The International Trade Journal

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/uitj20

Assessing Intra-Arab Trade Integration and Potential: Evidence from the Stochastic Frontier Gravity Model

Ebaidalla M. Ebaidalla & Mohammed Elhaj Mustafa Ali

To cite this article: Ebaidalla M. Ebaidalla & Mohammed Elhaj Mustafa Ali (2023) Assessing Intra-Arab Trade Integration and Potential: Evidence from the Stochastic Frontier Gravity Model, The International Trade Journal, 37:2, 221-239, DOI: 10.1080/08853908.2022.2029725

To link to this article: https://doi.org/10.1080/08853908.2022.2029725

THE INTERNATIONAL TRADE JOURNAL
2023, VOL. 37, NO. 2, 221–239
https://doi.org/10.1080/08853908.2022.2029725

Routledge
Taylor & Francis Group

Assessing Intra-Arab Trade Integration and Potential: Evidence from the Stochastic Frontier Gravity Model

Ebaidalla M. Ebaidalla [a] and Mohammed Elhaj Mustafa Ali [b]

[a]Ibn Khaldon Center for Humanities and Social Sciences, Qatar University, Doha, Qatar; [b]Development Studies and Research Institute, University of Khartoum, Khartoum, Sudan

ABSTRACT

This study aims to detect the presence of "*behind the border*" and "*beyond the border*" constraints on trade flows among Arab countries, using the stochastic frontier gravity model (SFGM) over the period of 1998 to 2015. The empirical results indicate that "*behind the border*" constraints are responsible for a considerable gap between potential and actual trade among Arab countries. The results also reveal that the influence of "*behind the border*" constraints on trade flows between Arab countries has been decreasing over time. Moreover, the efficiency scores of intra-Arab trade indicate a relatively low degree of trade integration among Arab countries.

KEYWORDS

Intra-Arab trade; stochastic frontier gravity model; behind the border; beyond the border; Arab countries

I. Introduction

In the Arab world, the initiatives for regional integration began in the second half of the past century. Many bilateral and multilateral trade arrangements for economic cooperation among Arab countries have been launched, including custom union and free trade areas. However, despite all these efforts, the actual intra-Arab trade performance remained at less than the potential level. According to the International Monetary Fund's trade statistics, the volume of intra-Arab trade during the last decade is very negligible and does not exceed 6% (International Monetary Fund 2016).

From a scholarly perspective, voluminous numbers of studies have tried to inspect the reasons behind the unsatisfactory intra-trade performance in the Arab region (e.g., Bolbol (1999); Söderling (2005); Bolbol and Fatheldin (2006); Al-Atrash and Yousef (2000); and Abdmoulah (2011), among others). However, all these studies have employed the two-stage conventional gravity model, which ignores the role of what is called "*behind the border*" and "*beyond the border*" inefficiencies in curbing (promoting) the achievements of trade potential levels (Bhattacharya and Das 2014; Kalirajan and Singh 2008;

CONTACT Ebaidalla M. Ebaidalla ebaidalla@gmail.com Ibn Khaldon Center for Humanities and Social Sciences, Qatar University, Doha, Qatar

Supplemental data for this article can be accessed on the publisher's website.

Ravishankar and Stack 2014; Tamini, Chebbi, and Abbassi 2016).[1] To this end, this study employs the stochastic frontier gravity model to assess the actual trade volume against the maximum level of possible trade (i.e., frontier) in the Arab region. Adopting this modeling technique would assist us to consider *"behind the border"* and *"beyond the border"* inefficiencies. In addition, the study examines how far intra-Arab trade is from reaching its potential level given the existing "*behind the border*" and "*beyond the border*" constraints to exports and imports.

This study would serve in assessing intra-Arab trade integration and trade potential and, therefore, contributes to the enhancement of regional integration among Arab countries on many fronts. First, this study fills the existing gap in the literature concerning the assessment of trade integration in the Arab world by using a stochastic frontier gravity model (SFGM). Second, investigating the impact of the hidden factors on trade integration between Arab countries (i.e., behind and beyond the border) would provide policymakers with the basis to be more strategic in dealing with trade and trade facilitation matters. Finally, this study is timely and relevant if taken in the context of the current political and social developments experienced by Arab countries.

The remainder of this article is structured as follows. Section 2 provides some stylized facts about intra-Arab trade. Section 3 discusses the related literature, while Section 4 outlines the methodology of the stochastic frontier gravity model (SFGM) along with data and data sources. Section 5 presents and discusses the empirical results. Finally, Section 6 concludes and offers some policy implications.

II. Some stylized facts about intra-Arab trade performance

Arab countries are made up of 22 Arab-speaking states, constituting the Arab League.[2] These countries have noticeable similarities in terms of language and cultural, historical, social, and religious values. It is worth mentioning that the history of economic integrations in the Arab world dates back to 1945, when the Arab League was founded (Neaime 2005). Subsequently, in 1953, the Economic and Social Council of the Arab League took further steps to promote intra-Arab trade by launching the first arrangements on Trade Facilitation and Organizing Transit Trade among Arab countries. In 1957, the same council approved an agreement on the free movement of people and

[1]Behind the border constraints are institutional and infrastructure rigidities that exist in home countries, which are concerned with regulatory policies that impede trade flows such as restrictions on foreign trade and investment, tolerance of business cartels, monopoly privileges given to public enterprises, and the cost and performance of infrastructure services, customs, and transport that generally affect the domestic costs of production (Kalirajan and Singh 2008). On the other hand, beyond the border constraints mainly refer to non-tariff barriers and other institutional rigidities that exist in the partner countries.

[2]The Arab League's countries include: Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, the United Arab Emirates, and Yemen.

capital as well as established a common customs area under the name "Arab Economic Union." The common market became effective in 1964, and a number of Arab states joined this agreement in 1965. In 1981, the Arab countries agreed to launch an agreement for the "Facilitation and Promotion of Trade among Arab States" which aimed to enhance the Arab Common Market agreement to all member countries of the Arab League (Abu Hatab 2015). In 1996, a program for creating the Greater Arab Free Trade Area (GAFTA) was approved by 17 Arab countries that agreed on a successive elimination of trade barriers (Abdmoulah 2011). Furthermore, the efforts for regional integration among Arab countries have continued over the last four decades with the adoption of many bilateral and sub-regional trade agreements (Abdmoulah 2011). The most prominent sub-regional economic agreements are the Gulf Cooperation Council (GCC), the Arab Maghreb Union (AMU), and the Agadir (AGADIR) Agreement.

Nevertheless, despite the rapid progress in the legislative framework toward promoting trade relations and economic integration among Arab countries, the performance of intra-Arab trade is the lowest when compared to other regional integration blocs such as ASEAN and NAFTA (Abu Hatab 2015). That is to say despite the relative homogeneity in terms of religion, culture, and language along with the preferential market access, the regional integration in the Arab region is far less than its potential.

Regarding the economic and trade performance of Arab countries, Table 1 shows some basic economic and trade indicators of Arab economies. The table reveals that the Arab region hosts about 383.06 million inhabitants. However, the distribution of those inhabitants varies considerably from one country to another, ranging from less than one million in Comoros and Djibouti to about 94 million in Egypt.

The table shows that the level of economic activity measured by GDP per capita (constant 2010 US$) also varies widely among Arab countries. Some countries like Comoros and Mauritania exhibit very low levels of GDP per capita, while others like Kuwait, Qatar, and the United Arab Emirates (UAE) report high levels of GDP per capita. Moreover, some countries have experienced a sizable increase in GDP per capita during the period of 2000 to 2015. For example, the per capita income of Morocco and Sudan increased remarkably during this period. These variations in per capita GDP and growth reflect the high disparities in the economic performance of Arab countries.

As shown in Table 1, Arab countries have experienced some improvements in terms of regional trade integration over the last two decades. This is indicated by the substantial increases in intra-regional exports and imports between 2000 and 2015. In 2015, for instance, the intra-regional exports of some countries like Saudi Arabia and the UAE were very high, while other countries like Djibouti, Libya, and Mauritania reported very low intra-regional exports and imports. Moreover, the intra-Arab exports and imports

Table 1. Arab countries: Selected economic and trade indicators (2000 to 2015).

Country	Population (million) 2015	GDP per capita (USD) 2000	GDP per capita (USD) 2015	Intra-Arab Exports- in USD million 2000	Intra-Arab Exports- in USD million 2015	Intra-Arab Imports- in USD million 2000	Intra-Arab Imports- in USD million 2015	Share in Total Arab Trade (%) 2000	Share in Total Arab Trade (%) 2015
Algeria	39.87	3,541.07	4,759.60	312.18	2,087.02	190.35	2,471	1.25	2.19
Bahrain	1.37	22,955.09	22,436.21	490.67	10,145.36	427.43	6,351.1	2.29	7.94
Comoros	0.77	806.43	769.48	0.03	0.57	2.35	41.79	**0.01**	**0.02**
Djibouti	0.92	1,072.62	1,579.92	2.451	121.97	20.08	612.28	**0.06**	**0.35**
Egypt	93.77	1,950.61	2,665.35	566.22	7,878.27	1,394.3	9,039.6	4.89	8.14
Iraq	36.11	4,311.28	5,285.67	1,124.58	1,947.88	463.34	3,099.5	3.96	2.43
Jordan	9.15	2,810.04	3,297.89	581.02	3,340.43	1,076.2	5,131.2	4.13	4.08
Kuwait	3.93	35,792.71	35,490.29	512.48	3,866.84	1,061.8	6,225.3	3.92	4.86
Lebanon	5.85	6,747.63	7,044.61	326.93	1,596.10	766.95	2134.2	2.73	1.80
Libya	6.23	8,967.25	N/A	189.57	518.43	214.02	630.1	1.01	0.55
Mauritania	4.18	998.11	1,306.65	2.44	43.72	15.482	413.7	0.04	0.22
Morocco	34.80	1,972.30	3,204.75	258.49	1,118.65	1,431.24	3,512.56	4.21	2.23
Oman	4.19	18,698.40	17,070.96	1,331.84	8,139.45	1,715.93	13,668.36	7.60	10.50
Qatar	2.48	60,858.19	67,277.24	728.71	7,280.00	539.46	5,755.89	3.16	6.28
Saudi Arabia	31.55	18,263.23	21,507.96	10,859.36	28,263.64	1,880.96	17,987.52	**31.75**	**22.27**
Somalia	13.90	N/A	NA	113.91	683.35	64.06	448.95	0.44	0.55
Sudan	38.64	1,003.00	1,881.90	447.09	1,833.78	418.11	2,058.54	2.16	1.87
Syria	18.73	N/A	N/A	3,159.73	531.06	458.6	932.2	9.02	0.70
Tunisia	11.27	3,004.61	4,264.52	432.91	1,541.95	666.7	1,573.1	2.74	1.50
UAE	9.154	62,833.25	40,159.56	3,245.50	29,084.46	1,603.00	13,374.44	**12.08**	**20.44**
Yemen	16.10	1,138.25	772.03	210.42	466.29	817.38	1,763.37	2.56	1.07
Arab World	383.06	257,724.06	240,774.5	24,896.53	110,489.22	15,227.74	97,224.7	100.00	100.00

Source: Authors' calculations based on data from World Bank Indicators and the IMF's Direction of Trade Statistics (DOTS).
Notes: Palestine is excluded due to a lack of trade data.

performance for Comoros, Djibouti, and Mauritania did not exceed 500 million US dollars in 2015. Notably, Saudi Arabia and the UAE captured the lion's share of intra-Arab trade during the last 15 years. The huge contribution of Saudi Arabia and the UAE can be explained by the successful efforts the two countries exerted regarding economic diversification and trade liberalization, as these countries have been considered a hub of trade in the region.

Except for Egypt, the Arab Spring countries have reported a decline in intra-Arab trade during the period (2000 to 2015). This declining trend in inter-Arab performance can be attributed to the conflicts and political instability that emerged in these countries during the last decades. That is, countries like Libya, Syria, Tunisia, and Yemen have witnessed a decreasing trend in intra-regional exports and imports from 2000 to 2015. Strikingly, the contribution of Syria in Arab trade has declined from 9.02% in 2000 to 0.7% in 2015. Overall, Oman, Saudi Arabia, and the UAE were the most active trading partners amongst Arab states, as their contributions to total trade in 2015 accounted for more than 10%. The remarkable increase in both exports and imports for most Arab countries between 2000 and 2015 implies that the creation of the

Greater Arab Free Trade Area (GAFTA) as well as sub-regional integrations, such as AGADIR and AMU, has led to notable improvements in intra-Arab trade.

III. Literature review

A huge body of literature on assessing regional trade integrations has emerged over the last decades. However, most of these studies have employed the conventional gravity model. In this section, we review a number of empirical studies on evaluating trade performance. On the whole, these studies can be divided into two categories, namely studies that used the conventional gravity model and the ones that employed the stochastic frontier gravity model.

Regarding the first category, there are relatively numerous studies that have adopted the conventional approach in evaluating trade performance in different countries and regions (e.g., Anderson (1979); Kalirajan (2000); Nilsson (2000); and Ebaidalla and Yahia (2014)). For example, Pastore, Ferragina, and Giovannetti (2009) examined the trade performance of European Union (EU) members with the Mediterranean (MED) countries and new EU members using a two-stage gravity model of intra-EU trade including 13 members throughout 1995 to 2002. Employing an out of sample method, they found that there is a substantial unexploited trade potential within both groups of partners, but the ratio of potential to actual trade with MED countries was much larger, more dispersed, and stable compared to that with new EU members. The study also indicated that the potential trade tends to congregate to actual trade in a much longer time in the case of Mediterranean countries. In the same vein, Chauvin and Gaulier (2002) examined the potential of intra-South African Development Community (SADC) trade. The authors indicated that there is some complementarity between SADC countries and that SADC countries have similar comparative advantages; hence, the potential for further trade integration within this trading bloc is limited. Moreover, Ebaidalla and Yahia (2014) examined the performance of intra-COMESA trade integration in comparison with ASEAN integration. Using an out-of-sample approach and the two-stage gravity approach, they pointed out that COMESA countries are far from their potential trade level, implying the unfavorable performance of the regional trade integration among COMESA members. The authors also found that the gap between potential and actual trade has decreased over time, suggesting a convergence toward the potential trade.

For Arab countries, Al-Atrash and Yousef (2000) examined the trade performance of 18 Arab countries with 43 trading partners during the period of 1995 to 1997. Using a gravity model, the authors found that within the sub-regional arrangements, intra-Arab trade is higher than overall intra-Arab trade. They also pointed out that the GCC and AMU trading arrangements have no significant effect on promoting integration among member countries. In

contrary, the Maghreb sub-regional arrangement is found to be effective in achieving higher levels of regional integration among member countries. Recently, Abdmoulah (2011) investigated the factors influencing Arab trade integration, focusing on the main trade arrangements (i.e., GAFTA, AMU, GCC, and AGADIR) over the period of 1997 to 2008. Adopting a zero-inflated negative binomial gravity model, he found that market size, distance between trading partners, and common colonizers and borders are found to be the most important factors affecting intra-Arab trade. The author also found that the performance of Arab trade arrangements is disappointing, except for GAFTA.

The second strand of empirical studies that adopted the stochastic frontier gravity model (SFGM) has emerged in recent decades. Kalirajan (1999) introduced the first edition of the SFGM with varying coefficients, but later a modified version of the SFGM where only the intercept term varies was adopted by a group of researchers including Ravishankar and Stack (2014), Bhattacharya and Das (2014), Stack and Pentecost (2011), and Tamini, Chebbi, and Abbassi (2016).

For instance, Stack and Pentecost (2011) employed a stochastic frontier specification of the gravity model for 20 OECD trading partners with EU countries during the period of 1992 to 2003. Based on an out-of-sample approach, they projected the potential trade for 10 new member states and 10 associated countries. Their results revealed that the projected trade ratios for the 10 new member states are multiples of actual 2003 levels, indicating that trade expansion between these countries will expand in the future. On the other hand, for the Mediterranean countries, the ratio of potential to actual trade was found to be a near unity value, implying fewer opportunities for further trade expansion within the EU. Likewise, Kalirajan (2007) examined trade flows between Australia and the Indian Ocean Rim Association for Regional Cooperation (IOR-ARC) countries. Using the stochastic frontier gravity model, his results showed that the socio-political-institutional factors (i.e., behind the border) are the most significant constraints preventing Australia from realizing its export potential with IOR-ARC countries. The empirical analysis also indicated that Australia has been able to achieve more (about 15%) of its potential exports with IOR-ARC due to regional trade cooperation with these countries.

Recently, Bhattacharya and Das (2014) studied the intra-trade performance of the South Asian Association for Regional Cooperation (SAARC). Employing a stochastic frontier gravity model, they investigated the presence of significant "*behind the border*" and "*beyond the border*" constraints and examined the potential synergy between trade and development goals in the context of SAARC. The article concluded that there is considerable potential for improvement of trade complementarities among SAARC members. Furthermore, their results also revealed that the country-specific "socio-

political–economical–institutional" rigidities (i.e., behind the border constraints) represent the main barriers to trade. More recently, Tamini, Chebbi, and Abbassi (2016) analyzed the trade potential versus actual trade among North African trading partners over the period of 2001 to 2012. Based on a stochastic frontier gravity model, their results indicated that Mauritania, as a country of both destination and origin, has the least efficient trading relationship. The results also show that Tunisia, followed by Morocco, faces the fewest behind- and beyond-the-border effects.

Despite the intensive and diverse empirical literature on assessing the intra-trade performance of different trading blocs, the performance of intra-Arab countries has not been studied adequately. Moreover, most of the previous studies on Arab countries (e.g., Abdmoulah (2011); and Al-Atrash and Yousef (2000)) used the conventional gravity model that measures potential trade from the mean and neglects *"behind the border"* and "*beyond the border"* constraints. With this shortcoming in mind, the distinguishing feature of this study is the use of the stochastic frontier gravity model to assess the observed trade against a maximum level of feasible trade for the group of Arab countries. In particular, a trade frontier representing the maximum possible level of bilateral trade will be constructed and then used as a benchmark for actual trade.

IV. The theoretical model and methodology

Stochastic frontier approach

To overcome the shortcomings associated with the conventional gravity model, the study adopts the stochastic production frontier analysis introduced by Kalirajan (1999) to address the inherent bias of the conventional gravity model of trade and to estimate potential trade flows. The stochastic frontier gravity model (SFGM) was further developed by Bhattacharya and Das (2014) and Kalirajan (2007).[3] The SFGM measures trade frontier as the maximum possible level of trade for a given bilateral trading pair that is impacted by a random error term, which can be positive or negative, thereby allowing the stochastic frontier trade level to vary about the deterministic part of the gravity equation. The observed trade levels can then be compared against this frontier level for each bilateral trading pair to assess the scope for trade expansion between them.

The stochastic frontier gravity model combines the gravity model and the stochastic frontier approach with the non-negative error term. Specifically, the non-negative error term represents "*behind the border*" inefficiencies in the

[3]It is worth noting that the first version of the stochastic frontier gravity model (SFGM) was introduced by Kalirajan (1999) and refers to the "varying coefficients" stochastic frontier gravity model in which both the slope and intercept coefficients vary, while the latter version refers to the conventional SFGM that was used by Bhattacharya and Das (2014) and others, in which only the intercept term varies.

exporting country that prevent it from reaching its trade frontier. The random term, on the other hand, captures all other disturbances including "*beyond the border*." Thus, the above conventional gravity model can be modified to an SFGM version as in the following form:

$$Trade_{ijt} = f\left(GDP_{it}, GDP_{jt}, POP_{it}, POP_{jt}, DIS_{ij}, Z_{ij}, X_{ijt}\right) \exp(V_{ijt} - u_{ijt}) \quad (1)$$

where $Trade_{ijt}$ is the bilateral trade between two countries i and j over a certain period of time t; GDP_{it} and GDP_{jt} reflect the economic sizes of both countries; POP_{it} and POP_{jt} are population of country i and j, respectively; and DIS_{ij} is the distance between a pair of countries. The error term involves two parts: the two-sided (V_{ijt}) and one-sided error term (u_{ijt}). The two-sided error element (V_{ijt}) captures the influence on trade flows of other variables, including measurement errors and the implicit *beyond the border* constraints that are not under the control of the exporting country and are randomly distributed across observations in the sample. Whereas, the one-sided error term (u_{ijt}) shows the combined effects of "*behind the border*" constraints on trade and can identify the degree to which observed trade levels deviate from the maximal possible. These deviations from the maximal trade level can occur due to multilateral barriers and socio-political-institutional factors (often unobservable or difficult to quantify) that prevent the trade level from reaching its potential (Anderson and van Wincoop 2003).

To estimate the above SFGM, the study uses the maximum likelihood estimation (MLE) which was adopted by Aigner, Lovell, and Schmidt (1977) to verify the impact of the "*behind the border*" constraints on potential trade.[4] Besides the estimation of the gravity model parameters, the SFGM analysis provides some supplementary estimators to evaluate the estimated model and to identify the effect of "*behind the border*" and "*beyond the border*" constraints. Therefore, based on the above specified model, the SFGM analysis estimates the *Sigma-squared* (σ^2), which is a measure of the mean of total variation in the model. The significance of σ^2 indicates that the potential trade over time has shown a significant variation from its asymptotic mean (Kalirajan 2007). To understand the nature of the variations in potential trade, the SFGM analysis also estimates the *gamma* coefficient. The *gamma* coefficient measures the total variation in trade that is due to the influence of country-specific socio-political institutional factors (i.e., *behind the border*).[5]

[4]The model was estimated using the "sfrontier" command of STATA 14.

[5]The gamma coefficient is an average over the time period, which can be measured as:

$$\gamma = \left[\left(\sum_t \sigma_{ut}^2\right) / \left(\sum_t \sigma_{ut}^2 + \sigma_{vt}^2\right)\right] / T$$

where σ_{ut}^2 is the variance of the one-sided error term at period t; σ_{vt}^2 is the variance of the random error term at period t; and T is the total number of time periods, that is 18 years (i.e., 1998 to 2015).

The significance of *gamma* implies that the influence of "*behind the border*" constraints are responsible for the gap between potential and actual trade. For further insight concerning the temporal behavior of the *gamma* coefficient, we rely on the *eta* coefficient. This is equivalent to examining whether the impact of "*behind the border*" constraints toward achieving the potential trade level has been increasing from one period to another or not. If, for instance, the *eta* coefficient is positive and significant, then the constraining impact of "*behind the border*" effects on achieving potential trade would be decreasing over time. On the other hand, if the *eta* coefficient is negative and significant, this implies that "*behind the border*" effects on potential trade would be increasing over time. Finally, if the *eta* coefficient is zero or not significant, then the impact of "*behind the border*" effects would be fixed over time (Bhattacharya and Das 2014; Kalirajan 2007).

After estimating the parameters, the point estimates of technical efficiency can then be measured using Battese and Coelli's (1988) formula:

$$TE\left[-u_{ijt}|\varepsilon_{ijt}\right] = \left[\frac{1-\left(\sigma_* - u*_{ijt}/\sigma_*\right)}{1-\left(-u*_{ijt}/\sigma_*\right)}\right] exp\left(-u*_{ijt} + \frac{1}{2}\sigma_*^2\right) \tag{2}$$

where $u*_{ijt} = \varepsilon_{ijt} - \sigma_v^2/\sigma_u$, and $(.)$ is the standard normal density function. The technical efficiency estimates for each country-pair range between zero and unity. A *TE* value of unity would imply that the actual and potential trade levels coincide, while values tending toward zero would indicate scope to raise actual trade levels.

Empirical model

Based on the existing literature and above discussion, the full gravity model to examine the determinants of intra-Arab trade performance can be specified as follows:

$$\begin{aligned} LnTrade_{ijt} = {} & \alpha_{ij} + \beta_1 LnGDP_{it} + \beta_2 LnGDP_{jt} + \beta_3 LnPOP_{it} + +\beta_4 LnPOP_{jt} + \\ & \beta_5 LnDIS_{ij} + \beta_6 LnREX_{it} + \beta_7 LnREX_{jt} + \beta_8 lnINFR_{it} + \beta_9 lnINFR_{jt} + \beta_{10} LnINS_{it} + \\ & \beta_{11} LnINS_{jt} + \beta_{12} CB_{ij} + \beta_{13} Sub_{ij} + \nu_{ijt} - u \end{aligned} \tag{3}$$

where $Trade_{ijt}$ is the trade flow. GDP_{it}, GDP_{jt}, POP_{it}, POP_{jt}, *and* DIS_{ij} are the core determinants of trade as previously defined. The gravity model is extended by two dummy variables, CB_{ij} and Sub_{ij}, which represent the vector of time-invariant explanatory variables. CB_{ij} captures the common border, taking a value of one if the two countries share a common land or sea border, and zero otherwise. Sub_{ij} is a dummy variable that reflects the membership of a sub-regional integration, it takes a value of one if the reporting and partner

countries are members in the same sub-regional trade integration. The definitions and source statistics of the variables used in the analysis are presented online in Appendix I.

Based on the previous discussion, we disaggregated the sample into three main sub-regional integrations, namely, GCC, AMU, and AGADIR. In addition, the model is extended by a vector of time-varying explanatory variables, such as real exchange rate, level of infrastructure, *INFR*, and institutional quality for both the reporting and trading partner. Finally, $v_{ijt} - u$ is the error term as previously defined. The one-sided error term u is usually assumed to follow a truncated (at zero) normal distribution, with mean μ and variance σ_u. Thus, the significance of μ indicates that the assumption of the truncated normal distribution for u is valid for the data set used in the estimation.

For the robustness check, Equation (3) is estimated for different specifications. First, to understand the effect of sub-regional Arab integrations on bilateral trade performance, we estimated two models: one includes sub-regional integration bodies (i.e., GCC, AGADIR, and AMU), while the other excludes these sub-regional integrations. Second, to gain further insight into the effect of a global financial crisis, the full sample period (i.e., 1998 to 2015) is divided into two sub-periods: the first period (1997 to 2007) covers the period which precedes the global financial crisis, while the second one covers the period after the financial crisis (i.e., 2008 to 2015).

Data sources

The data used in the gravity model includes 17 Arab countries over the period of 1998 to 2015. Appendix III shows the countries included in the analysis. This period is selected because trade between Arab countries witnessed some improvement, particularly after the establishment of the Greater Arab Free Trade Area (GAFTA).[6] This period also registers very few zero or missing trade observations; hence, our data is a nearly balanced panel. The trade data for Arab countries are extracted from UN COMTRADE international trade data and the International Monetary Fund's Direction of Trade Statistics (DOTS). The data on GDP, population size, exchange rate, and infrastructure are obtained from the World Bank's Development Indicators. Data on distance in kilometers between countries is calculated using the following website: http://www.distancefromto.net/countries.php. Information about common border is sourced from the CIA World Factbook. Finally, institutional quality is proxied by the polity index, which was gathered from Marshall, Keith, and Robert's (2016) database.

[6]The countries are chosen according to the availability of data.

The descriptive statistics in the online Appendix II shows some variations regarding the economic indicators of Arab countries. Appendix II reveals that the standard deviation of real GDP is very big, implying that there is a considerable disparity in economic performance in the Arab region. This heterogeneity supports the results in Table 1, as Kuwait and Qatar enjoy the very highest per capita GDP, while countries like Comoros, Djibouti, and Mauritania registered a very low GDP per capita. The descriptive statistics also indicate that population has a high standard deviation, suggesting that Arab countries exhibit a high rate of disparities. These discrepancies in the real GDP and population size reflect the disparities in market size in Arab countries, hence affecting the intra-regional trade performance. The descriptive statistics show that the mean of exports, imports, and total trade is relatively low with high standard deviations. Moreover, the relatively high standard deviation of the real exchange rate reflects the variation regarding exchange rate regimes. Finally, the political stability index reports a low mean of −4 and ranges widely from −10 to +7, implying lower institutional quality in the Arab region.

V. Empirical results and discussion

This section presents the empirical results and discussion. The section is divided into two sub-sections: the first one presents the estimation results of the SFGM pertaining to the determinants of trade flow between Arab countries using the maximum likelihood estimation (MLE). The second section outlines the efficiency scores of trade flow among Arab countries.

SFGM estimation results

Based on the methodology outlined above, the frontier stochastic gravity model specified in Equation (3) is estimated using the MLE for four specifications as presented in Table 2. Column 2 and Column 3 report the estimation results of the gravity equation for the models without and with sub-regional Arab integration, respectively. In addition, Columns 4 and 5 present the MLE results for models pertaining to pre- and post-global financial crisis, respectively.

First, the findings based on the full sample in Columns 2 and 3 indicate that most of the estimated coefficients carry their expected signs, in line with theory. The table also points out that all the variables are statistically significant, except real exchange rate. Specifically, the coefficients of real GDP for both the reporting and trading partner are positive and statistically significant, implying that an increase in the national income of exporters and importers encourages trade flows.

Table 2. Maximum likelihood estimates of the stochastic frontier gravity model for trade (Exports + Imports) among Arab countries (1997 to 2015).

Variable	Without sub-regs	With sub-regs	Pre-crisis	Post-crisis
Exporter' GDP	1.280***	1.301***	1.175***	1.032***
	(0.086)	(0.079)	(0.159)	(0.109)
Partner' GDP	0.907***	1.025***	0.478***	0.732***
	(0.103)	(0.092)	(0.142)	(0.117)
Exporter' population	0.774***	0.764***	1.063***	0.511***
	(0.072)	(0.066)	(0.105)	(0.100)
Partner' population	0.652***	0.736***	0.820***	0.496***
	(0.086)	(0.085)	(0.109)	(0.091)
Exporter' infrastructure	0.152***	0.111***	0.036	0.150
	(0.063)	(0.058)	(0.097)	(0.102)
Partner' infrastructure	0.191***	0.205***	0.196***	0.328***
	(0.59)	(0.057)	(0.097)	(0.088)
Exporter' RER	0.008	0.002	0.172**	0.030
	(0.026)	(0.023)	(0.071)	(0.046)
Partner' RER	0.010	0.057	0.106*	0.014
	(0.048)	(0.040)	(0.061)	(0.060)
Exporter' polity index	−0.003	−0.009	−0.050***	−0.013
	(0.008)	(0.008)	(0.015)	(0.011)
Partner' polity index	−0.019***	−0.019***	0.006	0.008
	(0.007)	(0.007)	(0.015)	(0.010)
Distance	−0.608***	−0.590***	−0.788***	−0.348**
	(0.178)	(0.121)	(0.222)	(0.162)
Common border	0.754**	0.333	1.127***	0.983***
	(0.310)	(0.258)	(0.353)	(0.339)
GCC		0.064		
		(0.354)		
AGADIR		0.972***		
		(0.365)		
AMU		1.342***		
		(2.255)		
Intercept	−19.148***	−16.165***	−18.689***	−10.510***
	(2.820)	(0.348)	(4.162)	(2.919)
Sigma-squared	2.196***	2.527***	1.449***	1.861***
	(0.221)	(0.277)	(0.122)	(0.225)
gamma	2.345***	2.700***	1.668***	2.503***
	(0.242)	(0.296)	(0.152)	(0.245)
Mu	2.430***	0.692	3.943***	2.616***
	(0.782)	(1.257)	(0.607)	(0.653)
eta	0.022***	0.024***	0.023***	0.010***
	(0.002)	(0.002)	(0.003)	(0.003)
Log Likelihood	−5110.49	−5100.91	−2397.87	−2491.52
Wald chi2	1013.01(0.000)	1141.55(0.000)	382(0.000)	404.57(0.000)
No. of Observations	4649	4649	2527	2122

Notes: Standard errors are reported in parentheses. ***, **, and * denote significance at the 1, 5, and 10% level, respectively.

Expectedly, the results reveal that the impact of population size in both the reporting and trading partner is found to be positive and significant, suggesting that population size exerts a positive effect on intra-Arab trade flows. In the same way, the coefficient of geographical distance is negative and significant as expected. These findings are consistent with most of the previous studies (e.g., Bhattacharya and Das (2014); and Ravishankar and Stack (2014)).

As expected, the results of Columns 2 and 3 point out that the impact of infrastructure in both the reporting and trading partner is positive and significant. This finding implies that infrastructure plays a significant role in

facilitating trade among Arab countries. Unexpectedly, the coefficients of real exchange rate are not significant, suggesting that exchange rate policy has no role in influencing trade between Arab countries. This may be justified by the fact that most Arab countries, particularly GCC members, have adopted a pegged exchange rate policy for a long time.

The impact of institutional quality in a trading partner is found to be negative and significant, contradicting empirical studies. That is, the political quality of trading partners reduces bilateral trade. This can be explained by the distorted political and institutional situation in Arab countries, as most of the largest trading partners in the region lack democracy and institutional quality. The coefficient of the dummy variable of common border is positive and statistically different from zero as expected. This result suggests that countries that share common borders have more opportunities to trade with each other.

Regarding the impact of sub-regional trade arrangements, the results of Column 3 show that the dummy variable of GCC is insignificant, suggesting that GCC integration has no important role in facilitating trade among members. This result can be explained by the fact that the members of GCC are oil-exporting countries and trade mainly with countries outside the region; hence, the level of bilateral trade among GCC members is relatively low. However, the coefficients of AGADIR and AMU integrations are positive and significant, implying that being a member of AGADIR and AMU integration has a positive and significant impact on intra-Arab trade among member countries.

Regarding the SFGM estimation for the sub-sample periods, Columns 4 and 5 present the results of the estimation for before and after the global financial crisis, respectively. The results of the two periods reveal that most of the variables carry their expected signs and are consistent with the full sample. However, unlike the results of the full sample, the results of the pre-crisis period model (i.e., 1998 to 2007) show that the effect of the bilateral real exchange rate of both the reporting and trading partners is positive and statistically significant. Moreover, the coefficient of institutional quality of the reporting country in the first period is positive and significant, contradicting the results of the full sample models. Interestingly, the empirical results reveal that the intercept term for the first period (i.e., 1998 to 2007) is larger than that of the second period (i.e., 2008 to 2015). This implies that intra-Arab trade declined after the financial crisis, as this period witnessed many transformations including the occurrence of the Arab Spring and the sudden reduction in international capital inflows.

Furthermore, the coefficient of *Sigma-squared* is found to be positive and statistically significant in all estimated models, indicating that the potential trade over time has shown significant variation about its asymptotic mean. This also suggests that the potential trade of Arab countries during the period under study has been changing over the period under consideration. This

variation in potential trade between Arab countries may be due to the incidence of random factors or it may be due to the influence of country-specific characteristics. Moreover, the significance of *Sigma-squared* justifies the use of the SFA approach to estimate the gravity model. This also suggests that all deviations from the frontier are due to noise and trade inefficiency.

The results in Table 2 also point out that the coefficients of *gamma* are positive and statistically significant in the models estimated. The large magnitude of *gamma* coefficients implies that the influence of "*behind the border*" constraints are responsible for a considerable proportion of total variations in the model. It is interesting to see how the *gamma* coefficients vary over time. Thus, the results indicate that the coefficient of *eta* is positive and statistically significant in all estimated models. This implies that the constraining impact of country specific effects (i.e., behind the border) on potential trade would be decreasing over time (i.e., 18 years). Moreover, this finding indicates that the potential trade between Arab countries changes over time during the period under study. This also suggests that the impact of country specific socio-political-institutional factors on trade flows between countries may change over time due to both bilateral and multilateral negotiations, as well as due to regional cooperation. These findings support many empirical studies that used an SFGM analysis such as Kalirajan (2007), Abdmoulah (2011), and Bhattacharya and Das (2014).

Overall, these results imply that besides the core variables of the conventional gravity model, the influence of country-specific socio-political-institutional factors is responsible for a large portion of the mean of total variation in the trade level among Arab countries. This confirms the significant impact of the so-called "*behind the border*" constraints in deciding the level of potential trade. Moreover, the influence of country-specific trade constraining effects on potential trade has been found to be decreasing during the period under study. This suggests the emergence of some improvement in intra-Arab trade over time. However, this may also infer the sluggish improvement in intra-Arab trade. Furthermore, the results show that the sub-regional integration enhances trade among member countries, emphasizing the key role of sub-regional and bilateral arrangements in supporting trade among Arab countries.

Estimating trade efficiency scores

Having estimated the SFGM of intra-Arab trade, the next step is to derive the trade efficiency scores by applying the coefficients of the SFGM estimation of Column 3 of Table 3 for the sample of Arab countries over the period of 1998 to 2015. The efficiency scores for each country pair are presented in Table 3.

Table 3. Efficiency score estimates from the SFGM (1998 to 2015).

	Algeria	Bahrain	Egypt	Iraq	Jordan	Kuwait	Lebanon	Libya	Mauritania	Morocco	Oman	Qatar	Saudi	Sudan	Tunisia	UAE	Yemen
Algeria		0.61	0.65	0.58	0.66	0.53	0.65	0.53	0.65	0.62	0.51	0.52	0.62	0.54	0.67	0.61	0.45
Bahrain	0.61		0.62	0.53	0.66	0.63	0.63	0.59	0.43	0.63	0.63	0.62	0.67	0.58	0.64	0.64	0.58
Egypt	0.65	0.61		0.61	0.64	0.63	0.69	0.64	0.65	0.61	0.58	0.60	0.64	0.66	0.64	0.64	0.66
Iraq	0.54	0.53	0.61		0.71	0.36	0.53	0.65	0.68	0.41	0.62	0.53	0.61	0.45	0.58	0.60	0.56
Jordan	0.67	0.69	0.66	0.72		0.71	0.71	0.64	0.65	0.54	0.66	0.65	0.69	0.72	0.65	0.69	0.69
Kuwait	0.51	0.62	0.63	0.31	0.63		0.68	0.39	0.61	0.43	0.62	0.57	0.62	0.55	0.60	0.63	0.65
Lebanon	0.62	0.65	0.67	0.62	0.67	0.66		0.63	0.67	0.64	0.61	0.64	0.67	0.68	0.65	0.68	0.63
Libya	0.51	0.59	0.64		0.61	0.43	0.62		0.62	0.48	0.53	0.50	0.56	0.52	0.68	0.61	0.49
Mauritania	0.65	0.44	0.59	0.40	0.50	0.47	0.60	0.40		0.77	0.50	0.49	0.61	0.48	0.66	0.66	0.50
Morocco	0.67	0.63	0.67	0.72	0.67	0.62	0.69	0.67	0.69		0.58	0.63	0.72	0.56	0.71	0.65	0.61
Oman	0.54	0.63	0.62	0.60	0.65	0.62	0.62	0.60	0.55	0.57		0.61	0.63	0.63	0.59	0.71	0.67
Qatar	0.53	0.62	0.60	0.60	0.66	0.57	0.64	0.46	0.65	0.70	0.61		0.60	0.60	0.75	0.62	0.60
Saudi	0.63	0.69	0.65	0.60	0.68	0.62	0.66	0.57	0.61	0.68	0.63	0.63		0.64	0.65	0.66	0.64
Sudan	0.56	0.62	0.68	0.48	0.72	0.59	0.69	0.54	0.39	0.55	0.62	0.60	0.69		0.65	0.70	0.67
Tunisia	0.71	0.61	0.66	0.60	0.65	0.61	0.65	0.71	0.68	0.68	0.69	0.59	0.65	0.67		0.63	0.58
UAE	0.60	0.63	0.63	0.62	0.67	0.62	0.69	0.61	0.61	0.74	0.58	0.62	0.64	0.67	0.61		0.68
Yemen	0.51	0.60	0.68	0.55	0.69	0.69	0.64	0.51	0.51	0.63	0.63	0.57	0.66	0.67	0.57	0.71	

Table 3 shows that the efficiency scores for most of the country pairs are less than one, indicating that the actual trade between Arab countries is below the potential level as indicated by the frontier. This outcome lends further support for the presence of both "*beyond the border*" and "*behind the border*" constraints to trade flows among Arab countries. However, most of the country pairs exhibit a relatively high degree of trade integration. The higher integrated efficiency scores are reported by country pairs that are close to each other, hence confronting few behind and beyond the border rigidities. The striking result is that Morocco has higher efficiency scores with all Arab countries, despite its far distance from some members like the Gulf States. This implies that Morocco faces lesser behind and beyond the border rigidities with respect to its trade performance. Furthermore, this outcome may also reflect the effective trade relations between Morocco and Arab countries.

The results also point out that the UAE, Morocco, Jordan, Saudi Arabia, and Egypt achieve the highest efficiency scores among other Arab countries, suggesting that these countries perform close to their frontier trade level. This result may also reflect the efforts in these countries regarding trade liberalization and removing trade restrictions, as these countries are members of the World Trade Organization (WTO).

Moreover, the results indicate that Iraq and Libya registered the lowest efficiency scores, and their performance is less than two-thirds of their frontier trade level. This indicates that these countries are less integrated and face the most behind and beyond the border constraints to trade in the Arab region. Such an undesirable outcome can be explained by political instability and the inefficiency of trade institutions in these countries. In addition, Iraq–Kuwait efficiency scores are lower, reflecting the weakness of the trade relationship between the two countries.

Furthermore, the table shows that sub-regional trade arrangements have a significant impact on the efficiency scores of intra-Arab trade. For example, the trade integration among Arab Maghreb Union (AMU) members is very high, implying that these countries realize most of their potential. Likewise, the integration efficiency scores among the members of the AGADIR agreement (i.e., Morocco, Tunisia, Egypt, and Jordan) are relatively high, supporting the success of this agreement. Furthermore, the efficiency scores among GCC members are around two-thirds of the maximum bilateral levels, indicating the existence of moderate trade tightness between these members.

Overall, the above results reveal that the level of trade integration in Arab countries is far from its potential level, as all efficiency scores are less than one. This confirms that all Arab countries face behind and beyond the border inefficiencies. This also signifies the geographical and/or institutional constraints to trade efficiency. However, the high scores for some country pairs, particularly those belonging to the sub-regional groups, indicate that the

efforts of bilateral and multilateral arrangements adopted in the last three decades have resulted in a relative improvement in bilateral trade among Arab countries.

VI. Conclusion

This study investigates the performance and potential of trade flows among Arab countries over the period of 1998 to 2015. Following the theoretical background on production theory, the study employs the stochastic frontier gravity model (SFGM) which measures trade performance against a maximum possible level of potential trade defined by a stochastic frontier. The emphasis of this approach is to address other factors affecting bilateral trade between Arab countries, such as "*beyond the border*" and "*behind the border*" inefficiencies, which have been overlooked by the conventional gravity model adopted in previous studies.

The empirical results indicate that the core variables of the gravity model such as real GDP, population size, and distance have a significant impact on trade flows among Arab countries, lending more support to the conclusion that has been reached by previous studies. The analysis also reveals that "*behind the border*" constraints have significantly contributed to gaps between potential and actual trade among the Arab members, despite the fact that these countries have initiated many trade arrangements to promote intra-Arab trade during the last one-and-a-half decades. In addition, the results suggest that the influence of country-specific socio-political-institutional factors (i.e., *behind the border*) is responsible for a large proportion of the mean total variation in the model. The results also point out that the impact of country-specific socio-political-institutional factors on trade flows between countries has been decreasing over time. This might be attributed to the efforts of bilateral and multilateral negotiations, as well as regional cooperation in Arab countries. Moreover, the results show that sub-regional trade arrangements have a significant impact on intra-Arab trade performance. That is, country-pairs who are a member of the same integration perform better than those without integration. In particular, country-pairs belonging to the AMU and AGADIR arrangements have relatively high efficiency scores compared to GCC members.

The findings of this study have many policy implications. Policymakers need to give more attention to the country's specific socio-political-institutional factors so as to eliminate the *"behind the border"* constraints. In other words, without removing or reducing such trade rigidities (i.e., *behind the border*), enhancing the intra-Arab trade performance to achieve the nation's goals cannot be actualized. In addition, the significant role of multilateral, bilateral, and sub-regional trade arrangements like the GCC, AGADIR,

and AMU require more effort to enhance the levels of integration among Arab countries.

Acknowledgments

Open Access funding provided by the Qatar National Library.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Ebaidalla M. Ebaidalla http://orcid.org/0000-0002-7561-6454

References

Abdmoulah, W. 2011. "Arab Trade Integration: Evidence from Zero-inflated Negative Binomial Model." *Journal of Economic Cooperation and Development* 32 (2): 39–66.

Abu Hatab, A. 2015. "The Impact of Regional Integration on Intra-Arab Trade in Agrifood Commodities: A Panel Data Approach" *MPRA Paper No. 67991*. Munich Personal RePEc Archive, Munich, Germany.

Aigner, D., K. Lovell, and P. Schmidt. 1977. ""Formulation and Estimation of Stochastic Frontier Production Function Models." *Journal of Econometrics* 6 (1): 21–37. doi:10.1016/0304-4076(77)90052-5

Al-Atrash, H., and T. Yousef. 2000. "Intra-Arab Trade: Is It Too Little?" IMF Working Paper No. 00/10. International Monetary Fund, Washington, DC.

Anderson, J. 1979. "A Theoretical Foundation for the Gravity Equation." *The American Economic Review* 69 (1): 106–116.

Anderson, J., and E. van Wincoop. 2003. "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review* 93 (1): 170–192. doi:10.1257/000282803321455214

Battese, G., and T. Coelli. 1988. "Prediction of Firm-level Technical Efficiencies with a Generalized Frontier Production Function and Panel Data." *Journal of Econometrics* 38 (3): 387–399. doi:10.1016/0304-4076(88)90053-X

Bhattacharya, S., and G. Das. 2014. "Can South–South Trade Agreements Reduce Development Deficits? an Exploration of SAARC during 1995–2008." *Journal of South Asian Development* 9 (3): 253–285. doi:10.1177/0973174114549129

Bolbol, A. 1999. "Arab Trade and Free Trade: A Preliminary Analysis." *International Journal of Middle East Studies* 31 (1): 3–17. doi:10.1017/S0020743800052946

Bolbol, A., and A. Fatheldin. 2006. "Foreign and Intra-Arab Capital Flows in the Arab Countries, 1990–2003." *The World Economy* 29 (9): 1267–1293. doi:10.1111/j.1467-9701.2006.00811.x

Chauvin, S., and G. Gaulier. 2002. "Regional Trade Integration in Southern Africa." *CEPII, Working Paper No. 12*. CEPII, Paris, France.

Ebaidalla, E., and A. Yahia. 2014. "Performance of Intra-COMESA Trade Integration: A Comparative Study with ASEAN's Trade Integration." *African Development Review* 26 (S1): 77–95. doi:10.1111/1467-8268.12094

International Monetary Fund. 2016. "Direction of Trade Statistics (DOTS)." International Monetary Fund, Washington, DC. Accessed 13 April 2018.

Kalirajan, K. 1999. "Stochastic Varying Coefficients Gravity Model: An Application in Trade Analysis." *Journal of Applied Statistics* 26 (2): 185–193. doi:10.1080/02664769922520

Kalirajan, K. 2000. "Indian Ocean Rim Association for Regional Cooperation (IORARC): Impact on Australia's Trade." *Journal of Economic Integration* 15 (4): 533–547. doi:10.11130/jei.2000.15.4.533

Kalirajan, K. 2007. "Regional Cooperation and Bilateral Trade Flows: An Empirical Measurement of Resistance." *The International Trade Journal* 21 (2): 85–107. doi:10.1080/08853900701266555

Kalirajan, K., and K. Singh. 2008. "A Comparative Analysis of China's and India's Recent Export Performances." *Asian Economic Papers* 7 (1): 1–28. doi:10.1162/asep.2008.7.1.1

Marshall, G., J. Keith, and G. Robert. 2016. "Polity IV Project: Political regime characteristics and transitions, 1800-2009: Dataset users manual." Center for International Development and Conflict Management, University of Maryland, College Park.

Neaime, S. 2005. "South-South Trade, Monetary and Financial Integration and the Euro-Mediterranean Partnership: An Empirical Investigation." *FEMISE Research No. FEM 22-39*. FEMISE Research Programme, Marseille, France.

Nilsson, L. 2000. "Trade Integration and the EU Economic Membership Criteria." *European Journal of Political Economy* 16 (4): 807–827. doi:10.1016/S0176-2680(99)00060-9

Pastore, F., A Ferragina, and G. Giovannetti. 2009. "A Tale of Parallel Integration Processes: A Gravity Analysis of EU Trade with Mediterranean and Central and Eastern European Countries." *Review of Middle East Economics and Finance* 5 (2): 21–44. doi:10.2202/1475-3693.1228

Ravishankar, G., and M. Stack. 2014. "The Gravity Model and Trade Efficiency: A Stochastic Frontier Analysis of Eastern European Countries' Potential Trade." *The World Economy* 37 (5): 690–704. doi:10.1111/twec.12144

Söderling, L. (2005). "Is the Middle East and North Africa Region Achieving Its Trade Potential?" *IMF Working Paper WP/05/90*. 1–23. International Monetary Fund, Washington, D.C.

Stack, M., and E. Pentecost. 2011. "A Gravity Model Approach to Estimating Prospective Trade Gains in the EU Accession and Associated Countries." *Discussion Paper in Economics No. 2010/11*. Nottingham Trent University, Nottingham, UK

Tamini, L., H. Chebbi, and A. Abbassi. 2016. "Trade Performance and Potential of North African Countries: An Application of a Stochastic Frontier Gravity Model." *AGRODEP Working Paper No. 0033*. International Food Policy Research Institute (IFPRI), Washington, D.C.