Does Gravity Model Fit Sudan's Trade Patterns?

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Abstract

This paper explains bilateral trade patterns between Sudan and 16 Arab countries over the period 1990-2009 using augmented gravity model. The estimation results show that the gravity equation fits the data reasonably well. Estimates of population, GDPs of Arab countries and distance elasticities are as expected. The Heckscher-Ohlin theory explains inter-industry, instead of intra-industry, highlighting competitiveness rather than complementarity between Sudan and Arab countries.

Keywords: bilateral trade, gravity model, competitiveness, complementarity, trade conformity index

JEL codes: C51, F14, F15

1. Introduction

In an anticipation to drive some gains from the international trade most countries, particularly the developing ones, have introduced economic reforms and joined bilateral and regional trade agreements. The economic reforms that have been launched by Sudan in early 1991 impacted its trade and external sector positively. This is evident as the trade to gross domestic product (GDP) ratio increased from 14 per cent for the pre-reform period (1980-1991) to 23 per cent after the reform period (1992-2009). Also, Sudan's exports as a share of the world exports have improved substantially from 0.48 per cent in the 1980s to 0.56 per cent during 1991-96 and attained 0.71 per cent in 2001-2002, the highest achieved so far since the 1970s.

Sudan's main exports to Arab countries are composed of agricultural products, Live and slaughtered animals while Sudan's main imports from Arab countries are utensils, cement, petroleum products, and cosmetics. Machinery and equipments, and vehicles are the items of re-export. The average share of this trade is 9 per cent and recently, their importance and value have increased owing to inter alia economic sanctions and deteriorating political relations with the West caused by problems in South Sudan initially and Darfur later on. Moreover, the Arab Investment and Export Credit Guarantee Corporation statistics showed that Sudan occupied the second recipient of the inter-Arab investment in 2010, attracting US\$ 23.3 billion during the period 1995-2010.

Given the importance of foreign trade to the Sudanese economy, and the weight of the Arab countries as major trading partners of Sudan, it is necessary to identify the main factors that influence the trade flows between Sudan and the Arab world. This paper aims to test if the gravity model is relevant to explain Sudan's bilateral trade patterns with 16 Arab countries, including Jordon, the United Arab Emirates, Bahrain, Tunisia, Algeria, Saudi Arabia, Syria, Iraq, Oman, Qatar, Kuwait, Lebanon, Libya, Egypt, Morocco, and Mauritania.

The rest of the paper is structured as follows. Section 2 presents a review of the empirical literature on gravity model and its application for analyzing trade patterns and policy analysis; section 3 describes the data and the methodology; Section 4 presents empirical results and discussion, and section 5 is concludes and offers some policy recommendations.

2. Empirical Literature Review

The gravity analysis is used extensively to evaluate various trade policy issues such as: **a**) trade flows - (Harris-1998, Zarzoso 2000, 2003, Burguet 2002, Batra 2004, Chan 2005, Claudio 2006, Westerlund 2006, Jacques 2006, Martin 2008, Lawless 2009, Nuroglu, 2009, and Kepaptsoglou 2010, Nuno 2010, Anderson 2011, Peter 2011); **b**) workers'

remittances (Lueth 2006; c) Immigration (Lewer 2008, Constantin 2004, and Letouse 2009); d) foreign direct investment (FDI) (Arranz 2006, and Deroza 2007); e) external debt (Andrew 2004, and Mark 2004); and f) financial prediction (Breton 2007).

Gravity models have achieved empirical success in explaining various types of inter-regional and international trade flows (Cheng 2005), and gained their popularity from their high explanatory power, data readiness, and availability of established standard practices that facilitate the work of researchers (Ben 2006).

Kepaptsoglou (2010) critically reviewed and analyzed recent empirical studies exploiting the gravity model in trade flows. Over 75 papers in the last decade have either used it for analyzing trade policies and their implications or improved its performance. Nuroglu (2009) extended the original gravity model of bilateral trade with population and volatility of exchange rates, and then used this modified gravity model in a panel data analysis. It shows how income and population of a country, distances between two countries and volatility of exchange rates affect bilateral trade flows among 6 big countries of the Organization of Islamic Countries (OIC0. The empirical literature using gravity models is very abundant. Lawless (2009) used a gravity model approach in order to analyze the geographical patterns of Irish exports. The gravity model in international trade has been demonstrated to be an extremely robust empirical method. The gravity model is first applied to aggregate Irish exports from 1980 to 2007. Distance is found to have a strong negative effect on exports. On the other hand, exports are positively related to sharing a common language and when communications infrastructure is well developed. Derosa's (2007) gravity model is based on bilateral merchandize trade flows and inward shocks of FDI among 170 countries from 1976-2005. The gravity model predicted impacts of Maghreb economic integration on merchandize trade and FDI for Arab Maghreb Union (AMU), countries are expected to materialize over a horizon of two to five years. Chan (2005) showed, via gravity model, that Korea's trade relies on the Heckscher - Ohlin pattern with more inter-industry relative to intra-industry trade. Batra (2004) used an augmented gravity model equation with maximum possible geographical coverage of world trade to estimate global trade potentials for India's trade flows. The variables used included infrastructure endowments, squared differences in per capita incomes, and real exchange rates. Panel data analysis was used to find that fixed effects model is preferred to random effects. Zarzoso (2003) augmented the standard gravity model with a number of variables to test whether they are relevant in explaining the bilateral trade flows between the European Union and Mercosur.

Lewer (2008) developed a gravity model of immigration using panel data for 16 Organization of Economic cooperation and Development (OECD) countries for the period 1991–2000. The model illustrated its usefulness for testing other hypothesized determinants of immigration i.e. population, GDP per capita ratio, distance, number of source country natives, property rights, common trading bloc, common boarders, colonial histories, rule of law, and language. Constantin (2004) emphasized the role of gravity models in various fields of spatial interaction analysis, focusing on market area boarder, commodity flows, and migration.

Lueth (2006) estimated a gravity model for remittances using a dataset from 11 countries in Asia and Europe for the period 1980–2004. The estimated gravity model, used to explain trade, FDI flows, and workers' remittances that describe the relationship between workers' host and home country, distance, common border, shared history, or bilateral trade, Additional variables were incorporated into the model such as: dependency ratio and an indicator of natural disasters. The model derived implications about the cyclical properties of remittances and their role in limiting vulnerability to shocks.

Breton et *al* (2007) applied the methodology of gravity models to study relationships between firms and analysts forecasts for earnings of 241 French firms over the period 1997-2007. They proposed a measure of soft information by regressing analysts forecast errors on observable firm-specific, analyst-specific and both firm- and analyst-specific characteristics, and the disturbance effect has been decomposed in order to extract a pair-specific effect.

3. Data and Methodology

3.1 Data

The data have been collected mainly from the Arab Monetary Fund Statistical Bulletin, and are all valued in terms of US dollars. Figure (1) depicts trade flows of Mauritania, Morocco, Algeria, Tunisia, Egypt, Kingdom of Saudi Arabia, Jordon, Syria, Iraq, Libya, Lebanon, Oman, Yemen, Bahrain, Kuwait, and Qatar respectively.



Figure 1. Sudan's Trade with Arab Countries

3.2 Gravity Models

The paper uses the gravity model approach to assess the trade patterns of Sudan with 16 of its main Arab trading partners for the period 1990 -2009.

Standard Gravity models utilize the gravitational force concept as an analogy to relate trade flows between countries to the size of their markets and the cost of moving goods between them. Bilateral trade volume (physical gravitational force) increases with the product of economic sizes (gravitational mass) and decreases with geographical distances (gravitational distance) (Chan 2005). The standard gravity models was augmented with many variables to embody a large number of explanatory variables of which are first traditional gravity effects i.e. joint GDP, joint population, and Distance between two capitals Batra (2004) considered distance as a proxy for transport costs, and an indicator of the time elapsed during shipment, c) synchronization costs: when factories combine multiple inputs, the timing of these needs to be synchronized so as to prevent mergence of bottlenecks, d) distance may be correlated with the costs of searching for trading opportunities an-d the establishment of trust between potential trading partners, e) cultural distance: It is possible that greater geographical distance is correlated with

larger cultural differences. Cultural differences can impede trade in many ways such as inhibiting communication, clashes in negotiating styles etc. Second joint GDP per capita, land area, FDI shocks, infrastructure (stock of public capital and length of motorway network), real exchange rate, foreign currency reserves, binary variables that are unity if i and j have the same: language, common border, landlocked, Island, common colonizer, currency, current colony, ever a colony, common country, and generalized system of preferences (GSP), Zarzoso (2003) suggests that high level of GDP in exporting country indicates high production which increase the availability of goods for export, while high level of income in importing country suggests higher levels of import. Population variables may have positive or negative coefficient depending on the absorption or economies of scale effects. and distance, which provides a broad proxy for the transportation and other costs involved in exporting to country j. Nuroglu, (2009) showed that the higher the population of exporting country the higher the production and exports as a result since it may increase the amount of labor force, and the level of specialization, the higher population of the importing country is expected to decrease income per capita which may lower the need for imports and also the level of exports. Per capita GDP serves as a proxy for income level and/or purchasing power of the exporting and importing countries. The Newton's Law-based Normal Trade is specified first in non-linear form as follows:

Normal trade is specified first in gravity non-linear form as follows:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} P_i^{\beta_3} P_j^{\beta_4} D_{ij}^{\beta_5} A_{ij}^{\beta_6} \mu_{ij}$$
(1)

where $Y_i(Y_j)$ indicates the GDP of exporter (importer), $P_i(P_j)$ population of exporter (importer), D_{ij} distance between the two countries, A_{ij} represents any other factors aiding or preventing trade between pairs of countries, and μ_{ij} is the error term captures any other shocks and chance events that may affect bilateral trade between the two countries. Taking logarithms of both sides of model (1) we obtain log-log linear equation:

$$x_{ij} = \beta_0 + \beta_1(y_i) + \beta_2(y_j) + \beta_3(p_i) + \beta_4(p_j) + \beta_5(d_{ij}) + \sum \beta_{ij} a_{ij} + \mu_{ij}$$
(2)

where, small letters denote the natural logarithm of the variables. Model (1) can be augmented by real exchange rate (e_{ij}) , infrastructure (I_i, I_j) , and FDI (F_i, F_j) in equation (3):

$$x_{ij} = \beta_0 + \beta_1(y_i) + \beta_2(y_j) + \beta_3(p_i) + \beta_4(p) + \beta_5(e_{ij}) + \beta_6(i_{ij}) + \beta_7(i_{ij}) + \beta_8(f_{ij}) + \beta_9(F_{ij}) + \sum \beta_{ij} D_{ij} + \mu_{ij}$$
(3)

Chan-Hyun (2005) added trade conformity index (TCI) to the gravity equation to identify trade patterns whether based on Heckscher-Ohlin trade model or differentiated product increasing returns model. TCI measures the degree of complementarities between two countries. Calculated as follows:

$$TCI_{ij} = \sum [X_{ki} \times M_{kj}] / \sum [X_{ki}^2 \times M_{kj}^2]$$
(4)

where:

 X_{ki} = share of commodity k in exports of country i

 M_{ki} = share of commodity k in imports of country j

i and j = 1, 2, ..., N (i refers to the reporter country and j refers to the partner country)

k = 1, 2, ..., n (refers to a commodity group)

TCI values ranges from 0 (perfectly competitive trade structure) to 1 (perfectly complementary trade structure).

The estimation of gravity models encounters two problems, i.e. heteroscedasticity and zero trade flows. With the existence of heteroscedastic errors log linear model cannot be expected to provide unbiased estimates of mean effects, the second concern arises from the existence of zero values of the dependent variables that are unidentified when converted into logarithms for estimation. Econometrics solutions were provided by (Burguet 2002), (Cheng 2005), (Westerlund Feb 2006), (Martin Feb 2008). (Letouse 2009)... (Burguet 2002) estimated non-linear gravity equation augmented with technological innovation and transport infra structure variables in order to analyze the impact of these variables on trade. Cheng *et al* (2005) showed that the bias problem will be eliminated if the estimation is carried out in two-way fixed effects model in which country-pair and period dummies are used to reflect the bilateral relationship between trading partners. Westerlund *et al*, (Feb 2006), proposed estimating the gravity model directly from its non-linear form by using the fixed effects Poisson maximum likelihood (ML) estimator. Since this removes the need to linearize the model by taking logarithms, the problem with zero trade disappears. Martin *et al* (2008) estimated the gravity model allowing for heteroscedasticity and zero bilateral trade flows, and they proposed the Poisson Pseudo Maximum Likelihood (PPML) as an alternative estimator. Letouse (2009) presented empirical estimates of a gravity model of bilateral migration that properly accounts for

non-linearity and tackles causality issues through an instrumental variables approach.

3.3 Common Coefficients

Explanatory variables are to have the same coefficient across all cross-section members of the pool. A single coefficient will be included for each variable, and will label the output using the ordinary or pool name, as appropriate. There is an option of using cross section weights via generalized least squares (GLS) i.e. using estimated cross-section residual variances.

3.4 Fixed Effects Model

The fixed effects model (FEM) is an unrestricted model as it allows the intercept and other parameters to vary across trading partners. It is appropriate when the unobservable element α does not vary over time and when COV $[\alpha_i X_i] \neq 0$. When the fixed effect model is run, $\hat{\beta}$ is identified from individual variation in X_i around the individual mean, i.e. $\hat{\beta}$ is estimated of those which switch (change x over time). The α_i 's are unbiased, but inconsistent if T is fixed (Jurajda 2003). The fixed effects capture those factors such as physical distance, the length of the border (or contiguity), history, culture, and language that are constant over the span of the data and that are correlated with the volume of bilateral trade. FEM would be a better choice when one is interested in estimating typical trade flows between an ex ante predetermined selection of nations (Egger, 2000).

3.5 Random Effects Model

The random effects model (REM) treat effects as random absorbed into the error term so it specifies a particularly simple form of the residual covariance structure, namely $\in_i = \alpha_i + \mu_{it}$ with $E[\alpha_i \alpha_j] = \sigma_\alpha^2 \alpha$ if i = j and is 0 otherwise. Other than the only covariance is between μ_{it} and μ_{jt} which is σ^2 (Jurajda 2003). This procedure is consistent, provided that the number of missing observations is asymptotically negligible (Pindyck 1976). REM would be more appropriate when estimating typical trade flows between randomly drawn samples of trading partners from a larger population

3.6 Preferred Model

To choose between the GLS and FEM specification we used the J-test proposed by Davidson and MacKinnon (1993). If one model is the correct model, then the fitted values from the other model should not have explanatory power when estimating that model. Annex (8) shows that the J-test failed to reject both models i.e. GLS and FEX, meaning that the data do not provide enough information to discriminate between the two models.

4. Empirical Results

4.1 Model Results

Annex (1) shows the main results of the standard gravity model, where T1, P1, and, Y1 are natural logarithms of total foreign trade, population, and GDP of the exporter country. And T2, P2, Y2, and TCI2 are natural logarithms of total foreign trade, population, GDP, and Trade Complementarily Index of the importer country. While D1 is the distance between 16 capitals of Arab countries and the capital of Sudan. The signs of all the estimated coefficients are compatible with a priori theoretical explanations except the sign of GDP of the Sudan.Judging by the overall statistical and econometric diagnostic tests i.e. t statistic, F statistic, R squared, Adjusted R squared, and, Durbin Watson, the estimated coefficients are statistically diffrent from zero, and no presence of serial correlation. The results suggest that a high level of GDP of Sudan does not increase the foreign trade, while high levels of income in Arab countries suggest higher levels of bilateral trade with Sudan. Results show that an increase in the importer's GDP causes an increase in imports from Sudan. The sign of the Sudan's population is positive indicating more production and hence more bilateral trade, while it is negative for the importing countries reflecting the lack of absorption or economies of scale effects. Larger countries have a greater capacity to absorb imports than do their smaller counterparts. The coefficient of the distance variable has the expected negative sign and is highly significant. All other variables that augment the gravity model have an insignificant coefficient, implying that they do not have an impact on bilateral trade with Sudan. The model previously suffers from autocorrelation, correcting for autocorrelation by Cochran-Orcutt procedure removed the autocorrelation and increased the explanatory power of the model to reach .98 percent instead of 77 percent for the weighted statistics, and from 28 per cent to 59 per cent for unweighted statistics. However, the FEM in Annex (4) gave poor results; none of the standard gravity model variables is significant. The REM is near singular and cannot be estimated because its determinant is zero and

cannot be inverted. Concerning the two problems i.e. heteroscedasticity and zero trade flows, the first was catered for by applying White Heteroscedasticity Consistent Covariance, the other problem was not encountered.

4.2 Discussion

The coefficient of Sudan income is negative, therefore not compatible with a priori theoretical explanations, this is caused mainly by one of four possibilities i.e. trade -barriers, home-market effect, lower level of inter- industry trade, or government policies. Despite persistent efforts by the government to liberalize trade. The Index of Economic Freedom in Sudan indicated that trade with Sudan was subject to a high weighted average tariff rate of 11.4 percent in 2008. Import restrictions, discriminatory taxes, delays in customs clearance and non-transparent regulations are some of the factors impeding Sudanese trade The possibility of significant 'home-market' effect is refuted by the fact that the Sudan GDP is totally dependent on the GDP's of partner countries j, which implies either no effect or neutral effect of the home-market effects (Davis and Weinstein, 2003). The third possibility is confirmed by *TCI) which is close to zero for all Arab countries implying closer perfectly competitive trade structure through intra-industry trade. Sudan and other Arab economies depend to a greater extent on outside world which means that their degrees of openness are high therefore are exposed to external shocks. Their total foreign trade is increasing as a ratio to GDP. The most obvious features of Arab foreign trade is its dependence on primary goods i.e. oil, gas and agricultural products, the price of which are volatile causing difficulties for Arab countries to finance their imports (Kimbish, 2003). Traditionally, most of Sudan's exports to Arab countries are in the form of live and slaughtered animals, cotton, gum Arabic, and groundnuts. There are many problems associated with this; first there is a risk of rejecting the exported live animals, either for health or political reasons. Secondly, most export products come from the traditional sector which is subject to weather hazards, using obsolete production techniques, depending on imported inputs, and subject to price volatility. Thirdly, these exports are constrained by transpiration and storage facilities, in addition to the heavy taxes and customs charged on them. The recent exploration and exportation of oil which is supposed to support these exports have led to a surge in import of luxury goods at the expense of investment (capital) goods. There is a need to diversify the traditional agricultural exports and encourage trade through the slashing of all types of trade barriers.

5. Conclusion

The aim of this investigation was to estimate a gravity equation to explain patterns of Sudanese bilateral trade with Arab countries. Results of the model indicated that all the variables included in the gravity equation revealed the expected signs, except for the GDP of Sudan. The estimated coefficients yielded in most cases, the expected signs and magnitudes. The coefficient for the exporter population variable is negatively signed which shows an absorption effect, the greater the size of the exporter, the lower the exports. However, the estimated coefficient corresponding to the importer population is negatively signed (the sign is positive which points towards the growing importance of the role played by scale economies and market-size effects in international trade models. Concerning geographic distance, its coefficient presents a negative sign. The TCI showed that Sudan and its Arab trade partners have competitive trade structure through intra-industry trade. This calls for Sudan for more economic reforms in order to promote trade with Arab countries and other partners.

References

- Alcalá, F., & A. Ciccone. (2004). Trade and productivity *The Quarterly Journal of Economics*, 119(2), 613-646. http://dx.doi.org/10.1162/0033553041382139
- Anderson, James, E. (Jan 2011). The Gravity Model National Bureau of Economic Research Working Paper, No. 16576
- Andrew, K., Rose, & Mark, M. Spiegel. (2004) A Gravity Model of Sovereign Lending Trade, Default and Credit, *IMF Staff Papers*, 51, Special Issue pp 50-63
- Batra, Amita. (2004). India's Global Trade: The Gravity Model Approach the Indian Council for Research. *International Economic Relations (ICRIER) Papers.*
- Ben, Shepherd. (Dec. 2008). Behind the Border Gravity Modeling. ARTNeT Capacity Building Workshop for Trade Research Niehaus Center, Princeton University
- Breton, Regis, Sebastien, Galanti, Chersitoph, Hurlin, & Anne, Gael. Vaubourg. (2007). Does soft information matter? An application of gravity models to financial analysts' forecasts. CNRS & LEO-Universite d'Orleans.
- Broda, C., J. Greenfield, & D. Weinstein. (2006). from groundnuts to globalization: a structural estimate of trade and growth. *NBER WP*, 12512.
- Burguet, Celestino, Suares, Zarzoso, Inmaculada, Martinez, & Ramos, Luara, Marquez. (2002). The non linear

application of gravity model: an application on international trade, Departmento De Economia Universidad Jaume I Castelon Spain.

- Chan Hyun Sohn. (2003). Does the Gravity fit the Korea's trade Pattern? *Korea Institute for International Economic Policy*, Yokohama National University.
- Cheng, I., Hu, I., & Howard, J., Wall. (Feb 2005). Controlling for Heterogeneity in Gravity Models of Trade and Integration, Federal Reserve Bank of St. Louis Review
- Claudio, E., Montenegro, & Isidro, Soloaga. (Jun 2006). NAFTA'S Trade Effects: New Evidence with a gravity Model, *Estudios Do Economia*, 33, 45-63.
- Davidson, Russell, & James, G., MacKinnon. (1993). *Estimation and Inference in Econometrics*, Oxford University Press.
- Davis, & Weinstein. (2003). Market Access, Economic Geography, and Comparative Advantage. Journal of International Economics, 59.
- Derosa, Dean, A. (2007). Gravity Model Analysis, Maghreb Regional Integration Peterson Institute.
- Egger, P. (2000). A Note on the Proper Econometric Specification of the Gravity Equation, *Economics Letters*, 66, 25-31. http://dx.doi.org/10.1016/S0165-1765(99)00183-4
- Frankel, J. A., & D. Romer. (1999). Does Trade cause Growth? American Economic Review, 89(3), 379-399. http://dx.doi.org/10.1257/aer.89.3.379
- Harris Mark A., & Laszlo, Matyas. (1998). Econometrics of Gravity Model. *Melbourne Institute Working Paper*, No5/98.
- Heritage, Foundation. (2008). 2008 Index of Economic Freedom. http://www.heritage.org/index/default "Retrieved on 12/3/2012
- Jacque, Melitz. (2006). North, South and distance in the gravity model. *European Economic Review*, 51(2007), 971–991. http://dx.doi.org/10.1016/j.euroecorev.2006.07.001
- Joakim, Westerlundy, & Fredrik, Wilhelmssonz. (Feb 2006). *Estimating the Gravity Model without Gravity using Panel Data*. Department of Economics Lund University
- Jurajda, Stepan. (2003). Econometrics of Panel Data and Limited Dependent Variable Models. Lecture Notes Series Charles University Czech Republic.
- Keller, W. (1998). Are international R&D spillovers trade related? Analyzing spillovers among randomly matched trade partners? *European Economic Review*, 42, 1469-81. http://dx.doi.org/10.1016/S0014-2921(97)00092-5
- Kepaptsoglou, Konstantinos, Matthew, G., Karlaftis, & Dimitrios, Tsamboulas. (2010). The Gravity Model Specification for Modeling International Trade Flows and Free Trade Agreement Effects: A 10-Year Review of Empirical. Studies Center for Applied Microeconometrics University of Copenhagen.
- Kimbish, Mohammad, & Saeed, Mohammad. (2005). The future of Arab foreign Trade in the context of World Trade organization, Unpublished Ph.D. Yemen.
- Lawless, Martina. (July 2009). Destinations of Irish Exports A Gravity Model Approach, Central Bank and Financial Services Authority of Ireland.
- Letouze, Emmanuel, Mark, Purser, Francisco, Rodreguez, & Mathew, Cummins. (2009). Revising the Migration Development Nexus: a Gravity Model Approach. *Human Development Research Paper*, 44.
- Lewer, Joshua, & Hendrik, Van, der, Berg. (2008). A Gravity Model of Migration Management, Department Faculty Publications University of Nebraska Lincoln. *Published in Economics Letters*, 99(1), 164-167. http://dx.doi.org/10.1016/j.econlet.2007.06.019
- Lueth, Erik, & Marta, Ruiz, Arranz. (Dec. 2006). A Gravity Model of Workers' Remittances. *IMF Working Paper*, No 290.
- Lumenga, Neso, O. M. Olarrega, & M. Schiff. (2005). on Indirect' Trade-related R&D Spillovers. CEPR Discussion Paper, No. 2871.
- Martin, Will, & Cong, S., Pham. (Feb 2008). *Estimating gravity Model when Zero trade flows are Frequent*, World Bank.
- Nuno, Carlos, Leitão. (2010). The Gravity Model and United States. Trade European Journal of Economics, Finance and Administrative Sciences, 21.

- Nuroglu, Elif. (2009). The Impact of Population on Bilateral Trade Flows in the Case of OIC. International University of Sarajevo.
- Pindyck, R. S., & D. L. Rubinfield. (1976). *Econometric Models and Economic Forecast*. McGraw-Hill Book Company Potabov Alex Potapovab, Jim R. Muirheada, C.
- Sucharita Ghosh. (2011). The Gravity Model in International Trade Advances and Applications. *Review of International Economics*, 19(5), 979-981. http://dx.doi.org/10.1111/j.1467-9396.2011.01000.x
- Wright, Mark, L., J. (2004). New Empirical Results on default: a Discussion of a Gravity Model of Sovereign Lending Trade. *IMF Staff Papers*, 51, 64-74.
- Zarzoso, Inmaculada Martinez. (2000). Gravity Model: An Application to Trade between Regional Blocs, International Atlantic Economic Conference.
- Zarzoso, Inmaculada, Martinez, Lehmann, Felictas, & Nowak. (Nov 2003). Augmented Gravity Model an application to Mercosur European Union Trade Flows. *Journal of Applied Economics*. 4(2), 291 316.

Annex 1. Estimation Results of Augment Oravity Mo

Dependent Variable: ?T2 Method: GLS (Cross Section Weights) Date: 04/06/12 Time: 09:41 Sample: 1999 2008 Included observations: 10 Number of cross-sections used: 16 Total panel (unbalanced) observations: 140 Convergence achieved after 14 iteration(s) White Heteroskedasticity-Consistent Standard Errors & Covariance Cross sections without valid observations dropped

Variable	Coefficient	Std. Error	t-Statistic	Prob.		
С	22.06823	8.244188	2.676822	0.0084		
P1	7.471462	2.656347	2.812683	0.0057		
?P2	-0.161288	0.059612	-2.705627	0.0077		
Y1	-0.740544	0.364333	-2.032603	0.0441		
?Y2	0.646520	0.120426	5.368618	0.0000		
?D2	-5.647972	0.732987	-7.705421	0.0000		
AR(1)	0.732041	0.057266	12.78318	0.0000		
	Weighted	l Statistics				
R-squared	0.983423	Mean dependent var	7.585127			
Adjusted R-squared	0.982675	S.D. dependent var		10.98014		
S.E. of regression	1.445269	Sum squared resid		277.8108		
F-statistic	1314.988	Durbin-Watson stat		2.462477		
Prob(F-statistic)	0.000000					
	Unweighte	ed Statistics				
R-squared	0.585286	Mean dependent var		3.095301		
Adjusted R-squared	0.566577	S.D. dependent var	dent var 2.19529			
S.E. of regression	1.445270	Sum squared resid		277.8110		
Durbin-Watson stat	2.617996					

Prob.

0.0383

0.0001

0.0028

t-Statistic

-2.092273

4.059491

-3.051175

Annex 2. Estimation Results of the Basic Gravity Model

Dependent Variable: T2										
Method: GLS (Cross Section Weights)										
Date: 04/06/12 Time: 08:29										
Sample: 1999 2008										
Included observations: 10	Included observations: 10									
Number of cross-sections used: 16										
Total panel (unbalanced) observations: 140										
Convergence achieved after 10 iteration(s)										
White Heteroskedasticity-Consistent Standa	rd Errors & Covariance									
Cross sections without valid observations dr	ropped									
Variable	Coefficient	Std. Error								
С	C -18.78385 8.977728									
P1 11.26818 2.775762										
P2	-0.169202	0.055455								
V1	-0.757553	0.372506								

Y1	-0.757553	0.372506	-2.033667	0.0440		
Y2	0.332625	0.086306	3.854023	0.0002		
D	-2.004682	0.811875	-2.469200	0.0148		
TCI2	-0.382502	0.064996	-5.884980	0.0000		
AR(1)	0.573634	0.074800	7.668885	0.0000		
	Wei	ghted Statistics				
R-squared	0.984227	Mean dependent var		7.269648		
Adjusted R-squared	0.983391	1 S.D. dependent var 10.32830				
S.E. of regression	1.331084	Sum squared resid 233.8757				
F-statistic	1176.680	Durbin-Watson stat		2.386243		
Prob(F-statistic)	0.000000					
	Unwe	eighted Statistics				
R-squared	0.650872	Mean dependent var		3.095301		
Adjusted R-squared	0.632357	S.D. dependent var	2.195295			
S.E. of regression	1.331085	Sum squared resid	233.8760			
Durbin-Watson stat	2.591307					

Annex 3. Trade Conformity Index

Country	TCI	
Jordon	0.000230829	
UAE	4.06E-06	
Bahrain	0.096414964	
Tunisia	0.003611659	
Algeria	0.273890444	
KSA	1.13803E-05	
Syria	0.000192853	
Iraq	0.151057402	
Oman	0.137564508	
Qatar	0.09742982	
Kuwait	0.002240615	
Lebanon	0.000676499	
Libya	0.007851144	
Egypt	3.50E-05	
Mauritania	0.00000000	
Yemen	0.003620936	

Annex 4. Results of Fixed Effect

Annex 4. Kesuits of Fixed Effect				
Dependent Variable: T2				
Method: Pooled Least Squares				
Date: 04/06/12 Time: 08:37				
Sample: 1999 2008				
Included observations: 10				
Number of cross-sections used: 16				
Total panel (unbalanced) observations: 14	0			
Convergence achieved after 30 iteration(s)			
White Heteroskedasticity-Consistent Stan	dard Errors & Covariance	;		
Cross sections without valid observations	dropped			
Variable	Coefficient	Std. Error	t-Statistic	Prob.
P1	22.10266	12.45013	1.775296	0.0784
Р2	0.249532	0.267312	0.933487	0.3525
Y1	-1.488364	1.508657	-0.986549	0.3259
Y2	-0.319194	0.372753	-0.856314	0.3936
D2	3.357974	1.51E+14	2.22E-14	1.0000
TCI2	-4.523335	1.16E+14	-3.89E-14	1.0000
AR(1)	0.246056	0.115696	2.126744	0.0355
	F	ixed Effects		
JORC	-119.1187			
UAEC	-136.6949			
BAHC	-94.00107			
TUNC	-111.6240			
ALGC	-90.85542			
KSAC	-129.9983			
SYRC	-120.8013			
IRQC	-91.34836			
OMNC	-93.66948			
QTRC	-93.56932			
KWTC	-110.8228			
LEBC	-115.0466			
LBYC	-106.1633			
EGPC	-126.1482			
MORC	-87.06421			
YEMC	-107.3618			
R-squared	0.707519	Mean dependent var		3.095301
Adjusted R-squared	0.652523	S.D. dependent var		2.195295

Sum squared resid

Durbin-Watson stat

1.294064

47.17111

0.000000

195.9284

2.180591

S.E. of regression

Prob(F-statistic)

F-statistic

Annex 5. Home – Market effect

Dependent Variable: Y Method: GLS (Cross Section Weights)

Date: 03/18/12 Time: 16:55

Sample: 1999 2008

Included observations: 10

Number of cross-sections used: 16

Total panel (balanced) observations: 160

White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
С	-6295.491	618.4412	-10.17961	0.0000
JORJOR_Y	3.141182	0.115620	27.16820	0.0000
UAEUAE_Y	0.297432	0.006246	47.61873	0.0000
BAHBAH_Y	2.988741	0.077697	38.46647	0.0000
TUNTUN_Y	1.377963	0.261130	5.276919	0.0000
ALGALG_Y	0.416477	0.008488	49.06818	0.0000
KSAKSA_Y	0.139877	0.003872	36.12560	0.0000
SYRSYR_Y	1.352292	0.042152	32.08159	0.0000
IRQIRQ_Y	0.792702	0.146128	5.424712	0.0000
OMNOMN_Y	1.267209	0.051916	24.40904	0.0000
QTRQTR_Y	0.824539	0.077619	10.62284	0.0000
KWTKWT_Y	0.502054	0.010993	45.67040	0.0000
LEBLEB_Y	1.832801	0.245218	7.474182	0.0000
EGPEGP_Y	0.368028	0.051878	7.094154	0.0000
LBYLBY_Y	0.889726	0.028374	31.35758	0.0000
MORMOR_Y	0.700843	0.040174	17.44528	0.0000
YEMYEM_Y	2.387792	0.042368	56.35897	0.0000
	Wei	ghted Statistics		
R-squared	0.955648	Mean dependent var		47737.55
Adjusted R-squared	0.950685	S.D. dependent var		38546.55
S.E. of regression	8560.010	Sum squared resid		1.05E+10
F-statistic	192.5739	Durbin-Watson stat		1.083742
Prob(F-statistic)	0.000000			
	Unwe	eighted Statistics		
R-squared	0.774624	Mean dependent var		30404.30
Adjusted R-squared	0.749407	S.D. dependent var		17440.76
S.E. of regression	8730.719	Sum squared resid		1.09E+10
Durbin-Watson stat	0.867625			

Annex 6. J-test G	LS-FEM
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		GLS					FEM		
Variable	Coefficient	Std. Error	t-Statistic	Prob.		Coefficient	Std. Error	t-Statistic	Prob.
С	-20.67975	6.335508	-3.264103	0.0014					
P1	8.164577	2.931950	2.784692	0.0063	P1	-9.311583	6.092892	-1.528270	0.1291
P2	0.042692	0.042855	0.996197	0.3212	P2	0.034613	0.363248	0.095287	0.9242
Y1	-1.185023	0.331041	-3.579684	0.0005	Y1	0.945395	0.467430	2.022538	0.0454
Y2	-0.060800	0.056151	-1.082789	0.2812	Y2	-0.323206	0.214168	-1.509126	0.1340
D2	0.549262	0.415453	1.322080	0.1888	D2	0.385764	1.56E+13	2.47E-14	1.0000
TCI2	0.061081	0.052169	1.170822	0.2441	TCI2	1.004102	1.98E+13	5.06E-14	1.0000
T4	1.181800	0.123380	9.578528	0.0000	T3	1.291961	0.328710	3.930397	0.0001
AR(1)	-0.296675	0.090225	-3.288176	0.0013					
R-squared		0.982851					0.981045		

Annex 7. Trade Flows

obs	MUR_T	MOR_1	FALG_T	TUN_T	EGP_T	KSA_T	JOR_T	SYR_T	IRQ_T	LBY_T	LEB_T	OMN_T	YEM_T	BAH_1	г кwт_т	QTR_T
99	0	0.6	148.1	4.5	80	304.3	42.2	20.2	0	1.9	20.1	7.6	30.6	3.8	0.5	2.7
000	0	0.3	99	0.4	81.2	294.1	67.7	26.3	0	2.5	18.2	8.7	43	3.5	0.5	6.1
01	0	0.5	26	0.2	80.5	350.9	60.7	25.4	3.9	3	18.7	18.7	39.8	4.6	0.6	5.1
02	0	0.2	124.5	1	110.8	739.2	82.2	24.8	0.1	3.1	13.6	6.6	16.3	3.1	0.7	1.5
03	0.3	0.6	99.4	3.9	164.56	862.6	126.9	28.8	66.3	17	87.8	10.4	4.5	5.2	27.4	10.4
04	0	0.1	167.9	4.5	319.8	666.6	167.5	29	87.9	39.1	134.3	8.6	6.1	9.4	35.8	24.5
05	4.6	0.8	0.7	10.74	448.2	769.7	48.4	638.9	0.3	14.8	32	0.2	10.8	183.1	28.4	11.1
06	0.1	1.1	5.7	14.1	525	800.8	124.1	26	18.7	41.2	153.7	8.3	47.6	19.7	101.2	31.8
07	0.4	1.2	3.3	15.6	547.4	774.1	72.5	59.9	0	26.6	46.5	14.4	2	59.8	53.9	31.1
08	0	2.4	4.9	43.2	511.9	892.1	103.2	94.9	0.1	11.5	49	32.3	66.1	6.1	18.2	35.8