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Revisiting the Effectiveness of African Economic Integration. A Meta-Analytic Review and Comparative Estimation Methods

Sylvanus Kwaku Afesorgbor

AARHUS UNIVERSITY
BUSINESS AND SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS AND BUSINESS

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By: Sylvanus Kwaku Afesorgbor

Aarhus University, Denmark

Abstract

The gravity model has extensively been used in estimating the effectiveness of a number of RTAs in the world. However, many previous studies that assess the effectiveness of African RTAs using gravity model produce contrasting results and are characterize by two main shortcomings. Firstly, these studies failed to account for multilateral resistance term (MRT). The omission of the MRT contributes to biased estimates for standard variables in the gravity model. This bias is reflected in parameters of these previous studies. Secondly, there is significant proportion of zero flows in developing countries' trade measurement; however, these studies fail in dealing with them properly. The zero flows are more endemic when one considers only African bilateral trade, which has over 50% zero flows. In an attempt to correct this anomaly, previous studies rely on the Tobit model or replacing zero flows with small values. However this strategy has been labeled as infeasible and producing inconsistent parameters. In this study, we conduct a meta-analysis of previous empirical studies to explain the potential heterogeneity in the studies and compare the different estimation methods of the gravity model to Poisson Pseudo Maximum Likelihood (PPML). Using panel data on trade flows from 1980 to 2006 for 47 African countries, we estimate the gravity model for the five major RTAs on the Africa continent. We find that although there is general positive impact of African RTAs, impacts are highly sensitive to different estimation methods and they tend to be significantly overestimated when zero flows are not properly dealt with. Comparative assessment of the five major RTAs indicates highly uneven performance.

JEL Classification: C33, F15, O55

Key words: Regional Integration in African, Gravity model, Meta-Analysis, Zero flows, PPML

1 Motivation of Study

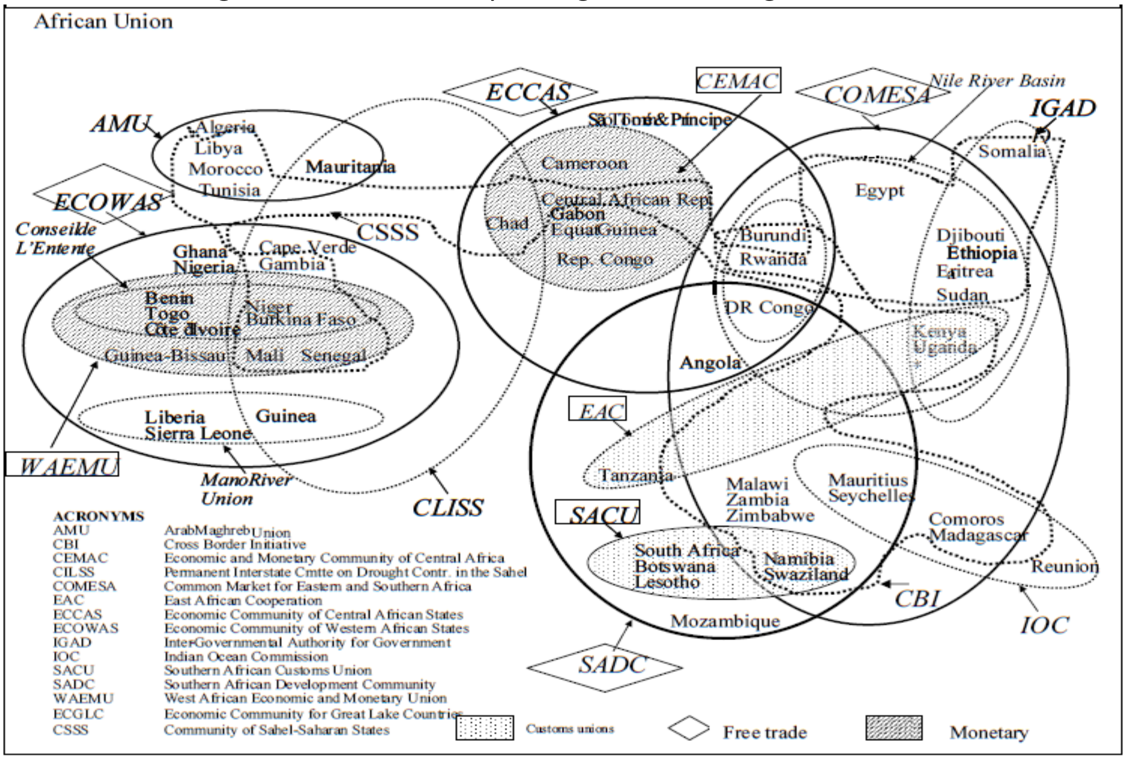
Regional Trade Agreements have become a major attachment to the world trading systems. World Trade Organization (WTO) recognises the upsurge in Regional trade Agreements (RTAs) as a very prominent feature of Multilateral Trading Systems (MTS). Current statistics from WTO indicate that the upsurge in RTAs continues unabated with about 489 RTAs notified to WTO as at 2011.

The African continent has also witnessed spiralling economic integration initiatives. These initiatives are mostly in the form of South-South and (or) North-South Free Trade Agreements (FTAs). The integration schemes are initiated with different political and economic persuasions. Politically, these blocs are perceived as very relevant considering the structural weakness inherent in African economies. Economically, there is general pessimistic view in terms the effectiveness of these African FTAs in stimulating trade and economic growth. Generally, the negative verdict assertion is extended to almost all the African RTAs. This is not surprising as the traditional integration theories fail to provide a convincing economic justification especially for developing countries RTAs (Swanson & Kapoor, 1996). This notwithstanding the African states may view regionalism as attractive option against the threats of globalization and as an alternative to stall progress of trade liberalisation at multilateral level.

The rising wave of regionalism on the continent gives credence to Bhagwati and Panagariya (1999) coined term “spaghetti bowl” of RTAs in the world. The Africa version of the crisscrossing RTAs described by Yang and Gupta (2005) as the “African Galaxy” is best delineated in the Figure 1. This rising wave has also translated into many empirical researches on the effectiveness of these regional blocs using the gravity model. Increasingly, the gravity model has gained acceptance in international economics as workhorse for determinant of bilateral trade. The model is applied to a varied number of economic integration schemes among (between) developing and developed countries. The advanced economic integration schemes, the European Union (EU), European Free Trade Agreement (EFTA) and North American Free Trade Agreement (NAFTA) has been mostly cited as the bench mark in assessing the performance of other regional blocs.

Hitherto the year 2000, studies on economic integration have not reached a consensus on the effectiveness of FTAs on bilateral trade, even in the case of North-North (N-N) schemes. For instance, Aitken (1973), Abrams (1980) and Brada and Mendez (1985) all conclude significant positive impact of EU on bilateral trade in contrast to Bergstrand (1985) and Frankel etal (1995). Subsequently, more studies focus on re-assessing the effectiveness of N-N FTAs and conclude a robust significant positive impact on bilateral trade after accounting for major econometric concerns with the gravity model. See for example, Baier etal (2008), Siliverstovs and Schumacher (2009) and Martinez-Zarzoso (2013).

Figure 1: African Galaxy of Regional Trade Agreements



Source: Yang and Gupta (2005)

Exhaustively, Cipollina and Salvatici (2010) and Head and Mayer (2013) conducting a meta-analysis reject the hypothesis of these advanced RTAs, EU or NAFTA, not contributing significantly to trade.

However, a similar re-assessment has not been carried out on African RTAs, taking into account the econometric concerns as with N-N RTAs. The results from previous studies on effectiveness of African RTAs are varied and diverse. The diversity arises in three dimensions; the sign, size and significance of the estimates measuring the impact of the RTAs on trade. The diversity in the results may depend on several factors such as the specification of the model, estimation methods, the regional blocs being studied, and how the econometric issues such the MRT and zero flows in data are dealt with. Additionally, characteristics of the studies such as the quality of the studies, in terms of whether the study is published or not, type of data, the sample size (list of countries) and time period of the data may also to a large extent affect the results. In line with this, we conduct a meta-analysis of the previous empirical studies that addressed the same common research interest.

Considering the fact that results from previous studies exhibit extensive variations, a meta-analysis is needed to determine a combined effect from the individual studies. To explain the potential heterogeneity in these contrasting studies, a multivariate meta-regression analysis (MRA) is also required (Stanley and Doucouliagos, 2012). The meta-analysis and MRA would be appropriate tools as these previous studies adopted the same model specification, the gravity equation. Meta-analysis involves collecting empirical results from individual studies for the purpose of summarizing, integrating and examining the combined effects from the contrasting studies. The combination of different studies helps to derive more precision and investigates the consistencies and discrepancies in those studies. Stanley (2001) concurs that combining the results from individual studies elucidates more insight and greater explanatory power. The application of meta-analysis technique is gradually gaining acceptance in field of economics considering the vast number of studies with contrasting results. To buttress it acceptability and application, the Journal of Economic Surveys in 2005, dedicated a special Issue [volume 19(3)] to meta-analysis and MRA. Stanley etal (2013) develop guidelines for MRA in Economics. Some of its contemporary application can be seen in studies such as Rose and Stanley (2005), Cipollina and Salvatici (2010), Genc etal (2011) and Head and Mayer (2013). Incidentally, all these studies focus on determinant of bilateral trade using the gravity model specification.

The specification of gravity model has evolved over the years. Aftermath, the Anderson van Wincoop (2003) paper, it becomes abundantly clear for the need to control for the MRT in the model specification. More importantly, recent development about the gravity model has shifted attention to the performance of the different estimation techniques in the presence of large proportion of zero flows and the robustness of these estimators in the presence of heteroscedasticity (Gómez-Herrera, 2013). With the proportion of zero flows in the African dataset extremely large even at aggregated level, model selection approach using a number of test as recommended by Martinez-Zarzoso (2013) should be used to determine which estimator fits the African data. This in line with Head and Mayer (2013) advocate for a tool-kit approach to estimate the gravity model as there is no one-estimation-fit-all method.

The gravity model has been relied upon extensively by studies that measure the effectiveness of these different economic integration initiatives in Africa. Notably, the model is useful for empirical analysis in explaining international trade flow in Africa because its relevance in testing the potency and efficacy of trade policy variables that can help the continent ammeliorate its dismal and dwindling trade performance. The distance factor (proxy for transport cost) as embodied in gravity model is very critical for trade in Africa as the region is noted as having poor transportational network.

Although, the previous studies used the gravity model to examine the effectiveness of African RTAs in line with relevance of the model, a review of the studies indicate contrasting outomes and most of them have been handicapped especially in dealing properly with two main econometric concerns, MRT and zero flows.

Previous studies omit the MRT in the determinants of bilateral trade in the specification of the gravity model. The MRT is relevant in the determining bilateral trade, as trade between two countries is not influenced only by bilateral variables relating to these two countreis, but their relative position in the world (van Bergeijk and Brakman 2010). This omission results in biased estimates due to possible endogeneity emanating from the failure to account for MRT. The most cited econometric studies that focused on Africa RTAs include Foroutan and Prichett (1993), Elbadawi (1997), Cernat (2001), Carrere (2004), Longo and Sekkat (2004), Musila (2005), Geda and Kebret (2008). However these studies did not account for MRT. The Anderson van Wincoop (2003) proposed method for estimating the MRT was computationally and data demanding data demanding as there is this problem of circular dependence and it requires the non-linear least squares.

In line with computational difficulty in esitmating Anderson van Wincoop's MRT, altenative estimation methods were proposed. For instance Feenstra (2004), Redding and Venables (2004) indicate the importer and exporter fixed effects could be used to control for MRT. Baier and Bergstrand (2007) and Baier etal (2008) also proposed time varying bilateral fixed effects. Proxy variables have also developed as measure of the MRT, the the exporter and importer remoteness index, developed by Wei (1996). The latest in line with proxy variable is by Baier and Bergstrand (2009) using a Taylor-series expansion. These methods for controlling for MRT has been showed to produce identical results comparable the original technique of Anderson van Wincoop.

The second concern of zero flows is link to the measurement of trade flows. Trade flow measurement among developing countries (Africa) is not of quality compared to developed countries. They are characterised by considerable number of zero flows mostly arising from missing data and (or) small value trade flows. Longo and Sekkat (2005) put the percetage of zero flows in African bilateral trade around 25%. However, the proportion of zeros become extreme and alarming when one considers only trade flow between African countries over longer time span in the distant past. This is the case with our study as the proportion of zero flows was about 55%.

Previous studies in accounting for these zero flows adopt these strategies; (1) simply omitting the zero values, (2) replacing them with an arbitrary small values and (3) using the Tobit estimator. The exclusion of the zero flows as result of double logarithnmic transfromation produces inefficient estimates. Santos Silva and

Tenreyro (2006) (hereafter SST) label these strategies as infeasible and producing inconsitent parameters. SST point out the PPML is a better altenative to linear logarithmic transformation of multiplicative models. The PPML estimator is gaining popularity and acceptance especially in estimating gravity model. This is unsurprising as it has been confirmed subsequently by SST (2011) and Maritinez-Zarzoso (2013) as consistent in the presence of heteroscedascity and well-behaved, when the proportion of zero flows are large.

Thus, we conduct meta-analytic review to assess how these econometric concerns affect estimates of previous empirical studies and also determine a general combine effect size of these studies. Secondly, we compare the different estimation methods employed in these previous studies to PPML to examine the sensitivity of the estimates to these different econometric methods. Apart, from these core objectives, this paper as well seeks to provide general comparative overview on the performance of the economic integration initiatives on the Africa continent, re-assessing the effectiveness of these African RTAs.

A comparative analysis will be beneficial, in a sense to identify weak and strong RTAs, so as to adopt and replicate the measures of the more successful RTAs in the less successful ones. In line with that, the study focuses on five major RTAs in the region that are recognised by the African Union. Seemingly, these RTAs have been perceived as the main building block for continental integration (Teshome, 1998). The membership of these economic integration schemes consist of the 47 African countries. The RTAs include Economic Community of West Africa States (ECOWAS) in Western Africa, Southern African Development Community (SADC) in Southern Africa, Arab Maghreb Union (AMU) in Northern Africa, Economic and Monetary Community of Central Africa (CEMAC) in Central Africa and Common Market for Eastern and Southern Africa (COMESA) in Eastern and Southern Africa. These RTAs span and represent all the regions on the continent.

Although there are other regional blocs on the continent, we limit our discussion to the five regional blocs considered in our study. These other regional blocs were mainly left out because they were minor regional groupings and have overlapping membership with the five major RTAs. For instance, members of the East Africa Community (EAC), West Africa Monetary and Monetary Union (WAEMU), Central African Economic and Monetary Community (CEMAC) share membership with major blocs COMESA, ECOWAS and ECCAS respectively.

The remaider of the paper is organised is as follows: Section 2 gives snapshot on the overview of the various RTAs and their current status. Section 3 provides a theoretical and empirical perspectives on African economic integration. Section 4 centres on the meta-analysis and conducts meta-regression analysis and section 5 focuses on the empirical model, the gravity model, and the main econometric concerns. Section 6 describes the data and estimation. Section 7 discusses and concludes the study.

2 Economic Integration in Africa

Economic integration in Africa has deep historical roots. The origin of African economic integration dates back as early as 1910 when the Southern African Custom Union (SACU) was formed (Söderbaum, 1996). Aftermath, there was a persistent call for regionalism on continent to be pursued at fast pace. However, this call was keenly associated with Pan-Africanism as the pioneering leaders such as Nkrumah (Ghana), Toure (Guinea), Nasser (Egypt), Kaunda (Zambia), Kenyatta (Kenya) and Nyerere (Tanzania) proposed a continental integration as panacea to colonization. Although, the continental integration became defunct as result of many independent African States leaders perceiving the plan as overly ambitious, a sub-regional integration scheme was embraced. The sub-regional integration was based on the plan of promoting development and market integrations among smaller and homogenous neighbouring countries. This results in the formation of myriad number of regional blocs across the continent, particularly from 1970s.

Over the years, sub-integration schemes have been labelled as purely ceremonial and not achieving any economic benefits. The economic benefits were viewed mainly in terms of limited success in creating intra-regional trade and dwindling share of Africa in world trade (Gunning 2001; Yang and Gupta 2005). Rather than this criticism dampening the initiatives at the many trial and error processes of the regional integration, this shifted their focus again to continental integration. The surge for continental integration was spearheaded by the United Nation Economic Commission of African (ECA). This quest culminated in the signing of the African Economic Community (Abuja) Treaty in the 1991. It was it this same vein, the Organization for African Unity subsequently issued the Sirte Declaration for the establishment of African Union (AU) to accelerate integration on the continent. Accordingly, AU proposed a step-by-step continental integration through the process of strengthening existing regional blocs (ECA 2012).The five major regional blocs considered have all an established Free Trade Area (FTA) operational. Details on membership, year of establishment and main objective are provided in table 1.

Table 1 Regional Bloc in Africa and Current Status

RTAs (year)	Members	Main Objectives	Current Status
SADC **(1994)**	Angola, Botswana, DR Congo, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe,	Promote deeper economic integration. Establish a common political, economic and social policies and values. Strengthen regional security.	-Tariffs removed and cover all products. -Power pool in place -Peace and security mechanism in place -Macroeconomic convergence in place -free movement of people
ECOWAS **(1975)**	Ghana, The Gambia, Sierra Leone, Nigeria, Guinea, Togo, Benin, Cote D'Ivorie, Senegal, Mali, Liberia, Cape Verde, Burkina Faso, Niger, Guinea Bissau	Forster cooperation and development in all economic activity. Establish a FTA, a common external tariff and free movement of people.	-Tariffs removed on unprocessed goods and traditional handicraft. -Full elimination on tariffs on industrial good started by Benin -Second monetary zone in progress - Free movement of people -Macroeconomic convergence in place
COMESA **(1993)**	Burundi, Comoros, Libya, Djibouti, DR Congo, Egypt, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia, Zimbabwe.	Promote development, regional cooperation and integration. Establish full FTA and create a custom union with common external tarriff.	-FTA established and covers all goods -A custom union established - Trade and development policy established
AMU **(1989)**	Algeria, Libya, Morocco, Mauritania, Tunisia	To establish a common market .Provide intra-union free trade, erection of common external tariff, free movement of people	-FTA established and covers agricultural products -Established transport and communication network. The trans-Maghreb highway and Maghreb airline -Launch the mediterranean security network
ECCAS **(1983)**	Angola, Burundi, Chad, Cameroon, Central African Republic, DR Congo, Congo, Equatorial Guinea, Gabon, Rwanda, Sao Tome and Principe	To promote regional cooperation and integration. Abolish trade restrictions and establish a common external tariff.	--Yet to secure the free movement of people. -insecurity in the region has hindered progress

3.1 Theoretical Perspectives on African Integration

Theoretically, African RTAs are not expected to contribute significantly to bilateral trade because of similar comparative advantage or supply structure. This is predicated on classical theory of factor proportions by Heckscher-Ohlin. This theory basically predicts that countries will export goods intensive in use of their abundant factor endowments. Thus, resource-endowed African countries are not expected to trade largely among themselves but rather with capital–abundant developed countries. It is based on this theoretical argument that Venables (2003) argues that LDCs should focused on North-South RTAs rather than South-South RTAs as LDCs are likely to derived potential benefits from North-South RTAs. Similarly, Yang and Gupta (2005) also conclude that African RTAs are ineffective in promoting bilateral trade because of limited resource complementarity.

Conversely, under the new trade theory with the assumption of economies of scale (increasing returns) and imperfect competition, there is rationale for international trade between countries with similar supply structure or capital-labour ratio (Feenstra 2004). Trade flow among developing countries could typically take the form of intra-industry trade whiles trade between them and developed countries is dominated by inter-industry trade. The intra-industry trade flow does not reflect comparative advantage whiles the inter-industry trade flow reflects comparative advantage. This is best captured in Krugman and Obstfeld (2009, p.131) that *"if Home and Foreign [countries] are similar in their capital-labour ratio, then there will be little inter-industry trade and intra-industry trade, based ultimately on economies of scale will be dominant*".

African RTAs stimulating trade may be necessary but not a sufficient condition in assessing the impacts of the RTAs. The welfare effects arising from trade diversion and trade creation as indicated by Viner (1950) would be relevant in analysing the effects of African RTAs mainly because of welfare-enhancing effect of cheaper imports from non-member states. Trade creation may result from a shift of domestic consumption from high-cost domestic products to low-cost products from a partner country as a result of elimination of trade barriers. Trade diversion involves a shift of domestic consumption from a low-cost non-member country to a high-cost member country.

For developing countries, the welfare effect is relevant as they tend to have less efficient production methods resulting relatively higher priced products. Thus, the risk that trade diversion outweighs trade creation should be taken into consideration. Van Dijck (1992) analyses the necessary conditions under which welfare gains will exceed welfare losses. Firstly, the import demand should be price elastic and price differences between member states should be large while price difference between member states and the world market should be small. Secondly, if more goods are imported from non-member states before the formation of the regional bloc, there is a high tendency of trade diversion. On both accounts African RTAs may have limited trade creation and possibly trade diverting, resulting in negative welfare effects.

Empirically, studies have not found any evidence of African RTAs being trade diverting. Musila (2005) discards the possibility of trade diversion and concludes that major African RTAs are trade creating and have positive net welfare effects. Theoretically, this is consistent with new trade theory under monopolistic competition. The larger market size created from integrating the member states markets could reduce the average cost of the firms, resulting in lower prices for goods and services in the sub-region. Additionally, there is increased varieties of products to the consumer, culminating in an improved welfare for consumers. All in all, holding weight of the argument of the limited relevance of the traditional Viner's static analysis (Baldwin, 1992).

3.2 Empirical Perspectives on African Integration

Previous empirical econometric investigations that focus on assessing the impact of African RTAs have just as in the case of previous studies on N-N FTAs indicated mixed results. We can classify them into different groups based they deal with econometric concerns with estimation of the gravity model.

The first group consisting of studies Deme (1995) and Cernat (2001) rely extensively on OLS estimation method and fail to account for zero flows. However, the traditional OLS estimation of gravity model produces inconsistent and biased estimates. It also makes restrictive and unrealistic assumptions[1] about the disturbance term (Cheng and Wall, 2005). OLS fails to control for unobserved time-invariant heterogeneity without the use of fixed effects (FE) estimator. This is inappropriate as it introduces endogeneity into model through possible omission of time-invariant variables such as political, ethnic, cultural and historic factors that can all simultaneously affect bilateral trade and RTA. Additionally, Fidrmuc (2009) indicates that a standard gravity models include non-stationary variables such as GDP and trade flows which may result in an inherited cross-sectional correlation between the panel units, which can only be remedied using FE estimator.

The second group consist of studies Carrere (2004) and Afesorgbor & Bergeijk (2011) that correctly use FE estimator but failed to account for zero flows in data set as they used double logarithmic transformation. This introduces a selection bias as country pairs with zero flows are excluded, which leads to dominance of upward bias in the coefficient of bilateral variables (Helpman etal 2008). An observable trend from

[1] OLS estimator imposes the restriction that the intercept and slope of the variables are the same irrespective of the time and trading partners.

the results of the first and second groups is that the regional blocs have a strong significant effect on intra-regional trade but very large magnitudes. For instance, these studies predict a range of 172 to 1000% in sharp contrast to Baier and Bergstrand (2007) average treatment effect of 114% for even N-N economic integration schemes.

The third group of studies consisting Foroutan and Pritchett (1993), Elbadawi (1997), Longo and Sekkat (2005), Kirkpatrick and Watanabe (2005), Geda and Kebret (2008) in an attempt to account for zero flows used the Tobit estimator (TE) or replacing the zero flows with an arbitrary small values. Incidentally, this group of studies are most cited papers with regards to African RTAs. A conspicuous trend with these studies is an analogous result of an insignificant effect of African RTAs on bilateral trade or very large estimates. Common to all these three groups, is the failure to account for MRT. The omission of the MRT also contributes to large estimates for standard variables in the gravity model (Anderson and van Wincoop, 2003).

4.1 Meta-Analysis

Meta-analysis is defined as the statistical and analytical technique of collecting the results from individual empirical studies for the purpose of synthesizing and integrating them into a common result (Wolf, 1986). Historically, the scientific method of combining individual studies was common practice in the field of natural sciences, however, became, a common tool in social science in 1976, when term meta-analysis was introduced by Gene Glass (Card, 2012). At its introduction, meta-analysis was heavily criticised resulting in many researchers' reluctance in its application. One major critique was its combination of different quality of studies, however, Stanley and Doucouliagos (2012) discard this criticism by indicating that quality of a study is vague and there is no objective way of measuring quality. Its acceptance is now widely recognised, to the extent that many medical findings that are reported on treatments, drugs and supplements are mainly anchored on the meta-analysis (Stanley 2001). Currently, the application of meta-analysis has become easy considering the introduction of "*metan*" command in the Stata. Details on meta-analysis in Stata can be found in Sterne (2009).

In literature, conducting a meta-analysis (regression) may help achieve these two main objectives. First, to derive a stylized combined effect size of particular research interest by providing the platform to test whether there is genuine empirical effect through pooling individual studies (Stanley, 2001). The second objective may be realised through moderator analysis or MRA to identify objectively how the study characteristics influence or explain the variation in individual estimates from a range of empirical studies. MRA explains the research process itself and links the sensitivity of the reported estimates to the researchers' choice of data, estimation methods, econometric models and issues (Stanley, 2005).

In conducting meta-analysis, the result of individual effect size ($ES = \delta_i$) and characteristics of different studies that address the common research interest are collated. The ESs are the reported point estimates of the variables of interest. In our case, the ES is RTA's impact on bilateral trade. Essentially, the collated ESs are treated as individual observations; use to test the hypothesis that the combined ES is statistically and significantly different from zero. In order to stay clear of selection bias, we selected almost all the available papers focusing on African RTAs provided the estimates and their standard errors are available. The papers were selected using snowballing sampling technique and complemented with Google scholar search engine. In all we obtain 139 estimates from 14 individual studies that focus on measuring the effect of different African blocs on bilateral trade. Of these studies, we have 8 of them published in journals and 6 unpublished.

Table 2: Descriptive Results from the Studies

Studies	**Publication**	**Mean of estimate**	**Standard Deviation**
Foroutan and Pritchett (1993)	Journal of African Economies	0.75	1.42
Carrere (2004)	Journal of African Economies	0.85	0.50
Musila (2005)	Journal of African Economies	0.42	0.61
Longo and Sekkat (2005)	World Development	1.81	0.63
Cernat (2001)	Global Economy Quarterly	1.28	0.60
Deme (1995)	Review of black political economy	0.68	0.24
Herman etal 2011	African Finance Journal	1.90	0.00
Kirkpatrick and Watanabe (2005)	Manchester School	1.53	0.80
Elbadawi 1997	Book	1.10	2.11
Afesorgbor and Bergeijk (2011)	Working paper	2.01	0.27
Ogunkola (1998)	Working paper	0.67	0.80
Ott and Patino (2009)	Working paper	-0.01	0.17
Subramanian &Tamirisa (2001)	Working paper	0.44	2.01
Turkson (2012)	Working paper	0.11	0.43
Total		0.86	1.06

A descriptive analysis on the studies used for the meta-analysis is provided in the table 2. It summarises the name of studies, the journals they were published, the average RTA effect per study. The estimates from these studies indicate varied heterogeneity in terms of sign, size and statistical significance. The measures of central tendency for the estimates indicate a mean (0.86) and median (0.76); however, the minimum and maximum estimates are -2.61 and 3.73 respectively, thus indicating the presence of outliners.

The absolute value of any trade effect of RTAs larger than 1, indicating a more than doubling of trade, may be an obvious signal of upward bias as plausible estimates for most RTAs are less than one. For instance, Head and Mayer (2013) indicate general effect of RTA effects on trade of 0.5 and on more specific RTAs, Cipollina and Salvatici (2010) indicates 0.52 (EU) and 0.90 (NAFTA). With regards to size and sign of the estimates, we divided the estimates into four different ranges, estimates indicating negative or positive effects and large or small magnitude. Detail of this is provided in table 3 and more than 45% of the estimates exhibit this large magnitude of RTA effects on trade. Out of the total number of estimates obtain, 74% of them are statistically significant.

Table 3: Categorisation of the Effect Sizes

Ranges of RTA Effect on Trade (estimates)	Frequency	Percentage
estimates≤-1	5	3.6
-1<estimates<0	26	22.30
0<estimates<1	50	35.97
estimates≥1	58	41.73
Total	**139**	**100**

In obtaining the estimates, different estimation techniques were employed by the different studies. The sign, size and significance of the estimates differ among the different estimation techniques. The mean estimates were greater than one in the OLS, RE and Tobit estimations, an indication obvious upward bias. This reflects the inadequacies of these techniques in addressing the econometric concerns with the gravity model. The Tobit estimation also has lowest number of estimates that were statistically significant.

Table 4: Estimates under Different Estimation Techniques

Methods	Frequency	Significant estimates	Mean	Std. Dev	Min	Max
Fixed Effect (FE)	16	75%	0.54	0.86	-0.57	2.43
Hausman-Taylor (HT)	12	92%	0.76	0.86	-0.54	2.41
Non-Linear Squares (NLS)	4	100%	0.44	2.01	-1.40	2.57

Ordinary Least Sqaures (OLS)	30	87%	1.04	0.78	-0.40	2.49
Random Effect (RE)	3	100%	1.30	1.03	0.12	2.01
Tobit (TE)	50	60%	1.05	1.35	-2.61	3.73
Weighted Least Sqaures (WLS)	24	71%	0.52	0.56	-0.26	1.29

To estimate the combined ES, two approaches are espoused; the Fixed Effect Method (FEM) and Random Effect Methods (REM)[2]. These methods are used to address the issues of within and between-study heterogeneity. In pooling data from different studies that exhibit some amount of heterogeneity in the estimates, simple measure of central tendency, which gives an equal weight to each estimate, may be misleading. Thus, in conducting the meta-analysis, two distinct approaches are used to account for differences in heterogeneity. The FEM assumes the differences across studies can be explained by only a within-variation as a result of sampling fluctuation. With the FEM, the ES from each study is assumed to be a function of two components. That is, $\delta_i = \theta + \varepsilon_i$, where θ is the single population ES and ε_i is the deviation of the ESs from the true population ES. This true population ES is unknown but is estimated as weighted average across the individual studies. The precision of the estimates is used as weight (w_i), which is inversely proportion to square of the standard error of the estimates (se (δ_i)).

$$\hat{\theta} = \frac{\sum_{i=1}^{n} w_i \delta_i}{\sum_{1}^{n} w_i}$$

$$w_i = \frac{1}{(Se(\delta_i))^2}$$

In contrast to FEM, the REM considers the differences in estimates to be explained by both within and between-study variations. It assumes the studies are random samples from a population of all possible studies. Technically, the REM conceptualises the population distribution of the ES as derived from the normal distribution with mean 0 and variance (τ^2). The ES under the REM is decomposed into three components, $\delta_i = \mu + \xi_i + \varepsilon_i$, where μ, is the mean of the distribution of the population of the effect sizes and ξ_i is the deviation (not due to sampling deviation) from the mean of the population ES and ε_i is the sampling deviation. In response to the two sources of imprecision, the population variability and sampling error, the REM incorporates an estimate of the between-study variation into the weights (${w_i}^*$). The weight comprises of the population variance (τ^2) and the square

[2] The FEM and REM are concepts in meta-analysis that are distinct from Fixed effect (FE) and Random effect (RE) estimations in panel data.

of standard error (σ^2) of the specific estimates (Card 2012).

$$w_i^* = \frac{1}{\tau^2 + \sigma^2}$$

$$\left(Se(\delta_i)\right)^2 = \sigma^2$$

$$\tau^2 = \frac{Q - n + 1}{\sum_1^n w_i - \frac{\sum_1^n w_i^2}{\sum_1^n w_i}}$$

n is number of observation and Q is a computed test statistic.

In evaluating heterogeneity, the Hedge Q test is conducted, which basically test whether the deviation in the ESs of the studies exceed the amount of expectable deviation due to sampling fluctuation. The test is conducted by computing Q statistic, which has a χ^2distribution, with (n-1) degrees of freedom. If the computed Q statistic is greater than the critical value obtained, χ^2_{n-1}, then the result is statistical significant and we reject the null hypothesis of homogeneity and conclude heterogeneity. Technically, the conclusion is that, the ESs are not estimates of a single population parameter but multiple population values. The Q is computed as weighted square of deviations of the individual ESs from their mean ($\bar{\delta}$). Mathematically, as follows:

$$Q = \sum_{i=1}^{n} w_i \, (\delta_i - \bar{\delta})^2$$

The Q-statistic is relevant in making statistical inference; however, it is limited in indicating the extent of heterogeneity or the percentage of variability in the ES that is attributable to heterogeneity rather sampling fluctuation. To determine the magnitude of heterogeneity, I^2 index is used. This index is interpreted as the proportion of variability between studies compared to total variability among effect sizes. According to Higgins and Thompson (2002), the index is computed as follows:

$$\mathrm{I}^2 = \frac{\tau^2}{\tau^2 + \sigma^2} = \begin{cases} \frac{Q - n + 1}{Q}, & Q > n - 1 \\ 0, & Q \geq n - 1 \end{cases}$$

Results from the MA are based on a total of 123 estimates, from which combined ES are obtain under the FEM and REM. The results consist of the test of heterogeneity, which indicate the rejection of the null hypothesis of homogeneity. The results additionally included the Z-test, which tests the significance of the combined ES. The Z-test indicates statistical significance result under both FEM and

REM. For the test of heterogeneity, Cipollina and Salvatici (2010) indicate that test could be spurious, in that homogeneity may be rejected even when the individual ESs do not differ significantly. This is attributed to low statistical power of the Q test. However, Card (2012) provides a simple chart using I^2 index as the rule of thumb to infer about heterogeneity. The chart displays the minimum detectable heterogeneity in connection with the number of studies that will result in statistically significant value of Q. If at a specific number of studies, the minimum detectable heterogeneity is less than the computed I^2 index, then concluding heterogeneity is reasonable. Based on this, our conclusion of heterogeneity is adequate. Details on the meta-analysis on overall RTAs effects reported in table 5. Table 6 display the meta-analysis of the RTA effect under different estimation methods.

Table 5: A Meta-Analysis of RTA Effects on Trade

Effects	**Pooled estimates**	**Lower bound of 95% CI**	**Higher bound of 95% CI**	**Q-Statistic**	**I-square**	**Z-Statistic**
Fixed	0.406	0.383	0.429	1981.24	93.8%	34.98
Random	0.634	0.526	0.742	1981.24	93.8%	34.98

Table 6: Meta-Analysis of Estimated RTA under Different Estimation Methods

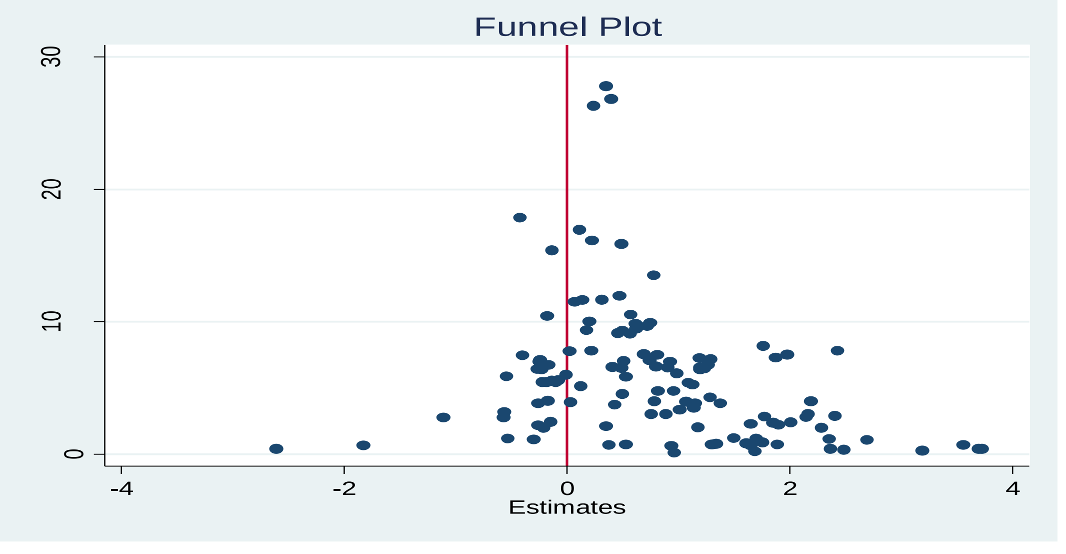
Methods	**Pooled estimates**	**ES**	**Lower bound of 95% CI**	**Upper bound of 95% CI**	**Q-Stat**	**I-sqaure**	**Z-Stat**
RE	FEM	0.196	0.083	0.309	41.040	95.10%	3.4
	REM	1.262	-0.151	2.675	41.040	95.10%	3.4
OLS	FEM	0.600	0.542	0.658	477.470	93.90%	20.3
	REM	0.896	0.635	1.158	477.470	93.90%	20.3
FE	FEM	0.270	0.232	0.307	703.510	97.90%	14.2
	REM	0.532	0.249	0.815	703.510	97.90%	14.2
HT	FEM	0.412	0.343	0.481	177.900	93.80%	11.7
	REM	0.651	0.334	0.968	177.900	93.80%	11.7
Tobit	FEM	0.395	0.334	0.457	136.450	72.90%	12.6
	REM	0.451	0.216	0.686	136.450	72.90%	12.6
WLS	FEM	0.567	0.515	0.620	300.650	92.30%	21.2
	REM	0.525	0.333	0.717	300.650	92.30%	21.2

For the combined ES of RTAs, the confidence interval (CI) under both FEM and REM is greater than zero, and a possible indication that African RTA may have a positive trade effect. The estimates obtained under FEM (0.406) and REM (0.634) were considerably smaller compared to the simple mean effect of 0.86. The results indicate the African RTA increase bilateral trade between 49 to 89%. This is plausible and comparable effect of African RTAs to N-N RTAS. The I^2 index indicates that about 94% of total variance is explained by between-study variance. Thus, the REM estimates are more consistent and appropriate. With regards to meta-analysis on different estimation techniques the RE and OLS estimates reports the highest effects of the RTA effects on trade about 140 to 250% effect of RTAs on trade. The FE, HT and WLS estimates fall within the confidence interval of the random effect estimates of the overall RTA.

4.2 Meta-Regression and Publication Bias

Though, the studies employed the same gravity specification there are some difference especially in estimation techniques, the topology of the data (cross sectional or panel data), definition of the dependent variables (some using exports, imports and average trade), the different RTAs under study and the way econometric concerns of the zero flows and MRT were dealt with. One major criticism of meta-analysis is publication bias, which can affect the results from the MA. This happens mostly because of the preference of academic journal to accept papers that report statistically significant results and reject papers that report negative or insignificant estimates. A conventional methods common in MA to determine this publication bias is the funnel plot. Typically, the funnel graph is scatterplot of the inverse of the standard errors (1/Se) relative to the individual effect sizes. Figure 2 is the funnel plot of the individual 122 estimates.

Figure 2: Funnel Plot



The funnel plot indicates the absence of publication bias if the plot has a pictorial view of an inverted funnel. Our funnel plot typically has the shape of an inverted funnel but does not perfectly have symmetric shape. Rose and Stanley (2005) note that asymmetry is mark of a publication bias. The funnel plot although very useful tends to be susceptible because of the subjective interpretation especially about symmetry. Thus, a simpler and appealing statistical technique using MRA can confirm the presence or absence of publication bias. This involves regressing ESs on their standard errors as in (2)

$$\delta_i = \beta_1 + \beta_0 Se_i + \varepsilon_i \qquad (1)$$

Stanley (2005), however, noted that since the ESs are obtained from individual studies with different sample sizes and modelling variation, the disturbance term will be heteroscedastic. Thus, the WLS is an apparent method to obtain the efficient coefficient, resulting in the transformation of equation (2) by dividing by $\mathrm{Se_i}$.

$$\mathrm{t_i} = \beta_0 + \beta_1 \frac{1}{\mathrm{Se_i}} + \epsilon_\mathrm{i} \qquad (2)$$

In equation (2), we regress the t-statistic on the inverse of the standard errors, and if we obtain statistically significant estimate for β_0, that indicates the presence of publication bias. This is because without publication bias, the ESs will be independent of the standard errors. The test of significance of β_0 is considered as a test of asymmetry of the funnel plot (Sutton et al., 2000). More details on the justification for this test can be found in Stanley (2005).

Table 7: Publication bias Regression

Dependent variable: t-statistics	
Inverse of st**andard** error	0.240***
	(0.0686)
Constant **($\boldsymbol{\beta_0}$)**	1.721***
	(0.386)
Observations	123
R-squared	0.094

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

Table 7 indicates statistically significant β_0, thus, revealing an asymmetry or publication bias, which could not explicitly be viewed from the funnel graph. Additionally, this test also confirms a genuine effect of RTA on trade as the precision variable was statistically significant. In assessing how the study characteristics and estimation techniques influence findings from individual studies, a multivariate MRA was employed. In this MRA, the t-statistics of the effect sizes are regress on the study characteristics and different estimation techniques. A similar approach was used by Rose and Stanley (2005) and Cipollina and Salvatici (2010). Results of the MRA are presented in table 8.

Table 8: Meta-Regression Analysis Results

Dependent variable: t-statistics	Model 1	Model 2
Inverse of std. error	1.932***	1.877***
	(0.393)	(0.355)
Number of countries	0.00241	-0.00310
	(0.00232)	(0.00243)
Type of data (Cross section=0/panel=1)	0.0940	0.141
	(0.229)	(0.321)
Control for Zero flows	-0.353*	-0.432***
	(0.188)	(0.154)
Published	-1.078***	-0.456
	(0.339)	(0.315)
Control for MRT	-1.054***	-0.821***
	(0.347)	(0.278)
FE	-0.638*	-0.142
	(0.331)	(0.231)
HT	-0.798**	-0.408
	(0.310)	(0.260)
OLS	-0.261*	-0.232***
	(0.136)	(0.0753)
RE	-0.894***	0.0755
	(0.207)	(0.226)
TE	-0.315**	-0.364***
	(0.136)	(0.110)
Constant	0.140	0.679*
	(0.375)	(0.378)
Control for specific RTAs	No	Yes
Observations	123	123
R-squared	0.393	0.765

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

Two models were estimated, in model 2, we control for the specific RTAs, while this is not done in model 1. Results indicate the study characteristics considerably affect the RTA effects on trade. Expectantly, we found that estimation techniques significantly influence the estimates. Additionally, whether the econometric concerns of zero flows and MTR are accounted for, influence the impacts of RTAs on trade. Studies that control for MRT tend to have lower estimates and similarly apply to studies that control for zero flows. This emphasizes that trade enhancing of RTAs may be significantly overstated if the two main econometric concerns are disregarded.

5 Specification of the Gravity Model

The traditional gravity equation as according to Tinbergen (1962) has the simple form.

$$X_{ij} = Y_i^{\alpha} Y_j^{\beta} d_{ij}^{\gamma}, where\ \alpha, \beta > 0\ and\ \gamma < 0$$

Where trade flow (X_{ij}) between countries (i and j) is directly proportional to the exporter's GDP (Y_i) and importer's GDP (Y_j) and inversely proportional to the distance between country $i\ and\ j$ (d_{ij})The GDP of the country i signifies the capacities of the exporter as supplier to all destinations j and similarly, the GDP of the country j indicates the market demand potential of the importer from all origins i. The model has become dominant in policy circles especially in international economics because of the robustness and high predictive tendency. The model to accounts for 70-80% variation in trade flows (van Bergeijk and Brakman, 2010). More importantly for gravity model has been the comprehensive theoretical derivation by Anderson (1979) based on standard economic techniques. This discards the earlier critique of the model lacking sound micro-economic foundation.

The specification of the model has evolved over the years. The naive specification of the gravity equation, in which the traditional gravity equation is augmented with bilateral accessibility variables (ϕ_{ij}). These variables are mostly dummy variables such as border, language, colonial link, common currency, free trade agreement and others that are likely to affect to trade between two countries. The naive specification is of the form

$$X_{ij} = Y_i^{\alpha} Y_j^{\beta} d_{ij}^{\gamma} \phi_{ij} \quad (3)$$

Anderson and van Wincoop following on the work on Anderson(1979) extended the gravity model by introducing the MRT. This became known as the structural specification of gravity model and it is specifies in the format.

$$X_{ij} = Y_i^{\alpha} Y_j^{\beta} \left(\frac{t_{ij}}{\Pi_i P_j} \right)$$

$\Pi_i and\ P_j$ are the exporter and importer MTR. t_{ij} is the bilateral trade cost between countries. The variabes in the term $\left(\frac{t_{ij}}{\Pi_i P_j} \right)$ are unobservable hence are estimated as follows:

$$t_{ij} = d_{ij}^{\gamma} e^{\phi_{ij}}, \Pi_i = \sum_i \left(\frac{t_{ij} Y_j}{P_j} \right) \text{ and } P_j = \sum_i \left(\frac{t_{ij} Y_i}{\Pi_i} \right)$$

Because of the multiplicative nature of the gravity equation, the model is most often estimated through a logarithmic transformation. For a panel data, a case in our study, country and time fixed effects are introduced in the equation. The fixed effect estimator has generally been accepted as excellent approach to obtain unbiased estimates of the gravity equations.

In estimating the gravity model, there is the concern of possible endogeneity emanating from reverse causality and unobserved heterogeneity. The reverse causality arises when countries that hitherto trade extensively are more likely to form RTA. In African context, this may not pose serious problem as the most of these African RTAs were formed when trade flows were not high. Endogeneity may also arise from the omission of unobserved heterogeneity such as historical, cultural, political and business factors that can affect the bilateral trade between two countries. This may produce inconsistent estimates when relevant proxies for these factors are not used to control for them. Essentially, the fixed effects estimator deals comprehensively with the unobserved heterogeneity in the gravity equation. The fixed effect estimator has the added benefits of easily application and controls for the computationally difficult MRT. In fact, Baier and Bergstrand (2009) attest to the simple technique of the fixed effects as being theoretically sound and producing identical estimates in the gravity model comparable to models that use Anderson van Wincoop Non-linear squares (NLS) computed MRT. Thus, the underlying model is specified in the log-log functional form as follows with both the dyadic fixed and time effects.

$$\ln\left(\mathrm{X_{ijt}}\right) = \alpha_{\mathrm{ij}} + \alpha_{\mathrm{t}} + \beta\ln\mathrm{M_{it}} + \gamma\ln\mathrm{M_{jt}} + \gamma\mathrm{D_{ijt}} + \delta\mathrm{RTA}_{ijt} + \varepsilon_{\mathrm{ijt}} \qquad (4)$$

α_{ij} is the dyadic fixed effects and α_t are the time dummies. $M_{i(j)t}$ is vector of monadic variables of the exporter (importer) in the gravity equation, and they consist of GDP, Population and Area. D_{ijt} is vector the dyadic variables (excluding RTA variables), consisting of distance between i and j, dummy variables capturing contiguity, common language and common currency. The variables of interest include a dummy for all the five major RTAs, AMU, COMESA, ECCAS, ECOWAS and SADC. The dependent variable (X_{ijt}) is the export from country i to j at time t.

Nevertheless, the FE estimator is not without blemish, the full rank assumption relevant for obtaining consistent coefficient could fail if there are too many dummy variables (Wooldridge, 2010). Introducing a time-varying country FE would introduce too may dummy variables. A more current criticism of using the FE is by Cipollina etal (2013), they indicate that the identification of trade policy variables is severely impaired when fixed effects are used to control for MRT. In order to address this issue, we use only dyadic FEs and introduced the proxy variable, remoteness, for the MRT as used by Wei (1996), instead of using time-varying FE. The remoteness index is computed as GDP weighted average distance.

6.1 Data

To achieve the second core objective of this study of comparing the different estimation methods and also assess the comparative performance of the five major RTAs in Africa. We obtained data on bilateral exports of 47 African countries from 1980 to 2006. The data on export flow was obtained from the IMF direction of trade database and gravity model variables from the CEPII website. Total number of observation was expected to be 58,374 but this was reduced to 46,081 because of missing values. The proportion of zero flows is extremely large in export value amounting to about 55%. Descriptive statistics on the on average export flows in terms of the RTAs is reported in table 9. The highest export flow is among AMU and lowest between countries without RTA.

Table 9: Summary of exports (million US$)

RTAs	Mean	Std. Dev.	Freq.
AMU	43.233689	79.926106	536
COMESA	9.73423	37.305468	1634
ECCAS	2.8686115	8.6140994	1098
ECOWAS	10.32932	51.888918	5454
SADC	35.120341	124.30776	1424
No RTA	1.8191457	16.787168	37458

6.2 Estimation Methods

In assessing the sensitivity of RTA effects on trade, we employ different estimation methods. The choice of the estimation methods are inform by the methods of previous studies and the need to correct for the two main econometric concerns. Using different estimation methods helps to compare the estimation methods of previous studies with the PPML and also to empirically determine the sensitivity of the RTA effects on trade to these estimation methods.

For the zero flows, different solutions have traditionally been used. Apart from majority of previous empirical studies dropping of the zero values, others rely on the Tobit estimation and adding of arbitrary small value to trade flow. These approaches would lead to inconsistent estimates especially if the zeros are not randomly distributed, which seems that case in our sample as the about 85% of zero flows occur in country pairs not in any RTA. The inconsistency of the estimates will be pervasive in an all-African trade flow data as SST (2006) indicate that severity of the inconsistency depends on the proportion of zero flows. In dealing with the zero flows, two major approaches are known as well-behaved, the Heckman based method proposed by Helpman etal (2008) and PPML proposed by SST (2006). However, the Heckman-based method tends to more applicable in providing estimates at the intensive and extensive margins of trade than estimating coefficients that combine extensive and intensive margins (Head and Mayer 2013). Gomez-Herrera (2013) also asserts that the Heckman method is more applicable in cross-sectional data and its application in panel data requires more research. In that view, we rely on the PPML as a solution to dealing with the zero flows. For the PPML, the expected trade is model using an exponential function.

$$E\left(X_{ijt} \middle| Z_{ijt}\right) = \alpha_{ij} \exp(Z_{ijt}^{\prime} \beta)$$

where Z_{ijt} and β are vector of covariates and coefficients respectively.

The PPML assumes a non-negative predicted trade flows. The PPML is consistent and well-behaved even if X_{ijt} is not logically consistent with the parametric approximation of Poisson distribution SST (2006). Whether X_{ijt} is count variable or not, the PPML makes inference fully robust to serial correlation and violation of the assumption of Poisson distribution. SST (2011) further confirm the PPML as better and it outperforms the Tobit estimator or arbitrarily adding of small values.

7 Results, Discussion and Conclusion

Details on the empirical estimation are reported in table 10. The standard controlling variables in models have expected signs. PPML estimates for exporter and importer GDPs are not close to one, a point well-noted by SST (2006). Focusing on trade policy variables of interest, the RTAs, one noticeable trend is the sensitivity of the impact of RTAs to different estimation techniques. The estimates differ considerably in sign, size and significance. Comparing the other estimation techniques to PPML is obvious observation of upward bias in the coefficient of the RTAs. In exception of PPML, the coefficients of the other estimation techniques report very high magnitude of RTA effects on bilateral trade. For instance, the approach of adding an arbitrary value (1) to exports reports an RTA impact of over 2000% ($e^{3.076} - 1$) in contrast to the less than 100% you find when zeros are correctly dealt with using PPML. A 2000% impact is obviously overestimated effect and unrealistic. Apart from the significantly overestimated impact of these RTAs in other estimation methods, most of the RTAs tend to have significant positive effect as well, which may be spurious outcome. This upward bias is conspicuously higher in the Tobit estimation and FE and OLS estimations, when zero flows are replaced with small values.

Table 10: Empirical Results under Different Estimation Methods

VARIABLES	OLS Ln (X)	OLS Ln(X)	FE Ln(X+1)	TE Ln(X+1)	RE Ln (X)	FE Ln (X)	PPML (X)
Ln exporter GDP	1.091***	0.486***	0.335**	1.288***	0.621***	0.462***	0.489***
	(0.0247)	(0.0646)	(0.132)	(0.123)	(0.0700)	(0.0966)	(0.112)
Ln importer GDP	0.682***	0.234***	0.371**	1.257***	0.297***	0.154*	0.192**
	(0.0235)	(0.0551)	(0.145)	(0.121)	(0.0557)	(0.0809)	(0.0894)
Ln distance	-1.451***	-1.587***		-4.997***	-1.506***		
	(0.0359)	(0.0398)		(0.347)	(0.106)		
Ln area exporter	-0.178***	0.480***		-0.548***	-0.143***		
	(0.0177)	(0.172)		(0.150)	(0.0476)		
Ln area importer	-0.163***	-0.905***		-0.462***	-0.137***		
	(0.0163)	(0.176)		(0.150)	(0.0450)		
Ln popn_exporter	-0.0696**	-1.109***	2.314***	1.782***	0.157**	-0.892*	1.800**
	(0.0301)	(0.328)	(0.775)	(0.212)	(0.0799)	(0.523)	(0.882)
Ln popn_importer	-0.0494*	1.991***	3.174***	1.221***	0.261***	2.268***	-0.101
	(0.0260)	(0.346)	(0.775)	(0.212)	(0.0718)	(0.519)	(0.879)
Remoteness exporter	0.000643***	-0.000718***	0.00102	0.000906	0.00169***	0.000951*	-0.000357
	(9.94e-05)	(0.000175)	(0.000843)	(0.000699)	(0.000287)	(0.000560)	(0.000490)
Remoteness importer	0.00106***	-5.20e-05	0.00211**	0.00121*	0.00142***	0.00126***	0.000562
	(0.000112)	(0.000161)	(0.000995)	(0.000708)	(0.000273)	(0.000467)	(0.000740)
Common currency	0.616***	0.732***	-0.409	0.241	0.0665	-0.327	-0.445
	(0.0612)	(0.0769)	(0.309)	(0.419)	(0.182)	(0.265)	(0.303)
Common language	0.644***	0.839***		3.798***	0.723***		
	(0.0402)	(0.0416)		(0.376)	(0.111)		
contiguity	0.774***	1.097***		3.414***	1.354***		
	(0.0614)	(0.0589)		(0.778)	(0.212)		
AMU	1.182***	0.139	3.076***	1.805***	1.389***	1.364***	0.629**
	(0.117)	(0.143)	(1.079)	(0.666)	(0.379)	(0.433)	(0.295)
COMESA	0.710***	1.269***	0.953*	0.000261	0.574***	0.936***	0.00220
	(0.0982)	(0.102)	(0.533)	(0.528)	(0.208)	(0.236)	(0.218)
ECCAS	-0.410***	-0.180	-0.331	-1.956**	-0.283	-0.233	-0.420**
	(0.120)	(0.125)	(0.878)	(0.762)	(0.330)	(0.508)	(0.211)
ECOWAS	0.789***	0.619***	-0.549	1.428***	0.0604	-0.442	-0.0568
	(0.0621)	(0.0844)	(0.706)	(0.459)	(0.187)	(0.317)	(0.262)
SADC	1.501***	0.579***	3.066***	2.159***	1.024***	0.951***	0.660*
	(0.0831)	(0.101)	(0.945)	(0.545)	(0.220)	(0.261)	(0.391)
Constant	-2.051***	8.225***	-10.72***	25.28***	3.878***	-9.572***	
	(0.442)	(2.646)	(2.772)	(3.703)	(1.223)	(2.048)	
Observations	21,094	21,094	46,081	46,081	21,094	21,094	40,758
R-squared	0.377	0.504	0.127			0.091	
FE		country	dyadic	dyadic			

Robust standard errors in parentheses, ***p<0.01, **p<0.05, *p<0.1, time dummies included in all model

Turning to RTAs' impact in the PPML model is modest impact on trade with coefficient less than one. The positive and significant coefficient obtain in PPML did not differ considerably from the one obtain from the meta-analysis of 0.63. Regarding the comparative assessment of the African RTA, the results delineate a varying effect of the RTAs, an indication that the performance and progress of the RTAs across the continent is unequal. Specifically, AMU and SADC are the two main regional blocs that have a significant positive impact on trade, with COMESA and ECOWAS not contributing significantly to trade. AMU increased trade by 88% and SADC by 93%. Unsurprisingly, ECCAS have negative and statistically significant impact on trade. ECCAS has extreme overlapping relationship with CEMAC, and has been relatively dormant. Incidentally, ECCAS is one the RTAs with many conflict prone countries.

In summary, this paper reviews the results of previous empirical papers assessing the impact of various African RTAs on trade. The results from the meta-analysis indicate that although these RTAs have general positive effect on bilateral trade, their effect sizes critically depend on the study characteristics and the estimation techniques employed. The empirical results evidently support this by demonstrating that trade enhancing impacts of RTAs are highly sensitive to the estimation methods employed. The effect of the RTAs tends to be overestimated when zero flows are over-look or incorrectly dealt with by replacing zero flows with small values. The PPML seems the best estimation technique in dealing with the endemic zero flows in African dataset. Contrary to the general pessimistic connotation of all African RTAs of not contributing significantly to intra-African trade, the result otherwise show that some RTAs have contributed significantly to trade. However, the pace of progress and performance is highly unequal. The result gives credence to ECA (2012) report that African RTAs have shown contrasting outcomes with some achieving tangible and modest outcomes whereas others have realised disappointing results.

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