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Research Article

The Quest for Participating to Global Value Chain in Sub-Sahara Africa: An Analysis of Determining Factors Using a Spatial Panel Model

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Abstract

This paper aims to determine the factors that influence the participation of the Sub-Saharan Africa countries in the global value chain (GVC). The paper use of a spatial panel Model to show that the variability of participation in the global value chain is explained by the total factor productivity, the dollar rate, the terms of trade, the type of economic zone and the degree of integration of countries into the Global Economy (Globalization). Empirical evidence displays a positive link between the total factor productivity growth and the participation in the global value chain. The rise of the Dollar against the Euro strengthens the participation in the global value chain. The deterioration of the terms of trade decreases participation in the global value chain. Special Economic Zones have a positive effect on the global value chain. On the other hand, a significant negative relationship between the free trade zones and participation in the GVC is observed. Finally, with the exception of the Economic Globalization Index and Political Index, all the other indexes have a positive and significant impact on participation in the GVC. The Sub-Saharan African countries have an interest in becoming more integrated into the globalization of trade, information technology and finance. They must also promote economic and political integration.

Keywords

Global Value Chain, Spatial Panel, Special Economic Zone, Globalization

1. Introduction

The rapid growth of international trade and the deepening of vertical specialization have pushed the global economy and Sub-Saharan Africa's economy in particular into the era of global value chains (GVCs). These are characterized by the international fragmentation of production and trade in intermediate inputs. The development of GVCs provides an opportunity for African countries to integrate into global supply, production and distribution networks. The concept of GVCs dates back to the late 1970s with the work on the 'Production Chain' by Bair [1]. The basic idea was to trace all the inputs and transformations that lead to a final good by describing all the processes [9]. The GVC participation measure reflects the share of a country's exports that crosses at least two borders. This participation is calculated as the share of GVC exports in total international exports. The GVC of exports includes transactions in which a country's exports contain value added

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that it has previously imported from abroad (upstream participation in GVCs), as well as transactions in which a country's exports are not fully absorbed by the importing country and are exported to third countries (downstream participation in GVCs) [17]. Developing countries, and in particular those in Sub-Saharan Africa, are increasingly facing competition and barriers to international trade, as well as pressures to introduce new technologies into production systems. Similarly, most Sub-Saharan African countries are ill- prepared to compete in national and regional markets [16]. Sub-Saharan African countries mainly export commodities with little or no processing and which contribute to the production of more sophisticated goods. This was supposed to facilitate their participation in global value chains. However, African products face strong competition in the international market. At the same time, with the advent of EPAs (Economic Partnership Agreements), African national and regional markets are increasingly open to foreign competition. This strong competition, relative to these goods, is thus at the origin of the weak control of prices by Sub-Saharan African countries, making these countries 'price takers'. In addition, there is a lack of advanced technology to improve productivity in order to achieve economies of scale in Sub-Saharan African countries, but also to improve the quality of exported products. Together with a strong currency and high factor prices, these factors skew the participation of Sub-Saharan African countries in global value chains. Faced with this problem, the question arises: what are the levers that will enable the countries of sub-Saharan Africa to actively participate in this new trade organization, the global value chain? To identify the different the levers that can facilitate the participation of Sub-Saharan African countries in global value chains, a spatial panel model will be used.

2. Theorical Framework and Choice of Model

Using the approach of Elhorst [6], four competing models will be estimated (i) spatial autoregressive (SAR) model containing the endogenous interaction effect WY_t(ii) the Spatial Error Model (SEM) containing the interaction effect (correlated effect) among the error terms Wu_t(iii) the combined spatial autoregressive model (SAC) containing both WY_t and Wu_t(iv) the Spatial Durbin model (SDM) containing both WY_t and WX_tThe parameters of these models were all shown to be identified and free of overfitting. From the residuals of the OLS model, the Lagrange multiplier tests show the presence of endogenous autocorrelation, i.e. $\rho \neq 0$ and $\lambda = 0$ (left-hand side of figure 1, Appendix II). We then estimate the SDM model. With a likelihood ratio test ($\theta = 0$), we can choose between the SAR model and the SDM model. A likelihood ratio test allows us to choose the SDM model. The latter has a higher explanatory power than the SAR model (lower AIC). For reasons of parsimony, the choice of a SAC model could be considered. Its explanatory power (AIC and BIC close to the SDM model). The interpretation of these models is easier but is limited to direct effects. The SAC model (endogenous and residual autocorrelation) estimates a weak and non-indicative endogenous autocorrelation compared to the residual autocorrelation. This result is not easy to interpret because of the bias related to the non- inclusion of exogenous interactions. The results of the SDM and SEM models converge. Indeed, the signs of the coefficients of the variables of both models are the same. The SEM model can be interpreted as the OLS model.

3. Methodological Framework

The paper adopts the Spatial panel data analysis. This is an area of econometrics that is experiencing increasing methodological progress. Recent contributions include, among others [2, 3, 13, 10, 11, 14]. In this paper, we focus only on a balanced panel. In a spatial panel framework, observations are associated with a particular position in space. The data are observed by country.

Spatial Panel Data Models

Spatial panel data models capture spatial interactions in space and time. Spatial autocorrelation is taken into account in several ways: by lagged spatial variables, endogenous or exogenous, or by spatial autocorrelation of errors. The following model incorporates three potential spatial terms:

$$y_{it} = \rho \sum_{i \neq j} w_{ij} y_{jt} + \beta x_{it} + \sum_{i \neq j} w_{ij} x_{jt}\ \theta + \alpha + u_{it} \quad (1)$$

$$uit = \gamma \sum i \neq j\ wijujt + \varepsilon it \quad (2)$$

w_{ij} is an element of a spatial weighting matrix WN of dimension (N, N) in which the neighbourhood relations between the individuals in the sample are defined. The diagonal elements w_{ij} elements are all set to zero to avoid self-dependence. The weight matrix is normalized in line. We thus consider a time-fixed spatial weighting matrix.

$\sum i \neq j\ ijyjt$ denotes the spatially lagged endogenous variable and is equal to the average value of the dependent variable taken by the neighbours (in the sense of the weight matrix) of observation i. The ρ parameter captures the endogenous interaction effect. The spatial interaction is also taken into account by specifying a spatial autoregressive process in the errors.

$\sum_{i \neq j} w_{ij} u_{jt}$ according to which unobservable shocks affecting individual i interact with shocks affecting its neighbourhood. The γ parameter captures a correlated effect of the unobservable shocks. Finally, a contextual (or exogenous interaction) effect is captured by the vector θ of dimension (k, 1). As before, it is assumed that ε_{it} i.i.d. ~ N $(0,\sigma^2)$. With the data stacked for each period t, the model can be written in the following form:

$$y_{it} = \rho W_N y_t + \beta x_t + W_N x_t \theta + \alpha + u_t \quad (3)$$

$$u_t = \gamma W_N u_t + \varepsilon_t \quad (4)$$

where y_t is the (N, 1)-dimensional vector of observations of the explained variable for period t, x_t is the matrix (N, k) of observations on the explanatory variables for period t. With the data stacked for all individuals, the model is written in matrix form as follows:

$$y = (I_T \otimes W_N) + x\beta + (I_T \otimes W_N) + \alpha \quad (5)$$

$$u = (I_T \otimes W_N) + \varepsilon \quad (6)$$

where $\otimes$ denotes the Kronecker product and (IT $\otimes$WN) is a matrix of dimension (NT, NT).

4. Material and Method

The model we present links the global value chain, productivity, trade, financial, political globalization etc., the presence of Special Economic Zones and other control variables. The basic specification is given by:

$$CVM_{it} = \alpha_0 + \alpha_1 PTF_{it} + \alpha_2 IMC_{it} + \alpha_3 IMF_{it} + \alpha_4 IMP_{it} + \alpha_5 IMEC_{it} + \alpha_6 IMINFOR_{it} + \alpha_7 ZES_{it} + \alpha_8 TE_{it} + \alpha_{10} TCEF_{it} + \varepsilon_{it} \quad (7)$$

where the α_i are the unknown parameters to be estimated and ε_{it} is an error term for which we first assume that ε_{it} i.i.d. $\sim$ N (0, σ^2). Taking into account spatial spillover effects requires estimating the specification augmented with a spatial autoregressive term:

$$CVM_{it} = \alpha_0 + \rho \sum_{i \neq j} w_{ij} CVM_{jt} + \alpha_0 + \alpha_1 PTF_{it} + \alpha_2 IMC_{it} + \alpha_3 IMF_{it} + \alpha_4 IMP_{it} + \alpha_5 IMEC_{it} + \alpha_6 IMINFOR_{it} + \alpha_7 ZES_{it} + \alpha_8 TE_{it} + \alpha_9 TCEF_{it} + \alpha_{10} u_{it} + \alpha_{11} d_{it} + \varepsilon_{it} \quad (8)$$

We consider an alternative specification corresponding to a spatial autoregressive model in the errors:

$$CVM_{it} = \alpha_0 + \alpha_1 PTF_{it} + \alpha_2 IMC_{it} + \alpha_3 IMF_{it} + \alpha_4 IMP_{it} + \alpha_5 IMEC_{it} + \alpha_6 IMINFOR_{it} + \alpha_7 ZES_{it} + \alpha_8 TE_{it} + \alpha_9 TCEF_{it} \alpha_{10} u_{it} + \alpha_{11} d_{it} + \varepsilon_{it} \quad (9)$$

$$\varepsilon_{it} = \beta_i + \theta \sum_{i \neq j} w_{ij} \varepsilon_{jt} + \mathrm{P}_{it} \quad (10)$$

Or

$$\varepsilon_{it} = \theta \sum_{i \neq j} w_{ij} \varepsilon_{jt} + \mathrm{P}_{it} \quad (11)$$

The GVC participation index (value of output crossing more than one border). It is the sum of the foreign and domestic value of imported inputs that are re-exported and the value of domestic production re-exported by bilateral partners;

PTF_{it} Total Factor Productivity;

IMC_{it} Trade Globalization Index;

IMF_{it} Financial Globalization Index;

IMP_{it} Political Globalization Index;

$IMEC_{it}$ Economic Globalization Index;

$IMINFOR_{it}$ Information Globalization Index;

ZES_{it} Special Economic Zone;

TE_{it} Terms of trade in volume;

$TCEF_{it}$ Real Effective Exchange Rate.

4.1. Construction of the Weight Matrix

To establish the spatial correlation between countries, we defined the neighbourhood relationships between countries. This relationship is estimated using the geographical coordinates of the countries (latitude and longitude). In our panel, we have 44 countries, there are 44 (44 - 1) /2 different country pairs. That is 946 pairs of countries. The difficulty is that it is not possible to identify the correlation relationships between the 44 countries without making assumptions about the structure of this spatial correlation. For the 44 countries, this amounts to defining a square matrix of size M (44,44) whose diagonal elements are zero (you cannot be your own neighbour).

4.2. Data Collection, Data Measurement and Data Presentation

Five data sources are used. For the global value chain, UNCTAD's Eora database is used, providing global coverage (189 countries and the rest of the world) and a time series from 1990 to 2019. For the globalization variables, we used the revised version of the Globalization Index of the Swiss Institute of Economics. For the Special Economic Zone variable, we use the database developed under the WTO Trade Policy Review Mechanism. The Penn World Table database is used to extract the Total Factor Productivity and the terms of trade. The CEPII database is used for the Real Effective Exchange Rate. The GVC database contains the main measures of value added and global value chains used in the WDR 2020. The cross-country input-output tables (ICIOs) used to calculate the measures are WIOD, OECD-TIVA and EORA (see Timmer et al. [15]; Lenzen et al. [12] respectively). Data are in millions of current US dollars (Annex 1). All measures included in the dataset and other relevant measures of trade in value added and GVC participation can be calculated using icio, a new Stata command for calculating trade value added and GVC analysis, developed by Federico Belotti, Alessandro Borin and Michele Mancini [4]. For the globalization variables, we present and describe the revised version of the KOF Globalization Index of the Swiss Institute of Economics. The base is composed of composite indices measuring globalization for each country of the world in its economic dimension noted as EMI (trade regulation, trade agreements, trade taxes and tariffs), financial noted as FDIIN (foreign direct investment, portfolio investment, international reserves, interna-

tional debt), informational noted as FTIIN (internet access, high-tech exports), and political noted as international organization, international treaty, treaty diversifying partners).

This dataset provides an indicator of whether a country has a special economic zone (SEZ) in place. As SEZs have many possible forms, the database provides information on three types of SEZs, a) an export processing zone (export processing zones are duty free on intermediates used in the production of exports), b) export and import processing zones that also waive duties on imports that are sold domestically, and c) a final classification that covers incentives beyond duty exemptions (e.g. preferential taxation or lower regulations). The data covers 125 WTO members.

5. Results

The variability of African countries' participation in the global value chain is explained at 48% and 38%, respectively, in the two models (SDM and SEM) by total factor productivity, the dollar exchange rate, the terms of trade, the type of economic zone and the degree of the country's integration into globalization. As the coefficients are all significant, the SDM model shows a positive link between TFP growth and participation in the global value chain. Indeed, an increase in total factor productivity of 1% leads to an increase in participation in the global value chain of 0.672%. This is in line with the results of several authors, including Grossman and Rossi-Hansberg [8] who formalize an analogy between offshoring and productivity. The rise of the dollar against the euro also strengthens participation in the global value chain. However, the coefficient remains low (2.98e-05) compared to the other variables.

Price terms of trade have a negative impact on participation in the global value chain. The deterioration of the terms of trade (decrease in domestic export prices relative to foreign export prices) by 1% decreases the participation in the global value chain by 0.110%. The explanation is that the value of domestic exports for a given volume declines and so does participation in the global value chain. As regards special economic zones (SEZs), their positive impact on the GVC (1.176%). The presence of a SEZ in Sub-Saharan Africa increases participation in the GVC. This is because these are geographical areas where a specific economic activity is encouraged through policies or other forms of support not available to the rest of the economy. This support includes a more streamlined business environment, better infrastructure, tax/duties exemptions for inputs. The SEZ is a catalyst for industrialization by encouraging foreign and domestic investment in the zones, increasing productivity spillovers from zone firms to firms outside the zone and participating in the global value chain. This result confirms that of Gebrewolde [7]. A recurrent finding is the negative relationship between free trade zones (FTAs and MTAs) and GVC participation. The presence of a FEZ and a MEZ decreases participation in the GVC by 1.042% and 0.786% respectively. This result is consistent with that of Davies and Fran ̧ois [5]. Indeed, there is some consistency with the role of FTAs as a shortcut to overcome regulatory burdens. In other words, bad performers are more likely to turn to such solutions. With regard to globalization, with the exception of the Economic Globalization Index (EMI) and the Political Globalization Index (PGI), all other indices favour participation in the GVC. The participation of Sub-Saharan African countries in the GVC falls by 7.604% when the EMI falls by one point. Trade deregulation and the dismantling of taxes and tariffs has had a negative impact on exports and de facto on the participation of Sub-Saharan African countries in the GVC. This is the case for the IMP, whose increase leads to a decrease in participation in the GVC by 0.0522%, as it restricts exports. On the other hand, the impact of the trade, finance and information globalization indices is positive and respectively 3.852%, 3.950% and 0.129%.

6. Conclusion and Policy Recommendation

The paper determined the factors that influence the participation of sub- Saharan African countries in the global value chain. Using a spatial panel, it was shown that the variability of participation in the global value chain is explained by total factor productivity, the dollar exchange rate, the terms of trade, the type of economic zone and the degree of integration of countries into globalization.

The results of the SDM model show a positive relationship between TFP growth and participation in the global value chain. The rise of the dollar against the euro also strengthens participation in the global value chain, but the coefficient remains low. Unlike the other indicators, the terms of trade have a negative impact on participation in the global value chain. Indeed, the deterioration of the terms of trade (lower prices of domestic exports compared to foreign exports) decreases participation in the global value chain. With regard to special economic zones, they act as catalysts for industrialization, encourage foreign and domestic investment in the zones, and direct productivity growth from firms in the zones to firms outside the zones and participating in the global value chain. On the other hand, there is a negative relationship between free trade zones (FTAs and EMZs) and participation in the GVC. Finally, for globalization, with the exception of the Economic Globalization Index (EGI) and Political Globalization Index (PGI), all other indices have a positive impact on participation in the GVC.

The Sub-Saharan African countries have an interest in becoming more integrated into the globalization of trade, information technology and finance. They must also pay particular attention in promoting economic and political integration.

Abbreviations

AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
EGI	Economic Globalization Index
EPAs	Economic Partnership Agreements
FTAs	Free Trade Zones
GIP	Political Globalization Index
GVC	Global Value Chain
ICIO	Inter-Country Input-output
OECD-TIVA	OECD's Trade in Value Added Database (TiVA)
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares
SAC	Spatial Autoregressive Combined Model
SAR	spatial Autoregressive
SDM	Spatial Durbin model
SEM	Spatial Error Model
SEZ	Special Economic Zone
SSA	Sub-Saharan African
TPF	Total Factor Productivity
WIOD	World Input-Output Database
WTO	World Trade Organization

Author Contributions

Adama Gueye: Preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation); Presentation of the published work, specifically visualization

Allé Nar Diop: Development or design of methodology; creation of models; Application of statistical, mathematical, computational, or other formal techniques to analyze or synthesize study data; scrub data and maintain research data

Mohamed Ben Omar Ndiaye: Conducting a research and investigation process, data/evidence collection; Provision of study materials, materials, computing resources, or other analysis tools; MANAGEMENT activities to annotate, Preparation, creation and/or presentation of the published work; Management and coordination responsibility for the research activity planning and execution

Conflicts of Interest

The authors declare no conflicts of interest.

Appendix

Appendix I. Model Data

Table 1. *Descriptive statistics of variables.*

Variables	Obs	Mean	Std. Dev.	Min	Max
gexp	25742	125,74	941,808	0,002	23061,060
dc	1775	107,47	815,461	-183,800	21938,570
dva	1775	107,43	815,042	-183,793	21937,710
vax	1775	107,26	813,409	-183,761	21914,580
ref	1775	0,17	2,014	-0,038	67,038
ddc	1775	0,05	0,597	-0,587	22,598
fc	1775	18,27	146,791	-1,079	4484,197
fva	1775	18,26	146,669	-1,079	4481,509
fdc	1775	0,01	0,134	-0,111	5,833
gvc	1775	49,60	426,293	-0,551	12490,320
gvcb	1775	18,31	147,341	-1,079	4496,438
gvcf	1775	31,29	295,354	-51,182	8654,460
Ecog	1775	51,07	18,52	4,32	98,63
Tradeg	1775	50,46	20,18	3,96	99,55
Fing	1775	51,75	21,66	3,07	100,00

Variables	Obs	Mean	Std. Dev.	Min	Max
Politg	1775	47,29	26,37	1,00	98,34
epz	1775	0,408	0,492	0	1
empz	1775	0,127	0,333	0	1
sez	1775	0,155	0,362	0	1
ctfp	1775	0,644	0,251	0,099	1,732
rtfpna	1775	1,008	0,192	0,424	2,200
pwt_xr	1775	286,073	1075,392	0,000	11865,210
EXCH_TERM	1775	1,018	0,098	0,586	1,313

Table 2. *Participation in the value chain by sector (variables related to exports).*

Sectors	vax	dc	fc	dva	fva	gvc	gvcb	gvcf
Agriculture	90,76	90,80	9,20	90,80	9,20	35,47	9,20	26,27
Construction	73,50	73,52	26,48	73,51	26,48	42,62	26,49	16,14
Education, Health and Other Services	86,12	86,14	13,86	86,13	13,86	28,68	13,87	14,82
Electronics and Machinery	60,60	60,64	39,36	60,63	39,36	52,71	39,37	13,35
Financial and Corporate Intermediation	84,53	84,55	15,45	84,55	15,45	38,81	15,45	23,36
Fishing	68,38	68,41	31,59	68,41	31,59	48,25	31,59	16,65
Food and Beverages	76,62	76,65	23,35	76,65	23,35	37,79	23,35	14,43
Hotels and Restaurants	86,35	86,37	13,63	86,36	13,63	31,15	13,64	17,51
Maintenance and Repair	76,30	76,32	23,68	76,31	23,68	45,10	23,69	21,41
Metal Products	67,65	67,70	32,30	67,70	32,29	55,34	32,30	23,04
Mining and Quarrying	84,74	84,80	15,20	84,80	15,20	45,51	15,20	30,30
Other products Manufacturer	67,42	67,44	32,56	67,43	32,56	45,48	32,57	12,91
Oil, Chime and Non-Metallic Minerals	58,83	58,87	41,13	58,87	41,12	55,46	41,13	14,33
Post and Telecommunications	87,63	87,65	12,35	87,65	12,35	34,44	12,35	22,09
Private Households	72,09	72,11	27,89	72,11	27,89	47,38	27,89	19,49
Public Administration	78,92	78,94	21,06	78,94	21,06	39,80	21,06	18,74
Re-export & Re-import	19,49	19,51	80,49	19,50	80,48	86,10	80,50	5,59
Retail Trade	88,97	88,99	11,01	88,98	11,01	33,09	11,02	22,08
Textiles and Wearing Apparel	71,30	71,32	28,68	71,32	28,68	44,80	28,68	16,12
Transport	82,67	82,70	17,30	82,70	17,30	37,95	17,30	20,65
Transport Equipment	55,17	55,20	44,80	55,19	44,80	55,97	44,81	11,16
Wholesale Trade	85,52	85,54	14,46	85,54	14,46	45,64	14,46	31,19
Wood and Paper	68,79	68,85	31,15	68,84	31,15	50,01	31,16	18,85
Average	73,58	73,61	26,39	73,61	26,39	45,11	26,39	18,72

Appendix II. The Approach of Elhorst

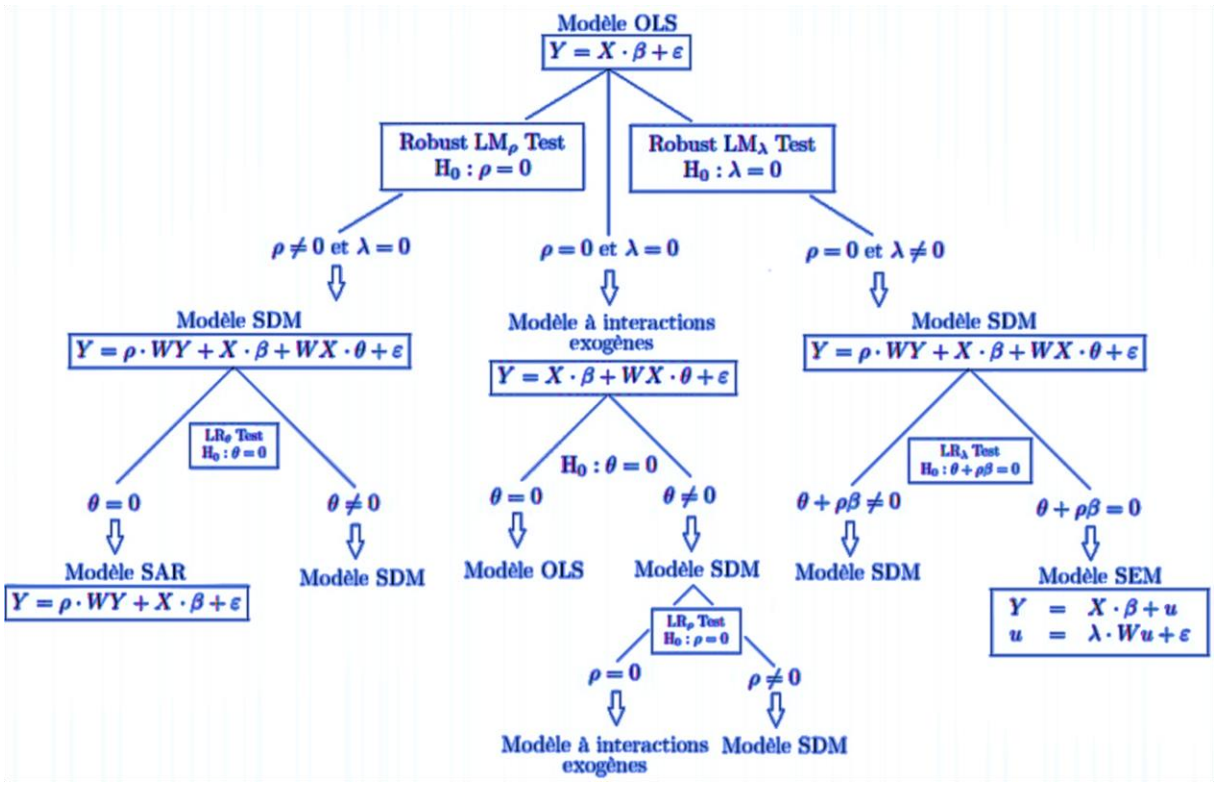

Figure 1. *Elhorst's (2010) Approach to the Choice of a Spatial Econometric Model.*

Appendix III. Model validation Tests

First, we present the Pesaran specification test to arbitrate between a model where the individual effects are uncorrelated and a model where such a correlation exists. This test will allow us to determine the estimation method. Then we will test for the existence of a first-order autocorrelation. Finally, we will perform the other specification tests to choose the most appropriate specification.

1) Cross-sectional independence test

To do this test, we use the Pesaran test. The test statistic is equal to 48.428 with a p-value of

0.00. The null hypothesis of country independence is rejected. There is a dependence of countries in the participation in the global value chain.

2) Woodbridge test of first-order autocorrelation of panel data errors

The test statistic F-stat=76.878 and the p-value =0. The null hypothesis of no first-order autocorrelation of errors is rejected. The errors are correlated of order 1.

Appendix IV. Estimation Results

Table 3. *Econometric estimation.*

Variables	OLS	BAG	SAR	SDM	SEM
PTF	0.339*	0.685***	0.734***	0.676***	0.633***
	(0.182)	(0.0750)	(0.0747)	(0.0754)	(0.0763)
TCER	0.00123***	0/00313**	0.00297*	0.002.98*	0.00328**
	(3.09e-05)	(1.51e-05)	(1.55e-05)	(1.55e-05)	(1.53e-05)

Variables	OLS	BAG	SAR	SDM	SEM
TE	-6.152***	-0.423***	-0.189***	-0.110***	-0.185***
	(0.358)	(0.014)	(0.014)	(0.015)	(0.015)
EPZ	-0.699***		-1.163**	-1.042**	-1.846***
	(0.0840)		(0.527)	(0.522)	(0.595)
ZFEM	-0.360***		-0.823***	-0.786***	-1.184***
	(0.114)		(0.074)	(0.073)	(0.084)
SEZ	0.490***		1.205*	1.176*	1.582**
	(0.110)		(0.680)	(0.671)	(0.765)
IMECO	12.62**	-8.143***	-7.915***	-7.604***	-8.341***
	(5.168)	(2.819)	(2.884)	(2.878)	(2.864)
IMCOM	-6.060**	4.121***	4.002***	3.852***	4.221***
	(2.579)	(1.409)	(1.441)	(1.438)	(1.431)
IMFIN	-6.398**	4.206***	4.101***	3.950***	4.289***
	(2.590)	(1.410)	(1.443)	(1.440)	(1.433)
IMINFOR	0.414***	0.137***	0.120***	0.129***	0.178***
	(0.0290)	(0.0159)	(0.0130)	(0.0136)	(0.0177)
IMPOL	0.963***	-0.0591***	-0.0542***	-0.0522***	-0.0479**
	(0.0219)	(0.0178)	(0.0175)	(0.0176)	(0.0193)
Rho		0.791***	0.812***	0.810***	
Phi		(0.0224)	(0.0170)	(0.0181)	
Lambda		0.234**			0.954***
		(0.0973)			(0.00707)
lgt_theta			-3.475***	-3.468***	
			(0.0889)	(0.0889)	
ln_phi					4.016***
					(0.173)
sigma_mu	1.2166				
sigma2_e		0.0889***	0.0891***	0.0881***	0.0902***
		(0.00288)	(0.00307)	(0.00303)	(0.00312)
Constant	5.071***		0.291	-0.953*	7.600***
	(0.375)		(0.391)	(0.534)	(0.485)
Comments	1232	1232	1232	1232	1232
R2	0.785	0.392	0.466	0.484	0.385
LL	-3067.102	-371.874	-659.864	-649.327	-714.802
AIC	6158.204	765.749	1349.729	1334.654	1459.605
BIC	6223.983	826.046	1431.95	1433.322	1541.829

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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