Demystifying the Effects of AfCFTA: A General Equilibrium Approach

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Preliminary draft
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Abstract

This paper estimates crucial parameters in the welfare analysis of trade policy changes- trade facilitation- using a structural gravity model for the disaggregate level of HS2. Extensive research has shown that trade facilitation has a significant potential for the welfare gain of trade policy. Tariff equivalents of non-tariff measures, such as –trade facilitation and infrastructure indicators vary across products and countries. In particular, they are needed to simulate the trade and welfare effects of trade liberalization's transaction cost reduction potential. However, its estimation has been hindered by data and methodology constraints. In this study, we exploit a wide range of trade facilitation indicators (time to export/import, logistics performance index and enabling trade index) and use a panel structural gravity model to estimate the trade elasticities of these indicators and further computation of the ad valorem tariff equivalents. We find a significant impact of trade facilitation indicators on the trade flow that varies from a 0.24 per cent trade elasticity for one day delay to 2.29 per cent for the enabling trade index. Our results suggest that trade facilitation has a significant trade-enhancing effect across different countries.

Keywords: Trade Facilitation, Gravity, PPML model.

JEL classification: F10, F14.

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1. Introduction

In the past few decades, improvement in information and transportation technology coupled with tariff reductions has contributed an immense role in the growth of world trade that was much faster than output. The impact of a modest improvement in trade facilitation would lead to a 2.6% increase in world GDP with a 9.4% increase in world exports (Finot 2017). The poor state of infrastructure in Africa has reduced economic growth by 2 percent and productivity by as much as 40 percent annually. Domestic food prices are 13 % higher than average due SPS measures and NTBs that account for 50 to 60 % of marketing costs in SSA (FAO and AUC 2021). Free trade, therefore, enhances trade by reducing costs, enabling countries to exploit their comparative advantage, attracting investment and learning or adapting new technologies. The use of tariff protection in trade has declined continuously, however, the NTMs have been increasing and increasing with the level of development at the aim of regulating trade (Hoekman and Nicita, 2011). Tariffs, subsidies and quotas, the most obvious factors limiting access to international markets are no longer assumed to be the most significant impediment to international goods trade. Regulations and procedures such as customs administration, inspections, trade financing, security issues and infrastructure including ports and roads can cause delays in shipping and are now considered among the most significant trade barriers limiting goods trade (Minor, 2011). Trade facilitation and infrastructure investments will have the benefits of enhancing efficiency in agriculture, boosting trade in food products, increasing returns to farmers, lowering prices for consumers, and reducing carbon emissions from agriculture. In addition, trade can be a key adaptation mechanism to climate change by adjusting the type and volume of crops to grow and trade which ultimately depends on the agricultural and trade policies (Brenton et al., 2022, Janssens et al., 2020).

The growth and trend of trade and production have been continually changing. Africa switched from a net exporter status in the 1960s and 1970s to a net importer and dependent on agricultural imports. By contrast, South America and Southeast Asia have remained consistently net exporters of farm products since the 1960s, and India has been a net exporter since its Green Revolution boosted its grain production after the 1960s. Despite all the dynamics, global agricultural products trade has shown a sluggish growth than the trade in other products in the 20th century due to three main reasons (Anderson et al., 2016) (Anderson, 2022). The continuous fall in agriculture's share of global GDP; the recent fragmentation of industrial production into ever more processes and the associated rapid expansion in the number of international links in their global value chains but with a limited expansion in the agricultural sector than the industry; and the trade-restricting policies in the agriculture sector. However, Anderson (2022) argues that further multilateral trade arrangements will have a much higher economic impact (even higher than the gain in the past century) on the agricultural products trade by reducing the WTO-bound tariffs. In addition to that, multilateral trade agreements have contributed to the existing tariff rates reduction at all times low whereas the non-tariff measures and trade facilitations have a considerable impact on the trade of goods and services. For instance, the World Bank (2020) study of the African continental free trade agreement predicted that trade facilitation is the major driver of the again which significantly will rise the real income of African countries from 2.3 percent to 7 percent. Another recent study by Gourdon et al. (2020) estimated the quantity and price effects of 24 TBT and 34 SPS measures to a 15 percent price increase on imported agricultural products due mainly to mostly administrative impediments such as registration requirements. International harmonization of such trade measures can reduce such kinds of costs (Disdier et al., 2019).

The recent trade wars among the developed countries, which have ramifications on the developing countries, coupled with the increase in the non-tariff measures and other economic supply chains disruption affected trade considerably (Nicita et al, 2018). Despite the general scepticism about trade (Devarajan et al., 2018; Nicita et al., 2014; Arkolakis et al., 2012; Martin and Messerlin, 2007), the number of regional trade arrangements has been dramatically increasing since the 1980s and 1990s intending to cut down tariff and nontariff measures and trade facilitation. According to the WTO (2022) regional trade agreements notification report, in Africa the number of RTA's increased from 15 between 1948 and 2000 to more than double (over 50) after 2001. However, de Melo (2013) argues that RTAs of Africa live less than the economic expectation in member countries due to below potential market integration that reflects high trade barriers in the region. Even though it is a difficult task to measure each trade restrictiveness indices, studies use simple indicators that are not well grounded in trade theory and, often, they only vaguely define the aspects of the restrictiveness of the trade regime they try to measure (Rodriguez and Rodrik, 2001). Therefore, sound and theoretically grounded trade restrictiveness measures are critically important for the social and economic impacts analysis (Kee et al, 2009).

Since 2014, there has been an increasing focus on trade facilitation as a means to promote economic growth and development. The World Trade Organization (WTO) Trade Facilitation Agreement (TFA), which was agreed upon in 2013 and entered into force in 2017, has been a significant catalyst for this focus. The TFA is aimed at simplifying and standardizing customs procedures, improving transparency, and enhancing cooperation among customs administrations. Up until now, 164 WTO members have ratified the TFA.

In the past few decades, several trade restrictiveness index measures have been developed and data has been collected by various institutions such as the Trade Across the Boarder and Logistics Performance Index (LPI) by the World Bank, Trade Enabling Index (ETI) by the World Economic Forum, different trade facilitation measures by the OECD, etc. Time to trade has become one of the most important factors in determining business competitiveness Hummels (2004). Thus, reducing the time to trade can have an immense benefit for international trade. The impact of longtime delays on trade is comparable to that of a tax on exports or imports due to the depreciation of goods Djankov, Freund and Pham(2010). The ETI of the World Economic Forum measures the extent to which economies have in place institutions, policies, infrastructures and services facilitating the free flow of goods over borders and to their destination. The ETI indicators are collected in four major groups market access, border administration, infrastructure, and operating environment.

Focusing on the potential of trade facilitation for Africa, this study at hand aims to investigate the trade flow impacts of trade facilitation and compute its ad valorem tariff equivalents for a further analysis of the socio-economic impacts of the AfCFTA using a global multi-sector multi-country model. The gravity model is done at the HS2 levels of disaggregations for 97 products using the structural gravity model. Trade facilitation measures are proxied by the number of days needed to export/import a good, using data from the World Bank Doing Business Database; the logistics performance of countries, using the data from the world bank LPI; and the trade enabling environment measures, using the data from the World Economic Forum.

This study also addresses most of the data and methodological issues suggested by Piermartini et al, (2016), Heid et al, (2021), Shepherd (2016), Shepherd (2013) and Fally (2015). A consistent and comprehensive analysis is therefore that uses: 1) Intra-national and international trade data; 2) Directional fixed effects of temporal variation (country-year or country-sector-year); 3) Country pairs fixed effects, and; 4) The Poisson Pseudo Maximum Likelihood (PPML) estimations (Ferreira, 2021). Therefore, in this study, we tried to address all those major issues for better estimations. This study is different from the previous studies at least in the following major estimation, data coverage. First, this study at hand uses panel data that enables us to account for unobservable and observable heterogeneities. Second, by using a diverse trade facilitation indicator from different sources such as the World Bank doing business, the world economic forum enabling trade index and the World Bank logistics performance, we compute robust AVEs. Lastly, this study produces a database for any trade policy change analysis using CGE models.

The remaining part of the paper presents an outline of a suitable theoretical framework for analyzing the mechanisms through which trade facilitation affects trade and how to compute the ad valorem tariff equivalents of trade facilitations. The types of trade facilitation measures are discussed including the data sources and how to measure them. Thereafter, the empirical estimation methods section proceeds and finally, the main results are discussed and the paper closed with some concluding remarks.

2. Literature Review

Trade facilitation measures aim to reduce the costs and time associated with importing and exporting goods. These measures include simplification and standardization of customs procedures, automation of documentation, and improvement of transportation infrastructure. While there is a growing body of literature on the benefits of trade facilitation, its trade impact and ad valorem tariff equivalents are still debated in the literature.

A study by Anderson and van Wincoop (2004) found that trade facilitation can have a significant impact on trade, with the potential to increase global trade by up to 15%. They argue that reducing trade costs through trade facilitation measures can lead to an increase in both import and export volumes, especially for developing countries. Moreover, the study shows that trade facilitation measures are more effective in promoting trade than traditional trade liberalization measures such as tariff reduction. In contrast, a study by Baier and Bergstrand (2009) found that trade facilitation measures have a limited impact on trade, with a 1% reduction in trade costs resulting in only a 0.7% increase in trade volumes. The authors suggest that the impact of trade facilitation measures may be less significant than previously thought due to factors such as market access, infrastructure, and institutional quality. Chahir (2014) used a gravity model to estimate the impact of time to export and import on bilateral trade flows between 182 countries over the period 2005-2011. The analysis finds that the time to export and import has a significant negative effect on trade, with a one-day increase in the time to export and import reducing trade flows by approximately 1%. The study also finds that the impact of time to export and import on trade is more pronounced for developing countries.

A more recent study by Cadot et al. (2015) found that the impact of trade facilitation measures on trade is highly dependent on the specific measure being implemented. They suggest that measures that reduce border delays and enhance customs procedures have a more significant impact on trade than those that focus on technical regulations and standards. The authors also argue that the impact of trade facilitation measures on trade may be limited by factors such as the level of corruption and political instability in a country. In terms of ad valorem tariff equivalents, there is limited research on the subject. A study by Hoekman et al. (2015) suggests that the ad valorem tariff equivalent of trade facilitation measures is relatively low, with a reduction in trade costs of 1% resulting in a reduction in ad valorem tariffs of only 0.05%. However, the authors note that the ad valorem tariff equivalent of trade facilitation measures may be higher in developing countries, where trade costs are generally higher. a study by Lee and Park (2016) analyzed the potential impact of the TFA on trade in the Asia-Pacific region and found that the agreement could increase trade of up to 11.3%. The study also highlighted the importance of improving infrastructure, reducing non-tariff barriers, and enhancing institutional capacity to fully realize the benefits of the TFA.

Another study by Francois et al. (2019) used a computable general equilibrium (CGE) model to analyze the impact of the TFA on global trade and welfare. The study found that the TFA could increase global welfare by up to $1 trillion and that the benefits of the TFA would be shared across all regions and income levels. The authors also noted that implementing the TFA would require significant investment in infrastructure and institutional capacity, particularly in developing countries. In addition to the TFA, there has been a growing focus on digital trade facilitation in recent years. Digital trade facilitation refers to the use of digital technologies to simplify and streamline customs procedures, such as electronic documentation and automated border clearance. In general, the literature on the trade impacts and ad valorem tariff equivalents of trade facilitation measures is mixed. While some studies suggest that trade facilitation measures can have a significant impact on trade, others argue that the impact may be more limited than previously thought. The impact of trade facilitation measures on ad valorem tariffs is also relatively low, but this may be higher in developing countries.

3. Methodology and Data

The Gravity Model has become a widely accepted framework for analyzing trade flows and is used extensively in international trade analysis stemming from the principle that trade between two countries is directly proportional to their economic size (measured in terms of GDP) and inversely proportional to the distance between them. A wide range of trade models generates a relationship in bilateral trade flows that satisfy the following general equation.

$$X_{ij} = \frac{Y_i}{\pi_i^{-\theta}} . D_{ij}^{-\theta} \frac{E_j}{P_j^{-\theta}}$$

In the above equation, Yi refers to the total output in country i; Ej refers to the total expenditure in country j; and Dij captures the costs of the trade from country i to country j. The parameter θ reflects the elasticity of trade flows to trade costs that measures the strength of trade costs to trade flows. The last terms P and Π are Anderson and van Wincoop's (2003) “multilateral resistance" indexes.

According to Phally (2015), there two broad approaches to estimating the above gravity equation that is due mainly depend on the treatment of the two terms of $\frac{Y_i}{\pi_i^{-\theta}}$ and $\frac{E_j}{P_j^{-\theta}}$. The first approach uses the exporter and importer fixed effects and estimates the gravity model simply including the trade cost variable $D_{ij}^{-\theta}$ in addition to the fixed effects.

The above model in this approach is expressed as follows:

$$X_{ij} = \exp[M_j - \theta D_{ij} + E_i] \, x \, \varepsilon_{ij}$$

Where, M_j *and* E_i are the importer and exporter fixed effects and θD *and* $_{ij}$ are as expressed above.

The second approach, on the other hand, uses the observed outputs and expenditures instead of the use of fixed effects. Therefore, our study follows the first approach. Hummels (2001) and Feenstra (2016) argued that it enables overcoming the computational difficulties of the custom programming from Anderson and van Wincoop (2003), while at the same time fully accounting for the multilateral resistance terms, consisting in using directional (exporter and importer) fixed effects in cross-section estimation. A recently developed gravity model recommends the multilateral resistance terms should be accounted for by exporter-time and importer-time fixed effects in a dynamic gravity estimation framework with panel data. Thus, in addition to accounting for the unobservable multilateral resistance terms, the exporter-time and importer-time fixed effects will also absorb the size variables (Ej,t and Yi,t) from the structural gravity model as well as all other observable and unobservable country-specific characteristics, which vary across these dimensions, including various national policies, institutions, and exchange rates (Larch and Yotov (2016)). Specifically, the directional fixed effects will control for the unobservable multilateral resistances, and potentially for any other observable and unobservable characteristics that vary over time for each exporter and for each importer. In addition, Anderson, Larch and Yotov (2015) and Larch and Yotov (2016) the estimates of the fixed effects can be used directly to recover estimates of the general equilibrium (GE) effects of trade policy changes as well as to construct a series of useful GE indexes that summarize and aggregate consistently the effects of trade policy and trade costs.

Piermartini & Yotov (2016) discussed the two major benefits of using pair-fixed effects; they can be used to account for the endogeneity of regional trade agreements and they provide a flexible and comprehensive account of the effects of all time-invariant bilateral trade costs. Agnosteva, Anderson and Yotov (2014) demonstrate that the pair fixed effects carry systematic information about trade costs in addition to the information captured by the standard gravity variables.

This paper follows, among others, Piermartini et al, (2016) and Heid et al, (2021) to estimate the trade elasticities of trade facilitation indicators and to compute the ad valorem tariff equivalents across different countries and products. To estimate the trade flow impacts of the trade facilitation indicators, the structural gravity model used is simple and intuitive, and it corresponds fairly well with the theoretical concepts. It would be an advantage to use variations over time, and across countries and products.

One of the main advantages of the structural gravity model with pair fixed effects is that they are a better measure of bilateral trade costs than the standard set of gravity variables (Egger and Nigai, 2015) and Agnosteva et al. 2014). The country pair fixed effects, Dij, absorb all possible time-invariant bilateral trade costs (Egger and Nigai, 2015, and Agnosteva et al. 2019) and mitigate endogeneity concerns related to the bilateral time-varying trade policy variables (Baier and Bergstrand 2007 and Yotove, 2022).

The general structural gravity model is specified:

$$X_{ijt}^{k} = \exp\left[\rho_{it} + \gamma_{jt} + \theta^{k} * Gravity_{ij} + \alpha^{k} * tariff_{ijt}^{k} + \mu^{k} * TFI_{ijt}\right] \times \varepsilon_{ijt}^{k}$$

Where, X_{ijt}^{k} is the trade flow of product k between country i and j at year t, $Gravity_{ij}$ is the set gravity variables, $tariff_{ijt}^{k}$ is the most favoured tariff line imposed by country j on the import of product k from country i. $TFI_{ijt}$is the trade facilitation measure as constructed above, and ρ_{it}, γ_{jt} are the importer*time and exporter*time fixed effects. ε_{ijt}^{k} is the error term.

To check the sign and magnitude of the standard gravity model, a simple OLS model with the year and product fixed effects is specified:

$$Ln(X_{ijt}^{k}) = \alpha_0^k + \alpha_1^k Ln(dist_{ij})\_MR + \alpha_2^k Ln(1 + Tariff_{ijt}^{k}) + \alpha_3^k (contig_{ij})\_MR + \alpha_4^k (langoff_{ij})\_MR + \alpha_5^k (Colony_{ij})\_MR + \alpha_6^k (RTA_{ij})\_MR + \alpha_7^k Ln(GDP_{it}) + \alpha_8^k Ln(GDP_{jt}) + \alpha_9^k Ln(TF_{it}) + \alpha_{10}^k Ln(TF_{jt}) + \alpha_{11}^k (landlocked_i) + \alpha_{12}^k (landlocked_j) + \delta_t + \gamma_k + \varepsilon_{ijt}^{k}$$

The time to export and time to import of trade facilitation impacts is specified as follows.

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_1^k * (1 + tariff_{ijt}^{k}) + \theta_1^k * Timetrade_{ijt}] \times \varepsilon_{ijt}^{k}$$

In the same fashion, the Logistics performance of the country's model is specified as:

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_2^k * (1 + tariff_{ijt}^{k}) + \theta_3^k * LPI_{ijt}] \times \varepsilon_{ijt}^{k}$$

Lastly, the Trade enabling indicator of trade facilitation is specified as follows.

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \pi_{ij} + \theta_1^k * Gravity_{ij} + \theta_2^k * (1 + tariff_{ijt}^{k}) + \theta_3^k * ETI_{ijt}] \times \varepsilon_{ijt}^{k}$$

We use the PPML estimator for the following reasons. First, following the works of Santos Silva and Tenreyro (2006), the gravity model is estimated in the multiplicative form of the PPML estimator that accounts for heteroskedasticity, which often plagues trade data. In addition, the PPML takes advantage of the information contained in the zero trade flows and resolves the zero trade problem. Finally, Anderson, Larch and Yotov (2015) demonstrate how the PPML estimator can be used to estimate theory-consistent general effects. Piermartini & Yotov (2016)

Reduction in fixed trade costs should encourage greater diversification to more markets and/or to more products in the same market. Part of fixed costs is time in customs and associated monetary costs. Reduction in fixed costs should also lead to greater participation in supply chain trade at both the regional and global levels where goods have to cross borders multiple times. (de Melo, Sergho & Wagner, 2021). Time to export measures the number of days it takes to export goods. This includes three distinct parts: 1) the time it takes to gather all domestic documents needed for exports, 2) the time to proceed through customs and comply with border regulations, and 3) the time of domestic transport to the national port of embankment. The data are collected via questionnaires sent out to exporting firms, port, and customs authorities as well as domestic freight companies. The bilateral trade facilitation measures are computed in three different ways to be estimated in a structural gravity model that captures the exporter-year, importer-year and country pair fixed effects. The equal-weighted average of the exporter and importer's trade facilitation measure if the first approach presumes that one unit (for instance a one-day) change in the trade facilitation indicator has a similar impact on the trade flow of importer or export.

$$TFI_{ijt} = [0.5 * \ln(TFI_{it}) + 0.5 * \ln(TFI_{jt})]$$

The second approach is the absolute value of the trade facilitation indicators:

$$TFI_{ijt} = |\ln(TFI_{it}) - \ln(TFI_{jt})\,|$$

In the third approach, the simple difference of the trade facilitation:

$$TFI_{ijt} = \ln(TFI_{it}) - \ln(TFI_{jt})$$

In these equations, TFI is the different trade facilitation indicators: Time cost of trade: Time to export and import, Logistics performance of countries, Enabling of trade. The time to export is the number of days it takes to export a standardized cargo of merchandise, including the time it takes to go through all official procedures that have to be fulfilled to export the good. Whereas, ETI capture more indicators than the time it takes to export/import. It has six broad categories which are aggregated from 13 indicators and again the ETI is computed. These are the Customs services index (1 indicator); efficiency of the clearance process (1); border compliance: time and cost to export/import (4); documentary compliance: time and cost to export/import (4); irregular payments and bribes: imports/exports (1); time predictability of import procedures (1); and Customs transparency index (1). As such, the ETI has incorporated the Trading across Borders indicators which were originally used for Doing Business, intending to reveal the full extent of the trade facilitation efforts for each of the countries. The Logistics Performance Index (LPI) is an index developed by the World Bank that measures the efficiency and effectiveness of logistics systems in countries around the world. The index is based on a survey of international freight forwarders and other logistics professionals, who rate countries on a scale from 1 to 5 on various aspects of logistics performance, such as customs procedures, infrastructure quality, and timeliness of shipments. It is widely used by researchers and policymakers in the area of logistics performance. It is also used to identify areas for improvement and to track progress over time. The LPI is updated every two years and covers over 160 countries.

To do the empirical analysis, we construct an unbalanced panel data set for 42 African importing number of countries with 163 partner countries based on the data availability for the years 2005 to 2019. As can be seen from the table1, the number of years varies with the data set used. We start in 2005 because data on one of our main regressors of interest (time to export and import) are available only since 2005. For the remaining variables, we use data from different sources. Most of the data are retrieved from the CEPII BACI, World Bank Doing Business, World economic forum, World Development Indicators, World Bank Logistics Performance Index etc. The detail of the data sources, available years and adjustments before using the data are presented in Table 1.

Table1: Dependent and independent variables adjustments and expected signs

Variable	Definition	Data used	Source	Adjustments	Expected sign
Trade volume	Trade in amount and value	2006-2019	CEPII-BACI	no	n/a
Time to export/import	Number of days to export/import	2006-20019	World Bank Doing business	# of days measure of up 2015 harmonized with # of hours 2016-2019	-
ETI	Average and difference of exporter and importer	2012-2017	World Economic Forum	Different weighted average of the exporter s and importers	+
LPI	Weighted Average of the indices	2007-2019	World Bank	Weighted average and absolute and simple difference of exporter and importer	+
Distance	Geographical distance between exporter and importer	2006-20019	CEPII	no	-
GDP	Gross domestic product of exporter and importer	2006-2019	WDI	no	+
Gravity	Gravity variables		CEPII		-/+

4. Empirical Results

The results of the OLS and a Poisson estimation of different model specifications for the three specified trade facilitation measures of the three trade facilitation measure namely the time to trade (number of days), LPI (indices) and the ETI (indices) are presented in this section. A separate estimation for the average of export and importer trade facilitation measures, the absolute value of the difference and the simple difference measures are conducted independently. First, the standard gravity variables are checked using OLS estimation and the expected signs and significances are achieved (result in the appendix). The estimation shows that all else equal, countries that have a huge economy, common colonial ties, and a common official language, share common border trade more and these effects are significant. Another interesting result is the coefficient of regional trade agreements. The coefficient of an RTA is consistent over the three specifications and has a positive significant effect.

The coefficient for the trade facilitation indicators can be interpreted as an elasticity. In the OLS estimation (first column) the coefficient of time to trade is 0.24 and statistically significant which indicates a decreasing border delay by 1 per cent will increase the trade flow by about 0.24 per cent. This corresponds fairly well with the findings of Heid et al (2021). These authors, while using a slightly different setup – for instance, using an intra-national and international trade and the difference equations found a 0.18 per cent effect.

Table 2: Estimates on the impacts of the Time to trade on international trade

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS average	OLS Abs diff (TF)	OLS Sim diff (TF)	PPML HDFE average	PPML HDFE Abs diff	PPML HDFE simp diff
Ln (gdp_o)	0.50***	0.51***	0.51***	-	-	-
	(0.04)	(0.03)	(0.03)			
Ln (gdp_d)	0.34***	0.34***	0.34***	-	-	-
	(0.05)	(0.02)	(0.03)			
Ln (1+tariff)	-6.05***	-6.01***	-6.01***	-5.34***	-5.20***	-5.51***
	(0.35)	(0.92)	(1.02	(0.67)	(0.74)	(0.75)
Ln(distw)	-0.74***	-0.73***	-0.73***	-	-	-
	(0.01)	(0.20)	(0.24)			
Contig dummy	0.56***	0.52***	0.53***	-	-	-
	(0.01)	(0.01)	(0.01)			
Common official language dummy	0.31***	0.31***	0.31***	-	-	-
	(0.01)	(0.01)	(0.01)			
Common colonizer post 1945 (dummy)	0.23***	0.22***	0.22***	-	-	-
	(0.01)	(0.01)	(0.01)			
RTA	0.45***	0.48***	0.48***	0.18 (0.12)	0.18 (0.13)	0.13** (0.02)
	(0.01)	(0.01)	(0.01)			
Ln(time to trade average)	-0.24***			-0.30*** (0.12)		
	(0.01)					
Ln(time to trade absolute diff		-0.22			-0.38*** (0.06)	
		(0.00)				
Ln(time to trade simple difference)			-0.26*** (0.02)			-0.36*** (0.02)

Constant	-8.84***	-9.85***	-9.82***	9.97***	9.88***	1.13***
	(0.07)	(0.06)	(0.06)	(0.39)	(0.08)	(0.01)
Imp_year FE				Yes	Yes	Yes
Exp_year FE				Yes	Yes	Yes
Imp_exp FE				Yes	Yes	Yes
Year FE	Yes	Yes	Yes			
Product FE	Yes	Yes	Yes			
Observations	1134255	1134255	1134255			
Adjusted R^2	0.331	0.330	0.330			

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results of the LPI impacts on the international trade flow

In the next estimation results, we present only the final model with country-year and country-pair fixed effects as this specification is taken as the most robust estimation. The results for our main trade facilitation variables are as expected and significant. The estimate of the coefficient on MFN tariffs is again highly statistically significant. In terms of economic magnitude, with a value of −3.11, our MFN tariff estimate is a bit smaller in absolute magnitude than the corresponding estimate from OLS and in the time to export and import model. The estimated coefficients of almost all variables are also comparable in the three different methods of bilateral trade facilitation indicators computation methods (weighted average, the absolute value of the difference and the simple difference of the log of the indicators. The LPI coefficients are statistically significant and positive indicating improving the efficiency and effectiveness of logistics systems would enhance the trade flow. A 1 percent improvement in LPI will increase trade by about 0.36 percent.

Table 3: gravity estimation on the impact of LPI on the international trade

	(1) PPML HDFE index	(2) PPML HDFE absolute diff	(4) PPML HDFE simple diff
RTA	0.17***	0.21***	0.19***
	(0.02)	(0.04)	(0.01)
Ln (1+tariff)	-3.02	-3.11	-2.91
	(0.02)	(0.02)	(0.02)
LPI index	0.36***		
	(0.06)		
LPI absolute diff		0.38**	
		(0.24)	
LPI simple diff			0.37***
			(0.05)
Constant	8.73***	9.12***	9.04***
	(0.33)	(0.07)	(0.06)
Imp_year FE	Yes	Yes	Yes
Exp_year FE	Yes	Yes	Yes
Imp_exp FE	Yes	Yes	Yes
Observations	956658	1018943	1018943
Adjusted R^2	0.656	0.690	0.695

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Results of the ETI impacts on the international trade flow

Table 4: gravity estimation of on the impact of ETI on international trade

	(1) ETI average index	(2) ETI absolute diff	(3) ETI simple diff
RTA dummy	0.63	0.26^{**}	0.26^{**}
	(0.45)	(0.10)	(0.10)
Ln(1+tariff)	-5.05***	-6.12***	-5.20***
	(1.31)	(0.81)	(0.56)
ETI average index	1.79		
	(1.20)		
ETI absolute diff		0.35	
		(0.31)	
ETI simple diff			2.29^{**}
			(1.00)
Constant	7.29^{***}	12.52^{***}	12.88^{***}
	(1.69)	(0.07)	(0.13)
Observations	399507	389275	389275
Adjusted R^2	0.632	0.9406	0.9406

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In the estimation of the ETI index, we found a strong impact on trade flow impact as can be seen in the table below. A possible explanation for the large ETI estimate may be that trade facilitation indicators of the ETI include other measures of trade facilitation than the time to export and import such as infrastructure and transport quality and service efficiency. The interpretation of the coefficients is as the previous LPI interpretation of elasticity of trade flows. The regional trade agreement coefficient is statistically significant across the three estimations.

5. Ad Valorem Tariff Equivalents of Trade Facilitations *(in progress)*

In a second stage, to assess more appropriately the impact of trade facilitation on trade, we adopt the methodology of Kee et al. (2009) to estimate ad-valorem equivalents (AVEs) for trade facilitation based on the gravity model. To make such regulations comparable with AVEs, the quantity impact must be transformed into price equivalents. This yields the AVEs of administrative barriers ave^{TF}_j noted as $ave^{TF}_j = dlog(p_j)$. Hence, the gravity equation is differentiated with respect to ER_j:

$$\frac{dln(x)}{d(TF)} = \frac{dln(x)}{dln(p)} * \frac{dln(p)}{d(TF)} = \epsilon^j ave_j^{TF} \tag{5}$$

where ε is the import demand elasticity in country *j* and *p* the domestic price in country j.

Hence, solving (5) for ave^{TF}_j:

$$ave_j^{TF} = \frac{1}{\epsilon^j} * \frac{dln(x)}{dln(TF)} \tag{6}$$

In other terms, the AVEs can be computed by taking the ratio between the coefficient of the trade facilitation (obtained from the gravity model) and the elasticity of demand (coming from Kee et al, 2008) as follows:

$$ave_j^{TF} = \frac{\alpha^j}{\epsilon^j} \tag{7}$$

This yields the ad-valorem equivalent of trade facilitation for the countries whose elasticity of demand is available. It is worthy to note that AVEs have been computed based on the output of the bilateral gravity model as it is the closest specification to Kee et al. (2009).

6. Simulating the Impact of Trade Facilitation *(in progress)*

We introduce the different AVEs along with the list of sensitive products to run different simulations pertaining to the implementation of AfCFTA in a general equilibrium framework using the MIRAGRODEP Model (a multinational, multisectoral and dynamic CGE model). The GTAP 10 database or the most recent version of the GTAP database will be used as main source of data for the MIRAGRODEP model. The model can cover up to 141 regions/countries in the world and up to 65 sectors. The sectoral definition of the GTAP database GTAP classifies agriculture, food, resource extraction, manufacturing, and service activities to describe all economic activities in each country. Specific commodities including rice, maize, wheat, dairy products, and other processed foods are highlighted

7. Conclusion and Policy Implications

Focusing on the different measures of trade facilitation, this study investigates the impacts of trade facilitations on the international trade flow at the disaggregate level of HS2 products. In this paper, we propose to estimate the trade flow impacts and the Ad valorem tariff equivalents of trade facilitation measures taken from different sources of the time to export and import and the logistics performance index from the World Bank and the enabling trade index from the world economic forum. To achieve our objective, we use a structural gravity model with the country year and country pair fixed effects that enables us to estimate the impacts of the different trade facilitation measures on the international trade flow. Bilateral trade facilitation indicators are computed from the unilateral trade facilitation indicators by taking the average of the exporter and importer and the absolute value and the simple difference. By contracting a bilateral time-varying variable, the impacts of the trade facilitation on international trade flow are estimated. The estimated trade facilitation indicators have a comparable magnitude with the prior studies.

The next task will be then, computing the ad valorem tariff equivalents of the trade facilitations using the estimated trade elasticities of trade facilitations and the MFN tariff so called the "price shifter".

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Appendix

A1. Disaggregated trade facilitation indicators on international trade flow

The logistics performance index and the enabling trade index are an index of six indices that are also constructed from many different variables. For policy implication, the disaggregated estimations on the disaggregated trade facilitation indicators enable us to see the impact of the policy-specific variables. However, we will not compute the ad valorm tariff equivalents for each for brevity purposes.

1. Each LPI indicators

$$X_{ijt}^{k} = \exp\left[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_1^k * (1 + tariff_{ijt}^k \ + \theta_1^k * \mathrm{Abilitytrack}_{\mathrm{traceconsig}_{ijt}}\right] \times \ \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp\left[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_1^k * (1 + tariff_{ijt}^k + \theta_1^k * \mathrm{Competencequalitylogistics\ services}_{ijt}\right] \times \ \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp\left[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_1^k * (1 + tariff_{ijt}^k + \theta_1^k * \mathrm{Ease\ of\ arranging\ competit\ priced\ international\ shipments}_{ijt}\right] \times \ \varepsilon_{ijt}^k X_{ijt}^k$$

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_1^k * (1 + tariff_{ijt}^k + \theta_1^k * \mathrm{Efficiency\ of\ the\ clearance\ process}_{ijt}] \times \ \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_1^k * (1 + tariff_{ijt}^k + \theta_1^k * \mathrm{Frequen\ shipments\ reach\ consignee\ scheduled\ expected\ time}_{ijt}] \times \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_2^k * (1 + tariff_{ijt}^k\ ) + \theta_3^k * \mathrm{Quality\ of\ trade} - \ \mathrm{and\ transport} - \mathrm{related\ infrastructur}_{ijt}] \times \varepsilon_{ijt}^k$$

Where, trade facilitation indicators are from the logistics performance index.

- ✓ Ability to track and trace consignments
- ✓ Competence and quality logistics services
- ✓ Ease of arranging competitive priced international shipments
- ✓ Efficiency of the clearance process
- ✓ Frequency with which shipments reach consignee within scheduled or expected time
- ✓ Quality of trade and transport related infrastructure

2. Each ETI indicators

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_2^k * (1 + tariff_{ijt}^k) + \theta_3^k * \mathrm{availability\ and\ quality\ of\ transport\ infrastructure}_{ijt}] \times \ \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_2^k * (1 + tariff_{ijt}^k) + \theta_3^k * \mathrm{availability\ and\ quality\ of\ transport\ services}_{ijt}] \times \ \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_1^k * (1 + tariff_{ijt}^k) + \theta_1^k * availability\ and\ use\ of\ ICTs_{ijt}] \times \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_2^k * (1 + tariff_{ijt}^k) + \theta_3^k * \text{efficiency and transparency of border administration}_{ijt}] \times \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_2^k * (1 + tariff_{ijt}^k) + \theta_3^k * \text{foreign market access}_{ijt}] \times \varepsilon_{ijt}^k$$

$$X_{ijt}^{k} = \exp[\rho_{it} + \gamma_{jt} + \theta_1^k * Gravity_{ij} + \theta_2^k * (1 + tariff_{ijt}^k) + \theta_3^k * \text{domestic market access}_{ijt}] \times \varepsilon_{ijt}^k$$

Here, each trade facilitation indicators are used to estimate the impact of each of the indicators.

1. Availability and quality of transport infrastructure
2. Availability and quality of transport services
3. Availability and use of ICTs
4. Efficiency and transparency of border administration
5. Foreign market access
6. Domestic market access