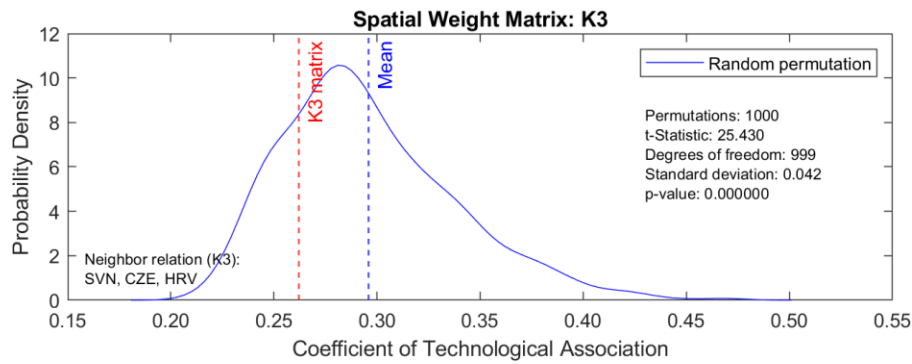
3. Does geographical proximity matter for the technological similarity between countries?

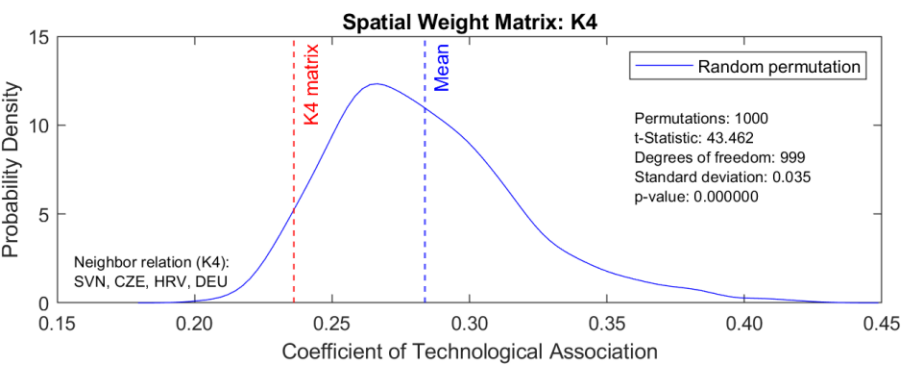
Austria

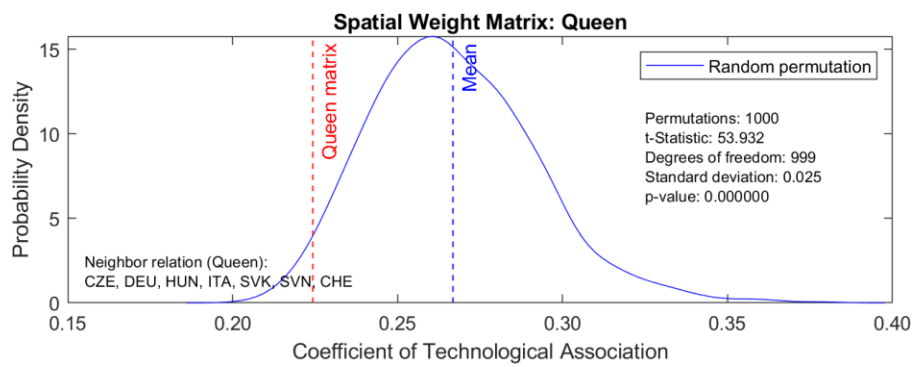












3. Does geographical proximity matter for the technological similarity between countries?

Table 4. Typology of countries based on the nature of the dominant geographical technological spillovers

Type of Geographical Technological Spillovers	*Countries*
1. Localized, contiguity-based (11)	**Austria**, **Belgium**, **France**, **Germany**, **Italy**, **Lithuania**, **Slovak Republic**, **Spain**, **Switzerland**, Myanmar, **Russian Federation**
2. Localized, distance-based (30)	Brunei Darussalam, **Bulgaria**, Cambodia, Chile, Colombia, **Croatia**, **Cyprus***, **Czech Republic**, **Denmark**, **Estonia**, **Finland**, **Iceland***, India, **Ireland**, **Latvia**, Kazakhstan, Lao People's Democratic Republic, **Luxembourg**, Mexico, **Netherlands**, **Norway**, Philippines*, **Poland**, **Portugal**, **Romania**, Saudi Arabia*, **Slovenia**, **Sweden**, USA, **UK**
3. Global (13)	Argentina, Brazil, Canada, China, **Greece**, **Hungary**, Hong Kong, Indonesia, Malaysia, Peru, Thailand, Turkey, Vietnam
4. "Islands", global (12)	Australia, Costa Rica, Israel, Japan, Korea, **Malta**, Morocco, New Zealand, Singapore, South Africa, Taiwan, Tunisia

4. Do the patterns of holistic similarity prevail at the sector level?

A final set of issues in this exploratory study refers to sectoral-level technologies, whose definition, in our context, is based on the column-standardized vectors of the technical coefficient matrix, $\breve{\boldsymbol{A}}_j^r$

We estimate yearly models for each sector

$CTA_{rs}^j = f\left(X_{rs}, Y_{r,} Z_s\right)$ for $j = 1, \ldots, J$; $r \neq s = 1, \ldots, \bar{R}$, and $\bar{R} \subset R$

where X_{rs} captures geographical (distance and contiguity) and institutional (language) proximity between each pair of countries, and Y_r and Z_s capture country-specific structural characteristics (country dummies)

4. Do the patterns of holistic similarity prevail at the sector level?

Table 5. Determinants of sectoral technological similarity: 2018

Dependent variable: Coefficient of Technological Association (CTA)

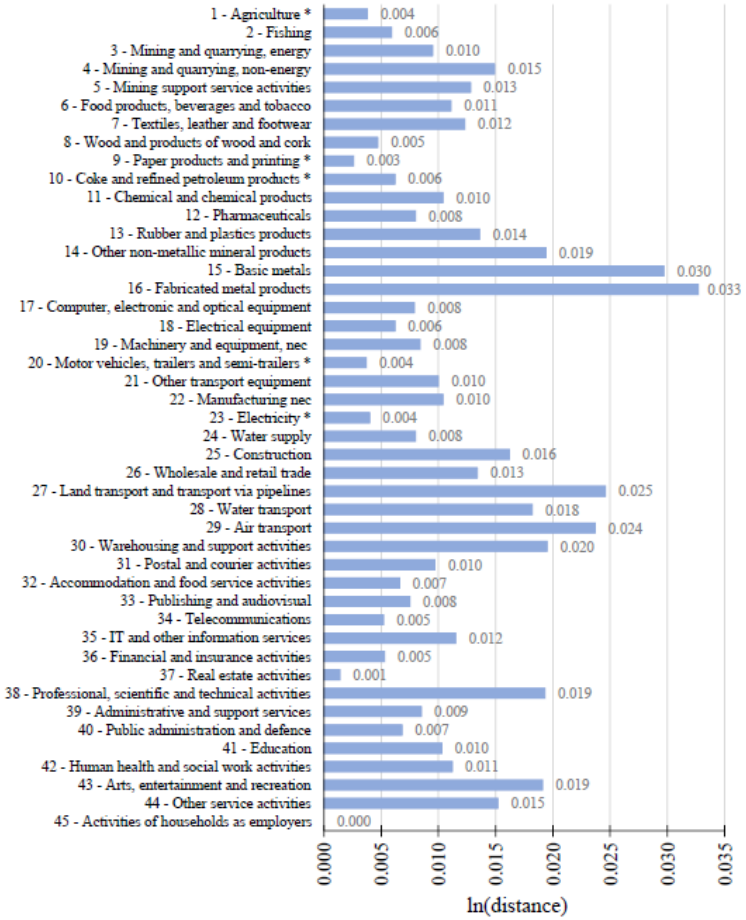
	ln_go_ecn_r		ln_go_ecn_s		ln_distance_km		contiguity		language		oecd		constant		Dummy	Dummy	Observa–t	R–square
	Coeff.	Stand. Err.	Coeff.	Stand. Err.	Coeff.	Stand. Err.	Coeff.	Stand. Err.	Coeff.	Stand. Err.	Coeff.	Stand. Err.	Coeff.	Stand. Err.	*r*	*s*	ions	d
(1) Agriculture	−0.0150***	(0.0016)	−0.0135***	(0.0046)	0.0038	(0.0024)	−0.0190**	(0.0084)	−0.0089*	(0.0051)	−0.1855***	(0.0109)	0.7337***	(0.0678)	YES	YES	2,145	0.7593
(2) Fishing	−0.0165***	(0.0016)	−0.0104***	(0.0030)	0.0059*	(0.0035)	−0.0279*	(0.0144)	−0.0002	(0.0069)	−0.1358***	(0.0345)	0.7839***	(0.0458)	YES	YES	2,080	0.6713
(3) Mining and quarrying, energy	0.0021	(0.0015)	−0.0118***	(0.0027)	0.0095***	(0.0034)	−0.0053	(0.0111)	−0.0097	(0.0073)	0.1078***	(0.0111)	0.6041***	(0.0397)	YES	YES	1,770	0.5786
(4) Mining and quarrying, non–energy	0.0025*	(0.0014)	−0.0087***	(0.0022)	0.0149***	(0.0027)	−0.0031	(0.0095)	0.0027	(0.0051)	−0.0999***	(0.0262)	0.3598***	(0.0340)	YES	YES	2,016	0.7208
(5) Mining support service activities	0.0253***	(0.0017)	0.0028	(0.0023)	0.0128***	(0.0031)	0.0113	(0.0105)	−0.0022	(0.0060)	−0.0084	(0.0109)	0.1680***	(0.0287)	YES	YES	2,080	0.8122
(6) Food products, beverages and tobacco	−0.0134***	(0.0014)	−0.0400***	(0.0026)	0.0111***	(0.0026)	−0.0165	(0.0101)	−0.0031	(0.0054)	−0.0880***	(0.0092)	0.7540***	(0.0410)	YES	YES	2,145	0.7356
(7) Textiles, leather and footwear	0.0081***	(0.0017)	−0.0165***	(0.0034)	0.0123***	(0.0026)	−0.0151	(0.0104)	−0.0202***	(0.0054)	−0.1503***	(0.0118)	0.4608***	(0.0344)	YES	YES	2,145	0.6960
(8) Wood and products of wood and cork	−0.0326***	(0.0013)	−0.0302***	(0.0027)	0.0047**	(0.0024)	−0.0082	(0.0088)	−0.0121**	(0.0055)	−0.2154***	(0.0103)	1.0601***	(0.0357)	YES	YES	2,145	0.7752
(9) Paper products and printing	−0.0360***	(0.0013)	−0.0374***	(0.0026)	0.0026	(0.0022)	−0.0054	(0.0080)	−0.0078*	(0.0044)	−0.2346***	(0.0106)	1.2752***	(0.0357)	YES	YES	2,145	0.8431
(10) Coke and refined petroleum products	−0.0263***	(0.0029)	−0.0484***	(0.0137)	0.0062	(0.0053)	−0.0059	(0.0167)	0.0019	(0.0106)	−0.1389***	(0.0275)	0.9996***	(0.0670)	YES	YES	2,080	0.6599
(11) Chemical and chemical products	−0.0094***	(0.0012)	−0.0233***	(0.0035)	0.0104***	(0.0024)	0.0042	(0.0077)	−0.0043	(0.0045)	−0.0262*	(0.0136)	0.5909***	(0.0384)	YES	YES	2,145	0.8639
(12) Pharmaceuticals	−0.0241***	(0.0012)	−0.0488***	(0.0027)	0.0080***	(0.0026)	−0.0049	(0.0092)	−0.0055	(0.0059)	−0.3197***	(0.0112)	1.0688***	(0.0304)	YES	YES	2,145	0.7866
(13) Rubber and plastics products	−0.0237***	(0.0013)	−0.0257***	(0.0026)	0.0136***	(0.0024)	−0.0035	(0.0086)	−0.0062	(0.0048)	−0.2332***	(0.0089)	0.8828***	(0.0353)	YES	YES	2,080	0.7706
(14) Other non–metallic mineral products	−0.0157***	(0.0014)	−0.0146***	(0.0022)	0.0194***	(0.0025)	0.0043	(0.0079)	−0.0010	(0.0047)	−0.1302***	(0.0103)	0.5701***	(0.0379)	YES	YES	2,145	0.7500
(15) Basic metals	−0.0195***	(0.0014)	−0.0321***	(0.0056)	0.0297***	(0.0049)	0.0148	(0.0110)	0.0004	(0.0081)	0.0392	(0.0260)	0.5888***	(0.0655)	YES	YES	2,145	0.7121
(16) Fabricated metal products	−0.0027**	(0.0011)	−0.0089***	(0.0018)	0.0327***	(0.0026)	0.0047	(0.0084)	0.0083**	(0.0040)	−0.0367***	(0.0082)	0.1290***	(0.0329)	YES	YES	2,145	0.7245
(17) Computer, electronic and optical equipment	−0.0316***	(0.0014)	−0.0320***	(0.0064)	0.0079***	(0.0028)	−0.0042	(0.0109)	−0.0055	(0.0055)	−0.3289***	(0.0106)	1.0595***	(0.0412)	YES	YES	2,145	0.7529
(18) Electrical equipment	−0.0245***	(0.0011)	−0.0124***	(0.0025)	0.0062***	(0.0023)	−0.0050	(0.0071)	−0.0098*	(0.0050)	−0.1896***	(0.0083)	0.7621***	(0.0373)	YES	YES	2,145	0.7843
(19) Machinery and equipment, nec	−0.0076***	(0.0010)	−0.0187***	(0.0023)	0.0084***	(0.0022)	−0.0074	(0.0077)	−0.0081*	(0.0044)	−0.0663***	(0.0090)	0.4442***	(0.0302)	YES	YES	2,145	0.8073
(20) Motor vehicles, trailers and semi–trailers	−0.0113***	(0.0017)	−0.0107***	(0.0027)	0.0037	(0.0031)	−0.0297***	(0.0109)	−0.0010	(0.0063)	0.0166	(0.0135)	0.5631***	(0.0453)	YES	YES	2,016	0.6567
(21) Other transport equipment	0.0013	(0.0010)	−0.0193***	(0.0068)	0.0100***	(0.0030)	−0.0035	(0.0092)	−0.0056	(0.0063)	−0.0323**	(0.0129)	0.3563***	(0.0320)	YES	YES	2,145	0.6177
(22) Manufacturing nec	−0.0218***	(0.0012)	−0.0040	(0.0039)	0.0104***	(0.0022)	−0.0146	(0.0090)	−0.0088*	(0.0045)	−0.2150***	(0.0086)	0.8424***	(0.0330)	YES	YES	2,145	0.8374
(23) Electricity	−0.0303***	(0.0022)	0.0062	(0.0041)	0.0040	(0.0042)	−0.0174	(0.0138)	0.0040	(0.0085)	−0.2209***	(0.0151)	0.6985***	(0.0634)	YES	YES	2,145	0.5323
(24) Water supply	−0.0174***	(0.0017)	−0.0133***	(0.0042)	0.0080***	(0.0030)	−0.0322***	(0.0100)	−0.0096	(0.0065)	−0.0205*	(0.0109)	0.7212***	(0.0584)	YES	YES	2,145	0.6211
(25) Construction	−0.0127***	(0.0018)	−0.0041	(0.0042)	0.0162***	(0.0038)	−0.0106	(0.0122)	0.0012	(0.0078)	−0.3977***	(0.0147)	0.5330***	(0.0530)	YES	YES	2,145	0.5325
(26) Wholesale and retail trade	−0.0216***	(0.0016)	−0.0029	(0.0037)	0.0134***	(0.0023)	−0.0128*	(0.0071)	−0.0105**	(0.0046)	−0.2094***	(0.0078)	0.7086***	(0.0561)	YES	YES	2,145	0.8174
(27) Land transport and transport via pipelines	−0.0070***	(0.0014)	−0.0072	(0.0046)	0.0246***	(0.0031)	0.0090	(0.0099)	−0.0090	(0.0059)	−0.1897***	(0.0101)	0.4992***	(0.0611)	YES	YES	2,145	0.6365
(28) Water transport	0.0149***	(0.0023)	0.0083*	(0.0045)	0.0182***	(0.0041)	0.0089	(0.0141)	−0.0050	(0.0078)	0.1343***	(0.0153)	0.0674	(0.0471)	YES	YES	2,145	0.5536
(29) Air transport	−0.0210***	(0.0026)	−0.0097	(0.0069)	0.0237***	(0.0030)	0.0114	(0.0111)	0.0033	(0.0061)	−0.0767***	(0.0115)	0.6003***	(0.0768)	YES	YES	2,145	0.6562
(30) Warehousing and support activities	−0.0255***	(0.0020)	−0.0401***	(0.0060)	0.0195***	(0.0031)	0.0018	(0.0103)	−0.0016	(0.0066)	−0.2494***	(0.0117)	1.0773***	(0.0673)	YES	YES	2,145	0.7089
(31) Postal and courier activities	−0.0426***	(0.0013)	−0.0055*	(0.0033)	0.0097***	(0.0033)	−0.0185	(0.0143)	0.0002	(0.0074)	0.0714***	(0.0134)	0.9341***	(0.0399)	YES	YES	2,145	0.5636
(32) Accommodation and food service activities	0.0028	(0.0017)	0.0220***	(0.0029)	0.0066**	(0.0027)	−0.0208*	(0.0110)	−0.0194***	(0.0059)	−0.1667***	(0.0083)	0.1501***	(0.0418)	YES	YES	2,145	0.7717
(33) Publishing and audiovisual	−0.0177***	(0.0016)	−0.0263***	(0.0035)	0.0075***	(0.0024)	−0.0101	(0.0094)	−0.0081	(0.0053)	−0.2465***	(0.0078)	0.9823***	(0.0512)	YES	YES	2,145	0.7732
(34) Telecommunications	−0.0227***	(0.0020)	−0.0139***	(0.0021)	0.0052*	(0.0027)	−0.0252**	(0.0101)	−0.0067	(0.0060)	−0.1562***	(0.0085)	0.7632***	(0.0375)	YES	YES	2,145	0.6487
(35) IT and other information services	−0.0175***	(0.0012)	−0.0181***	(0.0035)	0.0115***	(0.0031)	−0.0329***	(0.0125)	−0.0029	(0.0068)	−0.0950***	(0.0104)	0.7548***	(0.0445)	YES	YES	2,145	0.7025
(36) Financial and insurance activities	−0.0047**	(0.0020)	−0.0204***	(0.0022)	0.0053*	(0.0029)	−0.0095	(0.0085)	−0.0029	(0.0054)	−0.1799***	(0.0119)	0.7300***	(0.0407)	YES	YES	2,145	0.7315
(37) Real estate activities	−0.0071***	(0.0023)	−0.0088***	(0.0033)	0.0014	(0.0034)	−0.0215*	(0.0131)	−0.0018	(0.0063)	0.0369**	(0.0148)	0.5818***	(0.0622)	YES	YES	2,145	0.6096
(38) Professional, scientific and technical activities	−0.0024*	(0.0014)	−0.0111***	(0.0024)	0.0193***	(0.0027)	−0.0057	(0.0088)	−0.0107**	(0.0050)	−0.2808***	(0.0097)	0.4852***	(0.0404)	YES	YES	2,145	0.7790
(39) Administrative and support services	−0.0078***	(0.0012)	−0.0083***	(0.0029)	0.0085***	(0.0022)	−0.0153**	(0.0074)	−0.0131***	(0.0048)	−0.1840***	(0.0085)	0.5681***	(0.0460)	YES	YES	2,145	0.7619
(40) Public administration and defence	−0.0073***	(0.0012)	−0.0186***	(0.0016)	0.0068***	(0.0022)	−0.0132	(0.0088)	−0.0144***	(0.0044)	−0.2118***	(0.0077)	0.7672***	(0.0312)	YES	YES	2,145	0.7387
(41) Education	−0.0198***	(0.0011)	−0.0025**	(0.0013)	0.0103***	(0.0022)	−0.0177**	(0.0081)	−0.0052	(0.0047)	−0.1796***	(0.0073)	0.6736***	(0.0256)	YES	YES	2,145	0.7723
(42) Human health and social work activities	0.0043***	(0.0017)	−0.0020	(0.0022)	0.0112***	(0.0026)	−0.0132	(0.0126)	−0.0090	(0.0060)	−0.3038***	(0.0117)	0.5421***	(0.0352)	YES	YES	2,145	0.7216
(43) Arts, entertainment and recreation	−0.0079***	(0.0013)	−0.0111***	(0.0026)	0.0191***	(0.0025)	−0.0184*	(0.0099)	0.0048	(0.0047)	−0.1484***	(0.0091)	0.4818***	(0.0307)	YES	YES	2,145	0.7782
(44) Other service activities	−0.0048***	(0.0010)	−0.0007	(0.0023)	0.0152***	(0.0023)	0.0007	(0.0077)	−0.0056	(0.0044)	−0.1272***	(0.0076)	0.4422***	(0.0318)	YES	YES	2,145	0.8003

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4. Do the patterns of holistic similarity prevail at the sector level?

Figure 5. Effect of distance on technological similarity, by sector: 2018

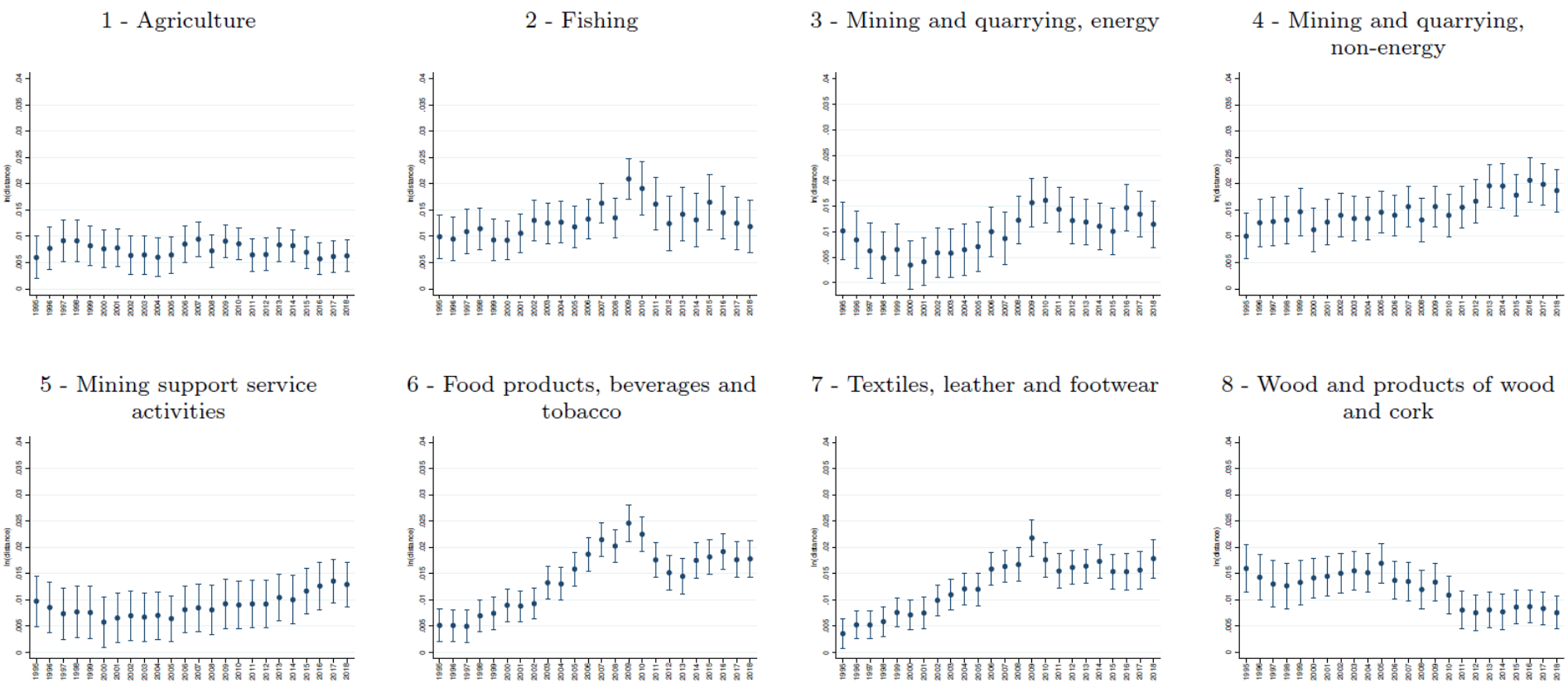


Note: We estimate Equation (3) based on yearly cross-sections by sectors. This graph presents the values of the 'ln_distance' coefficient for individual regressions for each sector for 2018 (Table 5)
* Non-statistically significant coefficient: sectors 1, 9, 10, 20, 23, and 37.

4. Do the patterns of holistic similarity prevail at the sector level?

Figure 6. Evolution of the effect of distance on technological similarity, by sector: 1995-2018

Dependent variable: Coefficient of Technological Association (CTA)



Note: We estimate Equation (3) based on yearly cross-sections by sectors. These graphs present the values of the 'ln_distance' coefficient for individual regressions for each sector.

4. Do the patterns of holistic similarity prevail at the sector level?

Dependent variable: Distance coefficient

	(1)	(2)	(3)	(4)
Import coefficient	−0.0229**			
	(0.0109)			
Herfindahl-Hirschman Index	−0.0029			
	(0.0036)			
Import coefficient # Group.1		−0.0069		−0.0320
		(0.0170)		(0.0213)
Import coefficient # Group.2		−0.0386*		−0.0443
		(0.0221)		(0.0286)
Import coefficient # Group.3		−0.0517***		−0.0321*
		(0.0175)		(0.0189)
Import coefficient # Group.4		−0.0398***		−0.0520***
		(0.0128)		(0.0144)
Import coefficient # Group.5		0.0284**		0.0280**
		(0.0118)		(0.0140)
Import coefficient # Group.6		0.0324*		0.0324
		(0.0178)		(0.0228)
Herfindahl-Hirschman Index # Group.1			−0.0072	−0.0136*
			(0.0052)	(0.0074)
Herfindahl-Hirschman Index # Group.2			0.0053	−0.0036
			(0.0050)	(0.0067)
Herfindahl-Hirschman Index # Group.3			0.0264***	0.0231***
			(0.0056)	(0.0062)
Herfindahl-Hirschman Index # Group.4			−0.0187***	−0.0247***
			(0.0051)	(0.0059)
Herfindahl-Hirschman Index # Group.5			−0.0139	0.0030
			(0.0104)	(0.0116)
Herfindahl-Hirschman Index # Group.6			−0.0176*	0.0037
			(0.0096)	(0.0112)
Constant	0.0087***	0.0130***	0.0187***	0.0126***
	(0.0027)	(0.0020)	(0.0014)	(0.0034)
Dummy Industry	YES	YES	YES	YES
Dummy Year	YES	YES	YES	YES
Observations	868	868	868	868
R-squared	0.7827	0.7906	0.7909	0.7989

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

Industries by group: Natural resources (1), Low technology (2), Medium technology (3), Medium-high and high technology (4), KIBS (5), and Services (6).

5. Can we find evidence of localized spillovers at the sector level?

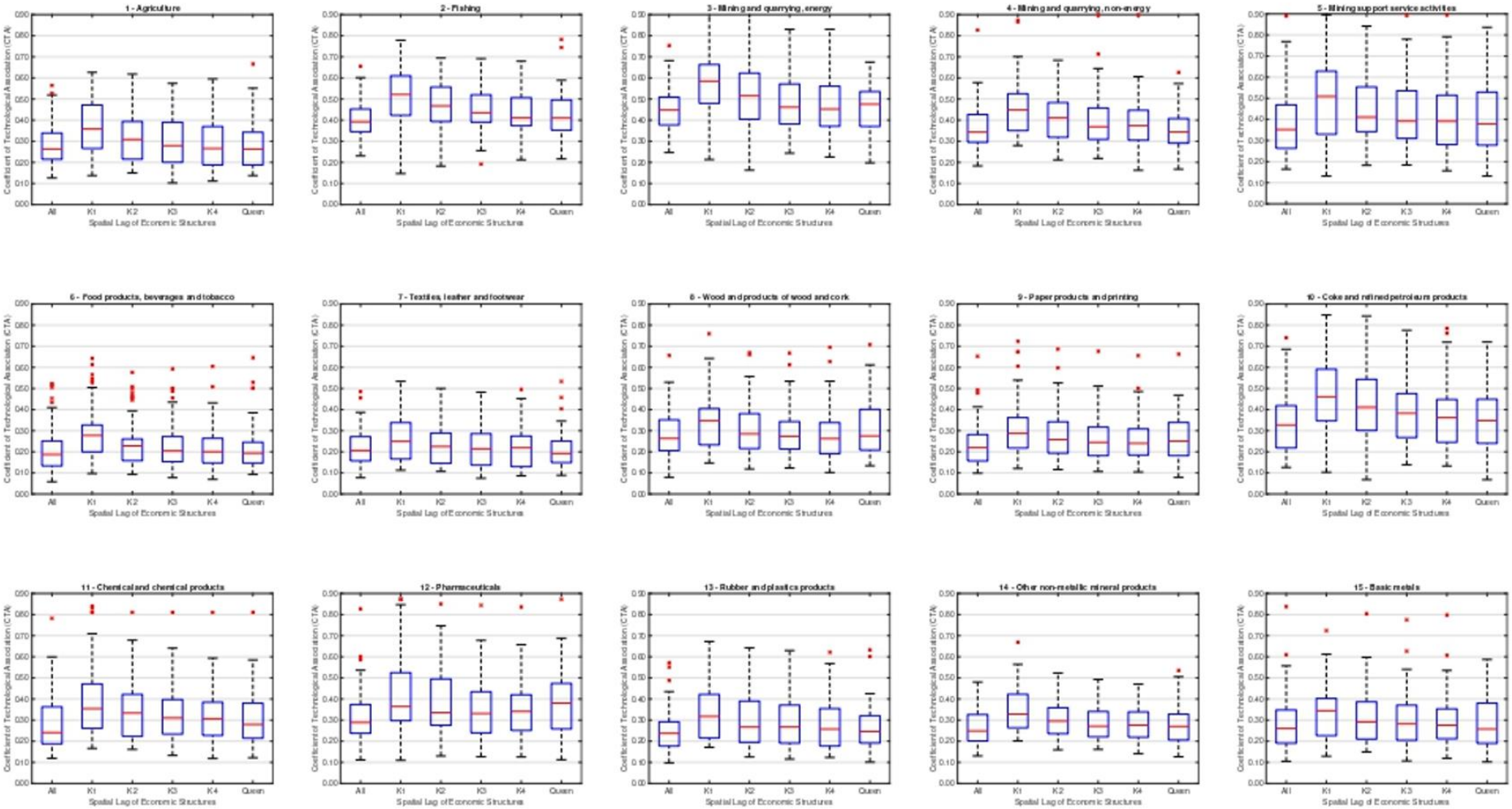
Are nearby countries more likely to share similar sectoral technologies?

We calculate the CTA_{rs}^{j} conditional on the different spatial weights matrix

$$CTA_{rs}^{j} = \frac{\sum_{i=1}^{J} \left| \breve{a}_{ij}^{r} - w_{rs} \breve{a}_{ij}^{s} \right|}{2}$$

5. Can we find evidence of localized spillovers at the sector level?

Figure 7. Distributions of the CTA_{rs}^{j} based on different neighborhood criteria for the calculation of the spatial lag of $\breve{A}_{j}^{r}$



Final remarks

We found that nearby countries are more likely to share similar technologies

We also found stronger holistic and sectoral similarities in comparing countries' structures with global average structures.

One of the methodological challenges is how to fill the gaps encountered in an environment of limited information

ICIO estimation procedures are not fully documented

Conjectures of how gaps are filled based on known practices of using regional and global average structures may add a layer of uncertainty to our results

If this is proven to be the case, it will bring important implications for the growing empirical literature grounded on different multi-country IO databases

Final remarks

There is a danger that such conventional truths, more and more supported by authority arguments, could lead to reinforcing the "performativity thesis" in the international trade literature

It is about time to open the black box of existing MCIO databases to avoid the reinforcement of potential conventional truths in the field

To what extent the results revealed in our study refer to a true process of technological convergence or a methodological trap from the employed methods to fill the gaps and consolidate the database remains a question to be pursued

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da Universidade de São Paulo

The University of São Paulo
Regional and Urban Economics Lab

Thank you!

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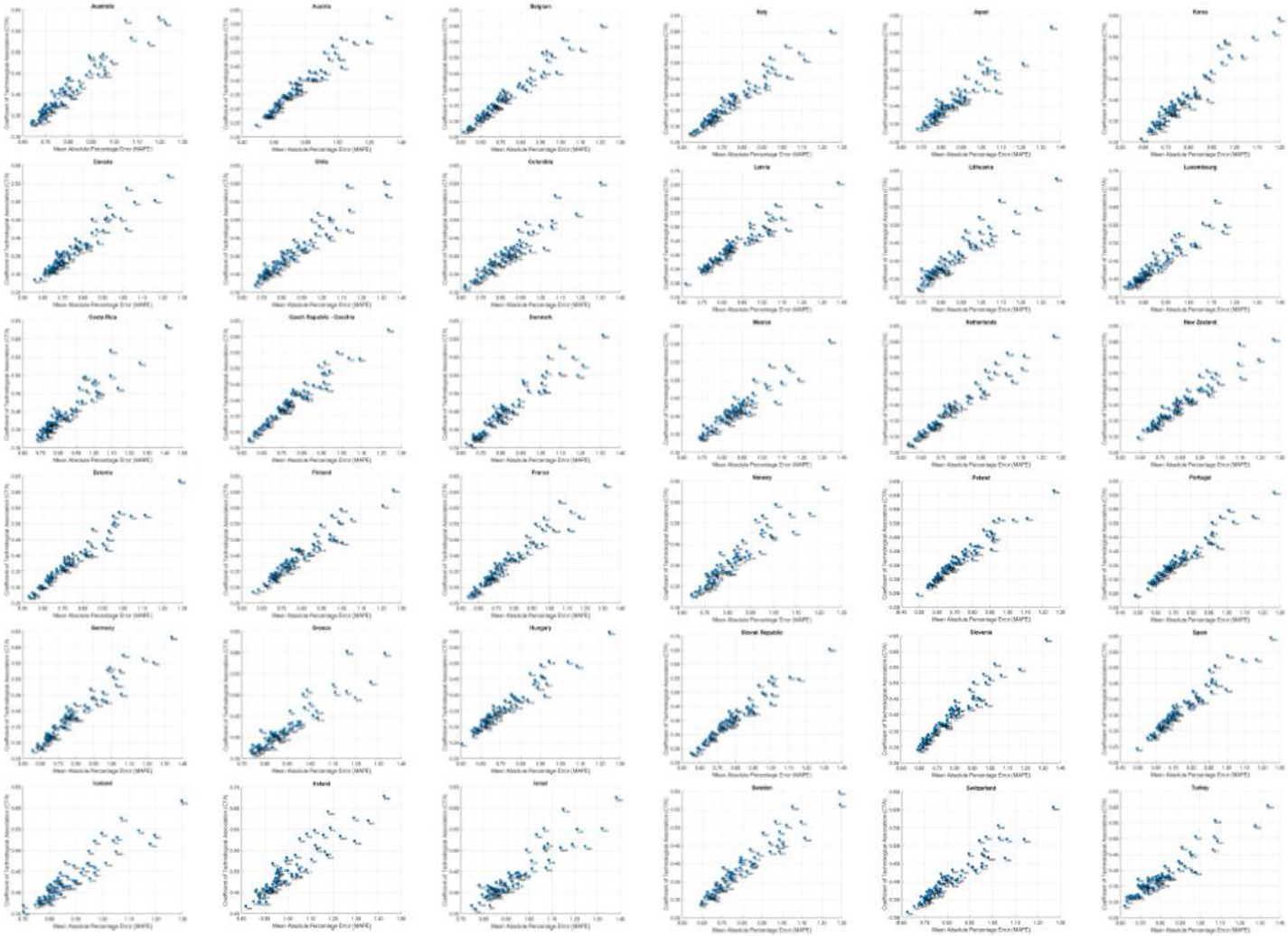
Professor of Economics, University of São Paulo, Brazil

What is performativity in Economics?

The performativity thesis suggests that economic or financial models, rather than objectively measuring some aspect of reality, instead help shape that aspect of reality to the form that the model describes.

Comparison between indicators of holistic similarity: CAT versus MAPE, 2018



Comparison between indicators of holistic similarity: CAT versus MAPE, 2018