Research Article

Current Research in Statistics & Mathematics

Gravity Model Applied in External Trade between Angola and SADC

Nerhum Laurindo Sandambi*

***Corresponding Author**
Nerhum Laurindo Sandambi

Submitted: 2023, Aug 21; **Accepted**: 2023, Sep 19; **Published**: 2023, Sep 25

Citations: Sandambi, N. L. (2023). Gravity Model Applied in External Trade between Angola and SADC. *Curr Res Stat Math, 2*(1), 26-32.

Abstract

The paper analyses foreign trade between Angola and SADC in the period 20002013. The main objective is to analyse the factors that influence foreign trade and, above all, to understand the main implications of this. A static gravity model was estimated using fixed effects (FE), random effects (RE) and ordinary least squares (OLS) models. Thus, the following results were obtained; the economic distance in the model is relevant and explains the foreign trade flows, with an impact of 0.978% on the volume of trade traded, the physical distance shows, however, a positive impact, it is plausible and justified by the reduced physical distance between Angola and the SADC member countries, "coeteris paribus". Trade Policy, through the Tariff variable, the results suggest an impact of 0.366% on the trade volume traded with member countries, keeping everything else constant, the FRONT dummy variable is relevant and explains the trade volume, being the trade made with the countries with which Angola shares the border, the impact is significantly higher, intuitively, the lower the costs related to the factors of attraction in the economy tend to be. Thus, the real effective exchange rate variable shows a negative impact, which translates into a decrease in trade volume, the impact may be related to volatility in the foreign exchange market.

Keywords: Comércio Externo, Angola & Sadc, Modelo Gravitacional, Política Commercial,

JEL classification: c01; c21; c23; c33; F10.

1. Introduction

Foreign trade is generally driven by the increase in variables such as exports and imports, which determine cyclical behaviour, being driven on the one hand by the increase in domestic production of countries and on the other hand by the needs of other countries with which trade flows with greater intensity at the outset. The study focuses on analysing whether in fact the countries have a different export matrix, considering the volatility of the markets themselves, different from the other countries under analysis, Angola for example, in general terms has a less diversified export matrix in relation to the other SADC countries, this is due to two different reasons, one is related to the fact that Angola so far has a dependence on the oil and diamond sector, another reason is related to the fact that Angola does not have, in addition to mineral resources, other key sectors that can contribute to productive diversification at the outset.

Thus, the gravity model has been formally used to analyse and explore bilateral relations between countries, shows the impact of GDP of origin and destination on the volume of trade transacted, the results also show the non-influence of physical distance on foreign trade, even when trade is made with the most distant country from Portugal within the PALOP [1]. In show the income elasticity of the exporting country to be higher than the incomes of the importing country, in line with the results found in, analyses the determinants of foreign trade in the European Union, the results suggest the positive dependence between the GDP of a member state and its export and import volume, similar results found in, explore the effects of distance on foreign trade, other pull factors such as transport costs are analysed in. studies foreign trade among CARICOM member states, countries that share a common border tend to show significant and positive effects on trade shows this relationship. Gravitational model applied to intra-trade studies is seen in with the analysis for IntraBrics trade. analyse in detail, the following studies of and [2-14].

2. Data and Methodology

2.1 Data

The sample data were extracted from the World Bank, COMESA, IMF, INE and the statistical portals of the countries under analysis, however, the following countries are analysed: Angola, Botswana, Lesotho, Mozambique, Mauritius, Malawi, Namibia, South Africa, Swaziland, Zimbabwe, Zambia, Seychelles, Tanzania, DRC, Comoros and Madagascar. The time horizon of the analysis is 2000-2013. Data are represented in US dollars at constant 2010 prices, the dependent variable Foreign trade volume naturally represents the sum of imports and exports. Panel data allow for greater sample variability according to the authors. The panel is strictly balanced, being, the number of observations greater than the time horizon, however, N>T [15-18]. The functional form of the model is the logarithmic transformation, this allows on the one hand the interpretation of the parameters as elasticities (in percentages) according to the expected signs of the parameters are analysed in Table 1

Parameters	Expected signs
β_0	+
β_1	+/-
β_2	+/-
β_3	+/-
β_4	+
β_5	+
β_6	+
β_7	-
β_8	-
β_9	-
β_{10}	-
β_{11}	+
β_{12}	+
β13	-

Source: Elaborated by the author

Table 1: Expected signs of the parameters

Some parameters have double expected sign. Descriptive statistics are shown in Table 2.

Variables	Obs.	Average	Standard Deviation	Min	Max
lnYi	195	11.26658	2.401349	9.095382	16.9703
lnYJ	195	10.55483	4.430722	6.416504	22.72732
lnYpci	195	7.492771	.8050246	6.469554	8.599667
lnYpcj	195	7.096471	1.113745	4.590495	8.599667
Lnreer	223	4.652662	.1785045	4.110619	5.834005
Lnpopi	223	16.75153	.137662	16.52746	16.9703
Lnpopj	221	15.12067	2.176232	9.228384	18.09983
lnDVx	223	9.318914	4.047539	5.666427	19.71455
lnDij	209	7.471224	.4129781	6.888369	8.354166
lnTarif	223	2.231923	.4817191	.7055697	2.973487
FRONT	223	.2511211	.4346336	0	1
LC	223	.1255605	.3320989	0	1
OIL_DEP	223	.1255605	.3320989	0	1

Note: Table presents descriptive statistics for the sample. **Source:** study results.

Table 2: Descriptive statistics

2.2 Metodology

The gravity model was first used in, intuitively the model studies bilateral foreign trade through the economic distances measured in real GDP of the country of origin and the country of destination, on the other hand, the model studies the physical distance between two countries, through the distance between the main capitals of the country of origin and destination, the sea ports are considered. The model proposed in, however, uses the volume of trade as the dependent variable, being the sum of imports and exports, on the other hand the same model considers transport costs as an influence on trade policy. shows this effect with the variables that at the outset constitute relevant pull factors in foreign trade. The gravity model was later improved in, with the derivation of Coubb Douglas functions. In, they use the model and decompose it through the Hecksher-ohlin model. explains the intra-industry model. Transport costs significantly influence the model, study these impact, propose the estimation of models with time invariant variables [19-29].

2.2.1 Model Specification

The gravity model proposed in is preferably followed, as it is a complete model [22]. Thus, the equation has the following specification:

$$PX_{ij} = \beta_0 (Y_i)^{\beta_1} \left(Y_j\right)^{\beta_2} \left(D_{ij}\right)^{\beta_3} \left(A_{ij}\right)^{\beta_4} u_{ij} \quad (1)$$

After the derivative the model is re-specified into:

$$PX_{ij} = ln\beta_0 + lnY_1\beta_1 + (lnY_i - lnP_i)\beta_2 + lnY_j\beta_3 + (\,lnY_j - lnP_j)\beta_4 + lnD_{ij}\beta_5 + lnA_{ij}\beta_6 + u_{ij} \quad (2)$$

Where:
PX_{ij}, represents the dependent variable, being however the trade volume between the country of origin (i) and the country of destination (j), the variables Y_i and Y_j, show real GDP of the country of origin and the country of destination respectively, P_{ij}, represents the population of the country of origin and the destination, D_{ij}, are the pull factors and represent the physical distance between the country of origin and the destination A_{ij}, are the dummies, show whether or not the country belongs to an economic zone, or if the countries share a common border.

2.2.2 Angola-SADC Gravity Model

According to the model proposed in the following model is proposed:

$$\boldsymbol{lnV_{ij}} = \beta_0 (Y_i)^{\beta_1} (Y_j)^{\beta_2} (Ypc_i)^{\beta_3} (Ypc_j)^{\beta_4} (pop_i)^{\beta_5} (pop_j)^{\beta_6} (reer)^{\beta_7} (Dij)^{\beta_8} (Dvx)^{\beta_9} (Tarif)^{\beta_{10}} (FRONT)^{\beta_{11}} (LC)^{\beta_{12}} (OIL\_DEP)^{\beta_{13}} u_{ij} \quad (3)$$

The derived equation has the following form:

$$\boldsymbol{lnV_{ij}} = \beta_0 + \beta_1 lnY_i + \beta_2 lnY_j + \beta_3 Ypc_i + \beta_4 Ypc_j + \beta_5 lnPop_i + \beta_6 lnPop_j + \beta_7 lnREER + \beta_8 lnDij + \beta_9 lnDvx + \beta_{10} lnTarif + \beta_{11} FRONT + \beta_{12} LC + \beta_{13} OIL\_DEP + u_{ij} \quad (4)$$

Where:
$\boldsymbol{lnV_i}$, represents the volume of foreign trade between Angola and SADC member countries, in millions of dollars at constant prices;
$\boldsymbol{\beta_0}$, constant of the model;
$\boldsymbol{\beta_1 lnY}$, represents the GDP of the country of origin, meanwhile the GDP of Angola in millions of dollars at constant prices;
$\boldsymbol{\beta_2 lnY}$, is the GDP of the destination country, naturally being the GDP of the remaining SADC countries in millions of dollars at constant prices;
$\boldsymbol{\beta_3 Ypc_i}$, GDP per capita of Angola, in millions of dollars at constant prices;
$\boldsymbol{\beta_4 Ypc_j}$, GDP per capita of SADC member countries in millions of dollars at constant prices;
$\boldsymbol{\beta_5 lnPop_i}$, Angola's population in millions;
$\boldsymbol{\beta_6 lnPop_j}$, population of SADC countries in millions;
$\boldsymbol{\beta_7 lnREE}$, represents the real effective exchange rate;
$\boldsymbol{\beta_8 lnDi}$, is the distance between Angola and each of the SADC member countries in thousands of kilometres;
$\boldsymbol{\beta_9 lnDvx}$,represents the external debt in millions of dollars at constant prices of the countries analysed;
$\boldsymbol{\beta_{10} lnTari}$, is the average tariff applied to all products traded between Angola and each of the SADC member countries;
$\boldsymbol{\beta_{11} FRON}$, is a dummy variable, equal to 1 when trade is between Angola and countries with which it shares a border and equal to 0 otherwise;
$\boldsymbol{\beta_{12} L}$, is a dummy variable, equal to 1, when trade is between Angola and the country with the same language;
$\boldsymbol{\beta_{13} OIL\_DEP}$, é uma variável *dummy,* igual a 1, quando o comércio é feito com um país dependente do setor petrolífero;
$\boldsymbol{u_{ij}}$, representa o termo erro, onde incluem-se todos os outros fatores que não foram previamente explicados pelas variáveis explicativas do modelo.

2.3 Estimation of the Gravity Model

For the estimation of the gravity model, the following models are used: Ordinary Least Squares (OLS), Fixed Effects (FE) and Random Effects. The problem of the ordinary least squares model is related to endogeneity, which is assumed in the model, where the correlation between the explanatory variable xj and the error term .. is verified, on the other hand, it ignores the heterogeneity verified in the bilateral relationship between the variables, analysed in show the problems with the use of these models in the analysis with panel data. In random effects models, variation in unobserved effects is assumed, where the unobserved heterogeneous component is randomly distributed with given mean and variances across the observed countries in the sample. In fixed effects models, the unobserved effects are constant over time according to analyse in detail the use of these models. In addition, this type of problem can naturally be solved by using the error correction mechanism, applying robust standard errors for the effect, or by estimating least squares dummy variables (LSDV). On the other hand, the fixed effects model does not take into account time invariant variables, i.e. those that are constant in the model, and it is preferable to use an estimator that produces efficient and consistent results, thus, we opted for the Hausman-Taylor estimator, proposed in the estimator allows the invariant variables to be estimated at the outset, on the other hand it also allows to avoid the correlation between the explanatory variables and the error term. Nevertheless, the use of the Hausman-Taylor estimator is not necessary in this analysis [30-33].

2.4 Specification Testing

The specification in the model is analysed through the tests, BP for choice between ordinary least squares (OLS) and random effects (RE) models, the test proposed in is used, where the null hypothesis of the test accepts the random effects model and alternative, accepts the ordinary least squares model, the test is in line with analysis of random effects in random effects (RE) models. Heteroscedasticity in the model is analysed through the BresuschPagam (BP) test analysed in thus, the null hypothesis of the test assumes homoscedasticity in the model, while the alternative hypothesis evidences the presence of heteroscedasticity, where, the difference in the variances of the residuals is verified. In they analyse the choice between random effects (RE) and fixed effects (FE) models. The null hypothesis of the test accepts random effects models and the alternative hypothesis accepts fixed effects models. To analyse autocorrelation problems, the test proposed allows us to check whether there is indeed a correlation between the residuals of the error term in the model, so the null hypothesis of the test assumes no autocorrelation in the model, while the alternative hypothesis assumes the presence of autocorrelation. The fixed effects in the model are analysed using the test proposed in [31, 37].

3. Analysis, Discussion, and Interpretation of Results

The choice between the OLS and RE models, the BP-LM test presents a p-value of 0.0000, being the departure rejects the null hypothesis, being naturally accepted the random effects models, the results also show the existence of random effects, the Hausman test, the results suggest the use of the random effects model, being the departure verified a p-value of 1.0000.

Heteroscedasticity problems were analysed with the BP test, the results show the presence of heteroscedasticity in the model, to correct the problem the error correction mechanism was applied, that is, the equation was estimated with robust standard errors. The autocorrelation test proposed in the results point to the presence of first-order autocorrelation in the model, these problems occur when the residuals are correlated with the explanatory variables, so the problem was corrected by applying the error correction method. The problems of multicollinearity were analysed with the correlation matrix (see Annex 1). the estimation results are presented in Table 3.

Correlation Matrix

Variáveis	lnVc	lnYi	lnYJ	lnYpci	lnYpcj	lnreer	lnpopi	lnpopj	lnDVx	lnDij	lnTarif	FRONT	LC	OIL_ DEP
lnVc	1.0000													
lnYi	0.9315	1.0000												
lnYJ	0.9501	0.9214	1.0000											
lnYpci	-0.2327	-0.0013	-0.2534	1.0000										
lnYpcj	-0.3264	-0.2143	-0.3565	0.6920	1.0000									
lnreer	-0.2658	-0.2781	-0.2482	0.0612	0.0979	1.0000								
lnpopi	0.1839	0.3944	0.1641	0.8223	0.4689	0.0681	1.0000							
lnpopj	-0.0498	-0.0725	0.0079	0.0622	0.0567	-0.0627	0.0289	1.0000						
lnDVx	0.9129	0.9019	0.9716	-0.3089	-0.3604	-0.2260	0.1058	0.0202	1.0000					
lnDij	-0.0946	0.0087	-0.0984	0.0146	-0.0052	-0.0198	0.0185	-0.3038	-0.0337	1.0000				
lnTarif	0.2826	0.3062	0.2955	-0.1357	-0.1842	-0.0593	0.0063	0.1187	0.3925	-0.3818	1.0000			
FRONT	0.3274	0.2021	0.3090	-0.0771	0.0356	-0.0130	0.0164	0.3194	0.2496	-0.7125	0.0483	1.0000		
LC	-0.1030	-0.1566	-0.1069	0.0526	0.1842	0.0569	-0.0198	0.2841	-0.0757	-0.1443	-0.0714	0.1977	1.0000	
OIL_DEP	-0.1517	-0.1566	-0.1797	0.0526	0.1842	-0.0713	-0.0198	0.0574	-0.1574	-0.0829	-0.1932	0.1977	0.4245	1.0000

Annexes: Annex 1

Source: Estimates results

Variables	OLS	RE	FE
LnYi	1.498*** (0.129)	0.978*** (0.253)	0.0801 (0.385)
LnYJ	0.873*** (0.121)	0.157 (0.0847)	0.0627 (0.0894)
LnYpci	-1.729*** (0.275)	-0.948 *** (0.282)	0.119 (0.431)
LnYpcj	0.332** (0.105)	0.178* (0.0700)	0.195** (0.0685)
Lnreer	0.242 (0.483)	-0.328* (0.149)	(-0.304) * (0.153)
Lnpopi	0.629 (1.585)	1.460** (0.450)	0.391 (0.606)
Lnpopj	-0.0164 (0.0427)	0.233 (0.204)	0.745* (0.322)
LnDVx	-0.787*** (0.122)	0.0633 (0.0526)	0.0458 (0.0536)
LnDij	0.796 (0.424)	1.038 (2.163)	0 (2229.8)
LnTarif	0.743* (0.295)	0.366 (1.306)	6.018 (10.21)
FRONT	1.089** (0.328)	1.889 (1.936)	0 (.)
LC	0.817** (0.262)	-0.346 (1.666)	0 (.)
OIL_DEP	-0.201 (0.266)	-0.632 (1.663)	0 (.)
CONSTANTE	-17.02	-32.47 (18.85)	(-16552.7) (16651.7)
Nº Observações	183	183	183
Efeitos Aleatórios		SIM	
Efeitos Fixos			SIM
Autocorrelação	0.0000[42,72]		
BP-LM	-		
Heterocedasticidade 0,0000[433,37]			
R2	0.7899		0.8049

Notes: The Table presents the results of the Ordinary Least Squares (OLS) model estimations, results of the Random Effects (RE) model, Fixed Effects (FE) model, the model specification tests, the model fit and the numbers of observations. The * represent the significance levels * $p<0.05$, ** $p<0.01$, *** $p<0.001$, being 5%, 1% and 0.1% respectively. Source: Estimation result.

Table 3: Estimation results

3.1 Discussion of Results

In the fixed effects and random effects models, the fit is 78.99%, suggesting, however, an optimal fit. Multicollinearity problems were analysed through the correlation matrix (see Annex 1), and there is no multicollinearity between the variables in the model. The distance variable serves as a proxy in the model, it analyses the attractiveness in foreign trade, the approach was introduced in [38]. The economic distance between two partner countries is analysed through the variables real GDP of the country of origin, Angola in particular, and GDP of the destination countries, being the SADC member countries. The variable is statistically significant at 10% level. Thus, these results suggest a positive impact on the volume of foreign trade, an increase of 1% in the GDP of SADC member countries stimulates foreign trade by 0.978%, "coeteris paribus", in line with the results found [39, 40]. GDP per capita is however used to capture the income effect on trade, analysed in where, a significant increase in GDP per capita, generates a stimulus in trade volume, justified by the possible increase in purchasing power. Thus, the results show a negative impact on foreign trade when the income of SADC member countries varies, on the other hand, the results show a significant increase of 0.178%, statistically significant at 1%

level. This result reflects a significant increase in trade volume, "coeteris paribus". In line with [41].

Traditionally, gravitational modelling approaches use the variables population of origin and population of destination country, both variables, however, seek to capture the effect of foreign trade based on the increase in the number of population, i.e. countries with a considerable number of population may at the outset experience a significant increase in aggregate expenditure through consumption. For the external debt variable, the results suggest a positive impact, also significant at 0.0633%. Thus, the results suggest no influence of external debt on foreign trade.

The Distance according to shows the pull factors in foreign trade, especially with the shipment of goods from one port to another port, as an example. Traditionally, the greater the distance between the two partner countries, the greater the impact on trade volume. The results show a positive impact, however, there seems to be no plausible justification for the increase in trade volume, so its impact is insignificant. Trade policy is analysed through the tariffs applied to goods and services imported and exported to and from SADC member countries, so when there is an increase in customs duties, there is also a significant increase in trade volume, which shows a correlation between the two variables. In this paper, the Tarif variable is used to try to capture the effect that these variables have on bilateral trade between the partner countries.

The results suggest a positive impact, assuming from the outset that variations in customs duties do not affect trade volume. The Dummie Variable, FRONT shows if the countries share a common border and LC, shows, if the countries share a common language, there seems to be a positive impact, when naturally trade is done with Namibia, Zambia and Democratic Congo, on the other hand, the results show for the variable Common language a negative impact, this negative impact is justified by the fact that there is only one Portuguese-speaking country in the sample, being Mozambique. The variable OIL_DEP was used in the model to analyse whether a country depends on the oil sector, thus, the results suggest a negative impact, resulting, however, in a deceleration of the traded trade volume, at the outset these results differ from those found [42].

4. Conclusion

In general, the variables can explain foreign trade between Angola and SADC countries. Thus, the random effects model was used in the analysis, being consistent and efficient, the use of other alternative models such as the Hausman Taylor estimator is not necessary.

Economic distance in the model is analysed through the variables real GDP of the country of origin and the country of destination, being statistically significant in the model, at 1% level, the results show a positive impact, so when there is for example a variation, the trade volume increases by 0.978%, keeping everything else constant.

On the other hand, the possible income effect was analysed through the GDP per capita of the countries of origin and destination, respectively. The results show a positive impact, coming from the possible increase in income levels in the economy of Angola's partner countries in SADC. The positive impact of the distance variable does not allow us to conclude on its real effect, however, there is a positive impact, so the theory of distance in the model is not proven, the greater the distance, the lower the trade volume in principle.

There is a positive impact on the FRONT variable, these show if the countries under analysis share a common border. The results at the outset proved to be consistent with theory, which translates into an increase in the volume of trade transacted when trade is carried out between SADC member countries and which share, above all, a common border, in the particular case when trade is made with countries such as Namibia, Zambia and the Democratic Republic of Congo.

The variable OIL_DEP, if the partner country depends on the oil sector, shows a negative impact, although these results do not seem to plausibly indicate the real effect, the sample countries being few dependent on the oil sector under analysis. However, this translates into, even if there is a small dependence, it does not influence the volume of foreign trade. Thus, it cannot explain the real effect on foreign trade. The Real Effective Exchange Rate, however, shows a negative impact on trade volume, which translates into a decrease in foreign trade, holding everything else constant, in line with the analysis done.

References

1. Sandambi, N. L. A. (2021). Comércio externo entre Portugal-Palop “Aplicação dos modelos gravitacional e VAR em painel” (Master's thesis, Universidade de Évora).
2. Martinez-Zarzoso, I. (2003). Gravity model: An application to trade between regional blocs. Atlantic Economic Journal, 31, 174-187.
3. Golovko, A., & Sahin, H. (2021). Analysis of international trade integration of Eurasian countries: Gravity model approach. Eurasian Economic Review, 11, 519-548.
4. Pieterzak et.al. (2015). Determinants of the European Union’s Trade - evidence from a panel estimation of the gravity model. TECHNICKÁ UNIVERZITA V LIBERCI.
5. García, E. C., Navarro Pabsdorf, M., & Gómez Herrera, E. (2013). The gravity model analysis: an application on MERCOSUR trade flows. Journal of Economic Policy Reform, 16(4), 336-348.
6. Marimoutou et.al. (2010). The "distance-varying" gravity model in international economics: is the distance an obstacle to trade? HAL SHS Sciencies Humanies et Sociales.
7. Alleyne, A., & Lorde, T. (2014). A gravity model approach to analyzing the trade performance of Caricom members states. Applied Econometrics and International Development, 14(2), 145-160.
8. Каукин, А. С. (2014). The Gravity Model of Russia’s International Trade: The Case of a Large Country with a Long Border.
9. Stay et.all. (2016). O modelo de gravidade do comércio internacional, um estudo de caso: o Reino Unido e seus parceiros comerciais. Amity Global Business Review, 28-39.
10. Kuza, A. (2012). Econometric Estimation of a Gravity

Model.
11. Rahman, M. (11 a 13 de setembro de 2003). Uma análise de dados de painel do comércio de Bangladesh: a abordagem do modelo de gravidade.
12. Ugurlu, & Jindrichovska. (2019). Estimando o modelo de gravidade na República Tcheca: estudo empírico do impacto do IFRS no comércio internacional tcheco. European Research Studies Journal, 22(2), 265281.
13. Okubo, T. (2004). The border effect in the Japanese market: A gravity model analysis. Journal of the Japanese and International Economies, 18(1), 1-11.
14. Camacho, P. (2013). Portugal's Integration in World Trade: A Gravity Model.
15. Baltagi, B. H. (2013). Econometric Analysis of Panel Data. United Kigdon: Jonh Wiley & Sons Ltd.
16. Hsiao, C. (2003). Analysis of Panel Data (2nd ed., Econometric Society Monographs). Cambridge: Cambridge Uiversity Press.
17. Cameron , A. C., & Trivedi , P. K. (2005). Microeconometrics: Methods and Applications. . Cambridge: Cambridge University Press. .
18. Màtyás. (1997). Proper Econometric Specification of the Gravity Model. World Economy, 363-368.
19. Tinbergen, J. (1962). Shaping the world economy; suggestions for an international economic policy.
20. Linnemann, H. (1966).Journal of Eastern Europe Research in Business & Economics.
21. Bergstrand, J. H. (1985). The Gravity Equation in International Trade:Some Microeconomic Foundations. The Review of Economics and Statistics, Vol. 67, No. 3, 474-481.
22. Bergstrand, J. H. (1989). The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade. Economics and Statistics, 143-153.
23. Anderson , J. E. (1979). A Theoretical Foundation for the Gravity Equation. American Econonomic Association Vol. 69 N01, 106-116.
24. Deardorff, A. (1998). Determinants of Bilateral Trade:. National Bureau of Economic Research, Inc.
25. Helpman, E. (1987). Imperfect competition and international trade: Evidence from fourteen industrial countries. Journal of the Japanese and International Economies, 62-81.
26. Limao, N., & Venables, A. J. (1999). Infrastructure, Geographical Disadvantage and Transport Costs. POLICY RESEARCH WORKING PAPER 2257.
27. Baier, S. L., & Bergstrand, J. H. (2009). Estimating the effects of free trade agreements on international trade flows using. Journal of International Economics, 63–76.
28. Schaefer, K. C., Anderson, M. A., & Michael , J. F. (2008). Monte Carlo Appraisals of Gravity Model Specifications. Global Economy Journal 8(1) .
29. Serlenga, L., & Chin , Y. (2007). Gravity model of Intra-EU Trade: application of the CCEP-HT estimation in heterogeneous panels with unobserved common time-specific factors . APPLIED ECONOMETRICS .
30. Wooldridge, J. M. (2002). Econometrics Analysis of Cross Section and Panel Data. London, England: The MIT Press Cambridge.
31. Davidová, L. (2015). Various Estimates Techniques of the Gravity model of the trade.
32. Hausman, J. A., & Taylor, W. E. (1981). Panel Data and Unobservable Individual Effects.
33. Breusch, T. S., & Pagan, A. R. (1980). The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. Oxford University Press Vol. 47 No. 1, 239-253.
34. Breusch, T. S., & Pagan, A. R. (1979). A Sample Teste for Heteroscedasticity and Randon Coeficient Variation. Econometrica Vol. 45 No 5, 1287-1294.
35. Hausman, J. A. (1978). Specification Tests In Econemetrics. Econometrica Vol. 46 Nº 6, 1251-1271.
36. Wald, A. (1943). Tests of Statistical Hypoteses Concerning Several Parameters When The Number of Observations is Large. Transactions of the American Mathematical Society, Vol. 54, No. 3, 426-482.
37. Linnemann, H. (1966). An Econometric Study of International Trade Flows. Amsterdam: Holland Publishing.
38. Doumbe, E., & Belinga, T. (2015). A Gravity Model Analysis for Trade between Cameroon and Twenty-Eight European Union Countries. Open Journal of Social Sciences, 3(08), 114.
39. Kubendran, N. J., & et al. (2015). Trade Flows between India and Other BRICS Countries: An Empirical Analysis Using Gravity Model. An empirical analysis using gravity model. Global Business Review, 107-122.
40. Sahin, H., Golovko, A. (2021). Análise da integração comercial internacional dos países da Eurásia: abordagem do modelo gravitacional. Revisão Económica da EURÁSIA, 519-548.
41. Rasoulinezhad, E., Popova, L. (2017). An Estimation of the Impact of Economic Sanctions and Oil Price Shocks on Iran-Russian Trade: Evidence from a Gravity- VEC Approach. Iranian Economic Review, 469-497.
42. Ozturk, I. (2006). Exchange Rate Volatility and Trade: A Literature Survey. International Journal of Applied Econometrics and Quantitative Studies, Vol. 3, No. 1.