Does aid for trade diversify Sub-Saharan Africa's exports at the intensive and extensive margins?

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Abstract

This article applies the flexible estimation approach to estimate an augmented gravity trade model to investigate the link between aid for trade (AfT) and export diversification along the intensive and extensive margins in 42 sub-Saharan African (SSA) countries for the period 1995 to 2019. The findings suggest that total AfT is conducive to export diversification along both margins. When analysed by the AfT category, the results reveal that AfT for trade facilitation is more effective in the short run in boosting exports at the extensive margin while AfT for productive capacity-building has a bigger impact along both export margins in the longer term. AfT for economic infrastructure seems to promote exports only at the intensive margin. A key policy implication for the donor community is that providing new and additional resources to trade facilitation in African countries could deliver the highest immediate returns in terms of aid effectiveness.

Keywords: Aid for Trade; Export Diversification; Intensive Margin; Extensive Margin; Gravity Model.

JEL Classifications: F14; F11; F35; C23

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1. Introduction

The Aid for Trade (AfT) initiative, formalised at the Hong Kong WTO (World Trade Organization) Ministerial Conference in December 2005, is based on the premise that trade and development policies are complementary, and that developing countries will not be able to exploit the expanded trade opportunities offered by greater market access to the developed markets unless they address their supply-side constraints. These constraints can take the form of inadequate or defective infrastructure, weak institutional structures, cumbersome and time-consuming customs procedures, among others. The AfT initiative was therefore introduced to provide financial and technical assistance to the developing countries to strengthen their trade-related infrastructure, build their productive capacity, and enable them to formulate and implement appropriate trade policies and regulations (WTO, 2015).

Supply-side deficiencies are prevalent in sub-Saharan Africa (SSA), resulting in significantly higher trade costs than in other developing regions. Africa's infrastructure deficit increases both inland transport costs and shipping costs caused by poor road conditions and an inefficient port system, respectively. Moreover, information and communication costs between traders are higher because of poor telecommunication networks. Weak institutional structures cause corrupt practices to thrive across the supply chain, resulting in additional transaction costs. The slow and sometimes complicated bureaucratic customs procedures in some countries cause significant delays in the shipping process. Landlocked countries face a higher burden because of the need to transit through their neighbouring countries, such that transit delays and trade costs are higher.

High trade costs constitute a potent explanation for SSA's marginalisation in world trade and its relatively low regional trade. Africa's share of world merchandise exports stands at 1.7% while regional trade represents only 14.8% of its total merchandise exports (UNCTAD, 2018). Besides, SSA's exports are concentrated in a few unprocessed primary commodities. Thirty-nine of the 47 SSA countries depend on two primary commodities for over 50% of their export earnings, and manufacturing exports represent only around 19% of the region's total exports (UNCTAD, 2018). The concentrated export structure and the implied absence of diversification increase SSA's vulnerability to commodity price fluctuations, make them less resilient to economic shocks and impede economic growth.

Since 2005, AfT flows disbursed to SSA have tripled, making the region the second largest AfT recipient after Asia. The bulk of these resources has flowed into the transport and storage,

energy, and agricultural sectors in the form of AfT for economic infrastructure and AfT for productive capacity-building. The amount of AfT disbursed to assist SSA countries in the formulation and implementation of trade policies and trade-related agreements, including trade facilitation initiatives, is comparatively low. The share of AfT for trade policy and regulations is 2.9%, while its sub-category, AfT for trade facilitation, is only 1.2% of the total AfT (OECD, 2018). While there exist several studies on the effectiveness of AfT in boosting the export performance of recipient countries, the evidence is still inconclusive (Cadot et al., 2014). Also, previous work focuses on analysing the effect of AfT on aggregate or bilateral export values of recipient countries (Cadot & de Melo, 2014; Gnangnon, 2018). There have been very few attempts to analyse the effectiveness of AfT on export diversification, despite this being one of the principal aims of the AfT initiative (UNECA, 2015).

Against this background, this study contributes to the literature in two important ways. First, an empirical investigation is conducted to assess the effectiveness of AfT on export diversification measured at two margins: the export share of existing products (intensive margin), and the export share of new products (extensive margin). This research is useful and timely because of the heightened awareness among African policymakers of the urgent need for structural transformation and export diversification into high value-added products to boost economic growth (AfDB, 2017). Second, it uses the gravity model that has robust empirical applications and employs the flexible estimation approach of Santos Silva, Tenreyro, and Wei (2014), to estimate the specified model in a panel setting of 42 SSA countries over the period 1995 to 2019.

This article proceeds as follows. Section 2 provides a critical review of the relevant literature followed by a discussion on the theoretical channels through which AfT could influence exports along the intensive and extensive margins in Section 3. Section 4 presents the specified model and describes the empirical strategy while the estimation results and analysis are presented in Section 5. Section 6 concludes.

2. A critical review of the literature

There is scant empirical evidence of the effectiveness of AfT in achieving its targeted outcomes (Cadot et al., 2014). Most of the existing studies focus on the impact of AfT in boosting export performance, as proxied by aggregate export values or bilateral exports (Calì & te Velde, 2011; Ferro, et al., 2014, among others). We do not review these studies here as the aim of our study is to assess the impact of AfT on export diversification. Nonetheless, it is worth mentioning that the evidence of the impact of AfT on export outcomes has been mixed, despite attempts to control for

estimation problems such as omitted variable bias and reverse causality. The empirical evidence varies by type of AfT, the geographical area being studied, the direction of the exports and the way AfT programs are designed and implemented by donors.

Relatively little work has been done to assess the effectiveness of AfT in stimulating export diversification in recipient countries. However, these authors come up with mixed results. Using a system-GMM estimation approach, Gnangnon (2018) finds that a one dollar increase in real total AfT is associated with a 0.019 point decline in the Herfindahl-Hirschman index (increase in export diversification) and that the impact is similar in both least developed countries and other developing countries. Kim (2017) employs a larger dataset of 133 AfT recipient countries over the period 1996 to 2013, and a similar empirical methodology, but finds that, except for aid for productive capacity, total AfT and its sub-categories contribute to a rise in export diversification only in the short run.

The main limitation of these two studies is the use of the HHI as their dependent variable. The HHI is an export concentration index that measures inequality in export shares across a country's export product lines. The closer the HHI is to 0, the lower the degree of inequality in export shares, and the less concentrated a country's export values are on a small range of export products. However, the index does not distinguish between a rise in export diversification that occurs among existing product lines (intensive margin) and those arising from new export products (extensive margin). This decomposition is worthwhile, particularly in the context of SSA, whose exports remain concentrated on unprocessed primary production. Pursuing export strategies that lead to the diversification of exports into higher value-added primary commodities and manufacturing is necessary to put SSA economies on a long-term growth path (IMF, 2017; UNECA, 2015).

Gnangnon and Roberts (2015) instead use the Theil index of export concentration, which distinguishes between the intensive margin and the extensive margin, to investigate the interaction between AfT and FDI flows and their relative influence in upgrading the exports of 86 recipient countries over the period 1995 to 2010. They find that total AfT flows have a substantial positive impact on the volume and quality of existing exports, while insignificant results for the expansion of new exports are obtained. The Theil index, however, like any other export concentration index, does not account for the expansion potential of new export product lines.

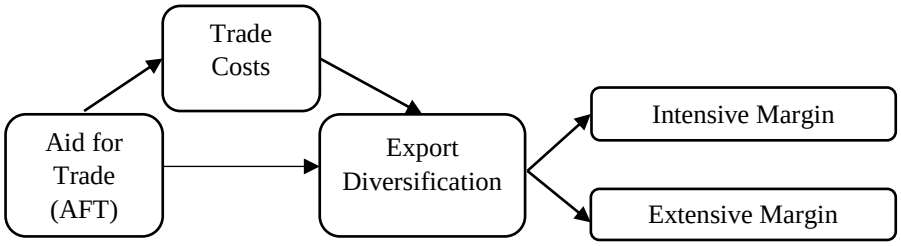
Hühne, et al., (2014) employ a different estimating equation –an aggregated gravity model, augmented with AfT flows – to assess the impact of the AfT initiative on exports of primary

commodities and manufactured goods over the period 1990 to 2012. They find that AfT is effective in promoting the exports of manufactured goods to both donor countries and non-donor countries. The results for primary commodities are, however, insignificant. Their findings are not specific to the case of SSA, and their gravity model estimation techniques are dated as well. However, we formulate an empirical gravity model based on the 'new-new' trade theory and applies a variant of the PPML (Poisson pseudo maximum likelihood) estimation technique, the flexible estimation approach (henceforth, the Flex method) introduced by Santos Silva, Tenreyro, and Wei (2014).

3. Transmission channels between AfT and export diversification

Following Cadot and de Melo (2014), we identify various channels through which AfT impact export diversification and decompose into the intensive and extensive margins. The core hypothesis is that AfT reduces trade costs, thereby making it more profitable for more firms to enter export markets, thus boosting exports at both the intensive and extensive margins. Some direct effects of AfT on export diversification can also be conjectured. Figure 1 illustrates this transmission mechanism.

Figure 1: Transmission Channels between AfT and Export Diversification



Source: Authors

AfT for economic infrastructure is theorised to reduce logistics and communication costs caused by soft and hard infrastructure deficiencies, while AfT for trade facilitation serves to reduce the time and costs of processing trade by simplifying border-related policies and customs procedures. AfT for productive capacity-building can help reduce behind-the-border trade costs caused by the presence of weak institutions through legal and regulatory reforms to improve the business and investment climate.

Recent heterogeneous-firm trade theories (Chaney, 2008; Helpman, et al., 2008; Melitz, 2003) highlight the role of trade costs in influencing trade at both the intensive and extensive margins. Trade costs can be decomposed into fixed and variable costs. Melitz (2003) suggests that

only a subset of heterogeneous firms will export at a given level of fixed and variable trade costs since firms vary by productivity. In particular, his model posits that for every export destination j, there is a threshold level of productivity that yields zero profit from exports for firms in the country i. Only firms in the country i with higher productivity than this will make a profit from exporting to j. Chaney (2008) extends Melitz's (2003) general equilibrium model of trade with heterogeneous firms to consider a world with many asymmetric countries separated by asymmetric barriers. The model makes it possible to track the impact of changes in fixed and variable trade costs on the intensive and extensive margins of trade. Chaney theorises that a fall in variable trade costs encourages an increase in the share of exports of each exporter (intensive margin), but also allows some new firms, attracted by the higher profit opportunities in export markets, to enter (extensive margin) in response to a fall in the productivity threshold. A fall in fixed trade costs also reduces the productivity threshold and allows less productive firms to start exporting. With more active firms in export markets, exports may grow at the extensive margin, but the fall in fixed costs does not affect the intensive margin of trade since these represent sunk costs for existing firms. Thus, by bringing two strands of complementary literature together, it can be hypothesised that AfT serves to reduce both fixed and variable trade costs, which then promotes export diversification at both the intensive and extensive margins.

Direct links between AfT and export diversification can also be established since AfT is targeted to exert a positive influence on some of its key determinants. For example, infrastructure quality, trade openness and market access conditions, and human capital formation are among the main factors influencing export diversification. Thus, aid targeted in these specific areas is expected to promote export diversification.

4. Empirical Strategy

The following augmented gravity model [1] is used to analyse the link between AfT and export growth at the two margins:

$$M_{ijt} = \beta_0 + \beta_1 \ln\left(GDP_{it}\right) + \beta_2 \ln\left(POP_{it}\right) + \beta_3 \ln\left(GDP_{jt}\right) + \beta_4 \ln\left(POP_{jt}\right) + \beta_5 \ln\left(AFT_{it-1}\right) + \beta_6 \ln\left(DIST_{ij}\right) + \beta_7 \left(Z_{ij}\right) + \beta_9 \left(RTA_{ijt}\right) + \lambda_t + \gamma_j + \varepsilon_{ijt} \qquad (1)$$

where *i* denotes the exporter, *j* denotes the importer, and *t* denotes a year. *M* refers to either export measured at the intensive margin (*IM*) or exports measured at the extensive margin (*EM*). One

[1] For detail about the augmented gravity model literature see Kabir et al.(2017).

method to calculate the extensive margin is through a simple count of the number of products exported from country *i* to country *j*, and the intensive margin can be computed as the average value of exports per product traded. However, Hummels and Klenow (HK hereafter) (2005) argue that such conventional measures do not account for the weight of each product in trade. Thus, they propose micro-founded weighted indices of the intensive and extensive margins of trade based on the methodology of Feenstra (1994). The HK method of calculating the extensive and intensive margins of goods exported from *i* to *j* in year *t* (EM_{ijt} and IM_{ijt}, respectively) are as follows:

$$EM_{ijt} = \frac{\sum_{m \in M_{ijt}} X^{m}_{Wjt}}{\sum_{m \in M_{Wjt}} X^{m}_{Wjt}} \quad \ldots \quad (2) \qquad\qquad IM_{ijt} = \frac{\sum_{m \in M_{ijt}} X^{m}_{ijt}}{\sum_{m \in M_{ijt}} X^{m}_{Wjt}} \quad \ldots \quad (3)$$

where X^{m}_{Wjt} is the value of country *j*'s imports from the world in product *m* in year *t*; M_{Wjt} is the set of all products exported by the world to *j* in year *t*; M_{ijt} is the subset of all products exported from *i* to *j* in year *t*. Hence, EM_{ijt} is a measure of the fraction of all products that are exported from *i* to *j* in year *t*, where each product is weighted by the importance of that product in world exports to *j* in year *t*. Again, X^{m}_{ijt} is the value of exports from *i* to *j* in product *m* in year *t*. Thus, IM_{ijt} represents the market share of country *i* in country *j*'s imports from the world within the set of products that *i* export to *j* in year *t*.

GDP_{it} and GDP_{jt} stand for the exporting and importing country's nominal GDP measured in US$ at time *t*. POP_{it} and POP_{jt} stand for the respective country's population at time *t*. These variables are included to capture the demand capacity of country *j* and the supply capacity of country *i* following the gravity trade literature. The main variable of interest is AfT received by exporting country *i* from all donor countries. The AfT variable could be aggregate aid for trade (*AfT_total*) or AfT components, such as aid for economic infrastructure (*AfT_inf*), productive capacity (*AfT_prod*), or trade policy and regulations and trade-related adjustment (*AfT_pol*) or its sub-component, aid for trade facilitation (*AfT_tf)*. Aid for trade values are lagged by one period to partially control for any potential endogeneity, and to cater for the view that aid exerts a lagged impact on export performance. All AfT data are reported in million US$ measured at current prices.

Other control variables include $DIST_{ij}$ to account for the geographical distance in kilometres between the trading partners measured using the great circle formula, and Z_{ij}, which is a vector consisting of a set of dummy variables taking a value of 1 if the trading partners share a

common land border (border), have common colonial histories (colony), and share a common language (language), and 0 otherwise. A dummy (RTA) equal to 1 is also inserted if the country pairs are members of a regional trade agreement [2] and zero otherwise. A dummy equal to one if exporter *i* is landlocked is also included. λ_t captures time-specific factors (such as commodity price variations) while γ_j accounts for the heterogeneity on the importer side. ε_{ijt} is assumed to be an *i.i.d* stochastic term. Since there is not enough time-series variation in the variable of interest, the identification of the AfT effect is difficult with an exporter fixed effect. The model, therefore, does not include an exporter fixed effects term.

Following the Baier and Bergstrand (2009) and Kabir and Salim (2011) methodology, we adjust the bilateral trade costs covariates by their multilateral resistance (MR) terms. This involves approximating the MR terms using a simple first-order log-linear Taylor expansion of the theoretically-motivated exogenous variables that proxy for trade costs. Finally, we use the Poisson Pseudo-Maximum Likelihood (PPML) estimator recommended by Santos Silva and Tenreyro (2006) to circumvent the bias caused by the presence of zero trade flows and heteroscedasticity in data. However, while the use of the PPML estimator accounts for the lower bound nature of the dependent variable, it ignores the upper bound that is produced when the HK trade margins decomposition is applied to the data. In particular, the extensive and intensive trade margins following the HK method are bounded between 0 and 1. The existence of these bounds implies that the partial effect of the regressors on the conditional mean of the dependent variable is not constant but tends to zero as the conditional mean reaches its bounds. Ignoring these bounds can lead to misleading results. Therefore, following Santos Silva, Tenreyro, and Wei (2014), we apply the Flex estimator, which takes into account the double-bounded nature of the dependent variable, to the AfT-augmented gravity equation.

The dataset consists of a panel of 42 SSA countries with export activities being observed with 222 other countries in the rest of the world over the period 1995 to 2019. Trade data is obtained from the BACI database created by CEPII using the UN COMTRADE import and export data reported at the 6-digit Harmonized System (HS) level of product disaggregation, and is used to calculate the intensive and extensive margins of SSA exports [3].

[2] An RTA can be in the form of a Free Trade Agreement, Customs Union, Economic Integration Agreement, or a Partial Scope Agreement.

[3] For details on the methodology used to compute the disaggregated trade data in BACI, see Gaulier and Zignago (2010).

AfT is a subset of ODA (Official Development Assistance) and these data are taken from OECD-CRS where such data is available from 2002 onwards. However, to obtain a longer period of AfT data, Hühne, et al. (2014)'s methodology is employed. Since the log of AfT is applied in the estimation equation, and the log of zero is undefined, the methodology of Wagner (2003) and later applied in the studies by Calì and te Velde (2011) and Lee and Ries (2016) is used to allow the data to handle cases of zero AfT flows with the insertion of non-aid dummies in the model. GDP and population data are obtained from the World Development Indicators (WDI). Information on the country pairs participating in a regional trade agreement is taken from de Sousa (2012)'s RTA dataset [4] and updated by the authors using the Regional Trade Agreements Information System of the World Trade Organisation (2020). Data on distance, and the gravity dummies to indicate whether the country pairs share a common language, border, and colony are obtained from the CEPII database. Appendix 1 presents standard descriptive statistics on these variables, and Appendix 2 displays the list of SSA countries used in the analysis.

5. Empirical Analysis

To estimate the empirical models it first considers whether total AfT received by SSA countries is related to the HK extensive and intensive margins of exports. The relationship is then analysed by each sub-category of AfT to assess the export performance at the two margins. The effects of AfT on trade within SSA, as opposed to exports of SSA with the rest of the world, are analysed. Some robustness checks are also performed.

5.1 Baseline Estimates

Table 1 displays the results of estimating Equation (1) with and without total AfT flows using the Flex estimator. Columns (1) and (2) report the effects of AfT flows on the HK extensive margin of exports while columns (3) and (4) project the corresponding intensive margin effects. The coefficients obtained are mostly in line with a priori expectations. With regards to aid for trade, which is the main variable of interest, the coefficient is positive and statistically significant at the 1% level in both margins. All else being equal, a 10% rise in total AfT flows appears to contribute to around 1.4% and 0.7% increase in exports of SSA to the world at the extensive margin and intensive margin, respectively. The evidence, therefore, supports the core contention of the study, i.e. AfT contributes to export diversification along both margins by reducing trade costs.

[4] http://jdesousa.univ.free.fr/data.htm

The specification given by Equation (1) includes some control variables, which deserve some attention. Distance, a proxy for variable transport costs and other distance-related costs such as communication costs, information costs, and search costs, is significant and negative in the sign at both margins of trade. This suggests distance reduces both the extensive and intensive margin of exports. Sharing a common border raises exports at both the intensive and the extensive margin as revealed by the positive and statistically significant coefficients. Having a common language facilitates trade by reducing information, communication and transaction costs, and by promoting affinity between countries. This is confirmed by the positive and statistically significant coefficients on this variable along both margins of exports. Having colonial links also positively influences the extensive margin of exports. The coefficients for landlockedness have the expected negative sign, but is statistically significant only at the extensive margin. Finally, the empirical results confirm that participation in a regional trade agreement serves to raise exports at both the intensive and extensive margins as expected.

Table 1. Effects of Total AfT on the Extensive and Intensive Margins of Exports: Full Sample

	HK Extensive Margin		**HK Intensive Margin**	
VARIABLES	*No AfT*	*Total AfT*	*No AfT*	*Total AfT*
	(1)	(2)	(3)	(4)
lnGDP_exporter	0.801***	0.793***	0.093***	0.071***
	(0.035)	(0.034)	(0.023)	(0.023)
lnGDP_importer	0.224***	0.211***	-0.035	-0.050
	(0.051)	(0.051)	(0.050)	(0.050)
lnPOP_exporter	-0.159***	-0.265***	0.180***	0.162***
	(0.025)	(0.027)	(0.024)	(0.026)
lnPOP_importer	0.249	0.211	-0.382**	-0.391**
	(0.162)	(0.164)	(0.156)	(0.154)
lnAFT_total (1yr lag)		**0.139*** **		**0.073*** **
		(0.016)		(0.015)
MRDIST	-0.512***	-0.514***	-0.116***	-0.122***
	(0.080)	(0.079)	(0.038)	(0.037)
MRBORDER	1.731***	1.670***	0.436***	0.406***
	(0.182)	(0.175)	(0.127)	(0.113)
MRLANG	0.642***	0.650***	0.256***	0.268***
	(0.076)	(0.074)	(0.056)	(0.055)
MRCOLONY	0.581**	0.553**	-0.097	-0.091
	(0.265)	(0.254)	(0.343)	(0.333)
Landlocked	-0.445***	-0.495***	-0.078*	-0.114***
	(0.054)	(0.053)	(0.046)	(0.044)
RTA	0.778***	0.755***	0.184**	0.178**
	(0.090)	(0.087)	(0.075)	(0.081)
Observations	184,967	177,869	184,967	177,869
R^2	0.43	0.44	0.47	0.49

Notes:

(a) Estimates are obtained using the Flex estimator.
(b) All specifications include time fixed effects and importer fixed effects.
(c) The models include non-AFT dummies to deal with zero AFT flows, but the coefficients are not reported as they are not of direct interest.
(d) Heteroscedastic robust standard errors are in parentheses.
(e) Superscripts *, **, *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

5.2 Results by AfT components

Results from estimating Equation (1) using disaggregated AfT data (AfT for economic infrastructure, AfT for productive capacity-building, AfT for trade facilitation, and AfT for trade policy and other regulations, *excluding trade facilitation*) is presented in Table 2.

The results are quite revealing for the different categories of AfT. Except for AfT for trade facilitation, which is not significant along the intensive margin, and AfT for trade policy and regulations, which is never significant, all the other coefficients are significant at conventional levels. The positive sign on most of the AfT coefficients is in line with the previous theoretical hypotheses. AfT for trade facilitation seems to be driving the results along the extensive margin followed by AfT for productive capacity-building: a 10% increase in AfT for trade facilitation increases the extensive margin of exports by 2.0% compared to 1.5% for AfT for productive capacity-building. The coefficient on AfT for economic infrastructure, albeit positive and statistically significant, is relatively small – exerting only around 0.4% increase in both export margins from a 10% rise in this aid category. These findings are similar to studies that suggest AfT for trade facilitation works better to promote exports of recipient countries (Hühne, et al., 2014) but contrasts with the work of Calì and te Velde (2011), and Vijil and Wagner (2012) who find a more significant role for AfT for economic infrastructure. All the control variables included in the baseline specification maintain their signs and statistical significances.

5.3 AfT and Intra-African Exports

Table 3 displays the estimation results when the baseline specification is run on a sample consisting only of SSA exporting and importing countries. In other words, the effects of AfT on intra-African exports are considered.

The AfT coefficients are statistically significant only for the extensive margin of exports, i.e. a 10% rise in total AfT flows seems to be raising exports on the extensive margin by around 2.5%. However, AfT coefficients are not statistically significant for the intensive margin which indicates that AfT does not play a role in boosting trade at the intensive margin within the continent. Among the sub-categories, AfT for economic infrastructure appears to contribute positively to raising

Table 2. Effects of AfT by Category on the Extensive and Intensive Margins of Exports: Full Sample

	HK Extensive Margin				HK Intensive Margin			
	AfT_inf	*AfT_prod*	*AfT_tf*	*AfT_pol*	*AfT_inf*	*AfT_prod*	*AfT_tf*	*AfT_pol*
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnGDP_exporter	0.797***	0.799***	0.783***	0.781***	0.085***	0.073***	0.090***	0.077***
	(0.034)	(0.034)	(0.035)	(0.034)	(0.023)	(0.023)	(0.024)	(0.023)
lnGDP_importer	0.213***	0.215***	0.207***	0.216***	-0.051	-0.051	-0.053	-0.051
	(0.051)	(0.051)	(0.051)	(0.051)	(0.050)	(0.050)	(0.051)	(0.051)
lnPOP_exporter	-0.209***	-0.278***	-0.159***	-0.163***	0.167***	0.155***	0.192***	0.190***
	(0.026)	(0.028)	(0.025)	(0.026)	(0.025)	(0.027)	(0.024)	(0.024)
lnPOP_importer	0.219	0.196	0.232	0.215	-0.399***	-0.395**	-0.424***	-0.406**
	(0.165)	(0.164)	(0.167)	(0.166)	(0.155)	(0.155)	(0.158)	(0.159)
lnAfT_*sub-category* (1yr lag)	**0.041*** **	**0.145*** **	**0.202*** **	**-0.042**	**0.045*** **	**0.075*** **	**-0.067**	**-0.062**
	(0.013)	(0.017)	(0.024)	(0.016)	(0.012)	(0.017)	(0.045)	(0.028)
MRDIST	-0.510***	-0.510***	-0.513***	-0.512***	-0.122***	-0.120***	-0.119***	-0.121***
	(0.079)	(0.079)	(0.080)	(0.080)	(0.038)	(0.037)	(0.038)	(0.038)
MRBORDER	1.691***	1.673***	1.720***	1.720***	0.411***	0.408***	0.433***	0.419***
	(0.177)	(0.176)	(0.181)	(0.181)	(0.116)	(0.115)	(0.127)	(0.128)
MRLANG	0.645***	0.648***	0.645***	0.646***	0.268***	0.267***	0.266***	0.265***
	(0.075)	(0.074)	(0.075)	(0.075)	(0.056)	(0.055)	(0.057)	(0.057)
MRCOLONY	0.564**	0.550**	0.569**	0.567**	-0.108	-0.087	-0.115	-0.092
	(0.259)	(0.257)	(0.264)	(0.263)	(0.342)	(0.333)	(0.354)	(0.344)
Landlocked	-0.455***	-0.531***	-0.450***	-0.468***	-0.092**	-0.125***	-0.096**	-0.096**
	(0.053)	(0.053)	(0.054)	(0.053)	(0.045)	(0.045)	(0.046)	(0.046)
RTA	0.776***	0.766***	0.780***	0.781***	0.181**	0.183**	0.193***	0.186**
	(0.088)	(0.088)	(0.090)	(0.090)	(0.079)	(0.080)	(0.075)	(0.075)
Observations	177,869	177,869	177,869	177,869	177,869	177,869	177,869	177,869
R^2	0.44	0.44	0.44	0.44	0.49	0.49	0.48	0.48

Notes: As of Table 1.

Table 3. Effects of AfT on the Extensive and Intensive Margins of Intra-African Exports

HK Extensive Margin					HK Intensive Margin				
AfT_total	*AfT_inf*	*AfT_prod*	*AfT_tf*	*AfT_pol*	*AfT_total*	*AfT_inf*	*AfT_prod*	*AfT_tf*	*AfT_pol*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0.710***	0.715***	0.713***	0.722***	0.709***	0.239***	0.243***	0.243***	0.241***	0.236***
(0.077)	(0.078)	(0.078)	(0.079)	(0.079)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
0.240***	0.245***	0.237***	0.235***	0.244***	0.008	0.005	0.007	0.007	0.010
(0.082)	(0.081)	(0.084)	(0.082)	(0.082)	(0.074)	(0.073)	(0.074)	(0.074)	(0.073)
-0.198***	-0.112*	-0.211***	-0.040	-0.042	0.044	0.049	0.030	0.052	0.051
(0.062)	(0.060)	(0.062)	(0.059)	(0.060)	(0.040)	(0.037)	(0.043)	(0.037)	(0.037)
-0.990*	-1.004*	-1.011*	-0.975	-1.008*	-0.168	-0.168	-0.165	-0.166	-0.173
(0.596)	(0.593)	(0.594)	(0.600)	(0.593)	(0.431)	(0.436)	(0.431)	(0.431)	(0.427)
0.247* **	**0.105*** **	**0.275*** **	**0.194*** **	**-0.027**	**0.023**	**-0.010**	**0.032**	**0.070**	**-0.076**
(0.036)	(0.027)	(0.040)	(0.059)	(0.035)	(0.024)	(0.018)	(0.026)	(0.061)	(0.037)
-0.513***	-0.508***	-0.510***	-0.508***	-0.507***	-0.019	-0.016	-0.020	-0.019	-0.020
(0.105)	(0.104)	(0.105)	(0.103)	(0.103)	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)
1.550***	1.582***	1.559***	1.626***	1.629***	0.473***	0.477***	0.469***	0.471***	0.465***
(0.215)	(0.223)	(0.218)	(0.232)	(0.233)	(0.119)	(0.121)	(0.119)	(0.120)	(0.121)
1.104***	1.103***	1.105***	1.096***	1.101***	0.177**	0.174**	0.176**	0.174**	0.175**
(0.115)	(0.117)	(0.115)	(0.120)	(0.119)	(0.073)	(0.073)	(0.073)	(0.072)	(0.073)
-44.429**	-51.257**	-45.103**	-36.041	-40.027*	74.626***	76.540***	75.803***	76.488***	76.895***
(21.766)	(21.507)	(21.536)	(23.008)	(21.907)	(14.911)	(14.723)	(14.933)	(14.845)	(14.623)
-0.724***	-0.650***	-0.787***	-0.657***	-0.680***	-0.039	-0.037	-0.048	-0.026	-0.031
(0.120)	(0.120)	(0.123)	(0.123)	(0.122)	(0.072)	(0.073)	(0.073)	(0.073)	(0.072)
1.037***	1.072***	1.046***	1.076***	1.078***	0.350***	0.356***	0.348***	0.348***	0.345***
(0.131)	(0.135)	(0.133)	(0.140)	(0.139)	(0.108)	(0.107)	(0.111)	(0.109)	(0.112)
41,261	41,261	41,261	41,261	41,261	41,261	41,261	41,261	41,261	41,261
0.44	0.44	0.45	0.43	0.43	0.73	073	0.73	0.73	0.73

Notes: As of Table 1

intra-African trade along the extensive margin but only by 1.1% against 2.8% and 1.9% concerning AfT for productive capacity and trade facilitation, respectively.

5.4 AfT and Extra-African Exports

The sensitivity of the baseline results is also analysed by restricting the analysis to a sample of SSA exporting countries with non-SSA importing countries. The AfT coefficients, in terms of their sign and statistically significance, are quite similar to what was obtained with the full sample. The results are not reported here to conserve space, however, can be obtained from the authors upon request.

5.5 Robustness Checks

5.5.1 Results with extended AfT lags

An analysis of whether time lags affect the relationship between AfT and the two export margins is also warranted. In previous estimations, AfT lagged by one year was used to minimise the risk of endogeneity coming from reverse causality, and to account for the fact that aid takes time to become effective. Aid for trade to finance a new automated system for the use by border authorities, and to build and implement such a system may be reasonably achieved in one year but the intended effects of other aid seem to take much longer time to achieve. For example, the effects of AfT for productive capacity-building are not expected in the short run, and much more than one year would be needed for people to first be educated, and then have time to innovate and contribute to export diversification. Table 4 gives the results of running the same regression specification with different lags in the AfT variable.

The significance and sign of the coefficient of all variables are similar to the baseline results, except for aid for economic infrastructure which is statistically insignificant along the extensive margin. The magnitude of the coefficient on the main variable of interest also differs but is consistent with a priori expectations. The effect of aid for trade on both export margins seems to amplify when more lags are allowed. Concerning the sub-components of AfT, the coefficient of aid for productive capacity building is positive and significant, and the magnitude rises over time along both export margins.

The results obtained for aid for trade facilitation along the extensive margin are also plausible. The coefficient on this variable seems to decrease over time, with the greatest effect observed when a 2-year lag is allowed. This result seems to support the hypothesis that aid for trade facilitation has a relatively immediate positive effect on the extensive margin of exports while the effect fades out in the longer term.

Table 4: Robustness Checks Using Extended AfT Lags

	HK Extensive Margin				HK Intensive Margin			
VARIABLES	*AfT_total* (1)	*AfT_inf* (2)	*AfT_prod* (3)	*AfT_tf* (4)	*AfT_total* (5)	*AfT_inf* (6)	*AfT_prod* (7)	*AfT_tf* (8)
lnAfT (2yr lag)	0.123***	0.016	0.141***	0.222***	0.073***	0.045***	0.077***	-0.006
	(0.016)	(0.015)	(0.018)	(0.026)	(0.015)	(0.013)	(0.016)	(0.046)
lnAfT (3yr lag)	0.127***	0.008	0.145***	0.178***	0.082***	0.059***	0.084***	-0.049
	(0.015)	(0.014)	(0.018)	(0.026)	(0.015)	(0.014)	(0.017)	(0.048)
lnAfT (4yr lag)	0.133***	-0.002	0.159***	0.196***	0.087***	0.054***	0.086***	-0.025
	(0.015)	(0.015)	(0.018)	(0.036)	(0.015)	(0.014)	(0.017)	(0.046)
lnAfT (5yr lag)	0.136***	-0.016	0.163***	0.132**	0.094***	0.055***	0.089***	-0.052
	(0.015)	(0.013)	(0.018)	(0.054)	(0.015)	(0.015)	(0.017)	(0.050)
lnAfT (7yr lag)	0.141***	-0.046	0.191***	0.061	0.067***	0.070***	0.053***	0.026
	(0.015)	(0.013)	(0.018)	(0.064)	(0.016)	(0.016)	(0.017)	(0.072)

Notes: As of Table 1.

5.5.2 Results with alternative estimators

Table 5 presents the results of estimating the AfT-augmented gravity model with some alternative estimation methods mentioned in the gravity trade literature. This is to ensure the baseline estimates and analyses do not depend heavily on the choice of the Flex estimator of Santos Silva, Tenreyro, and Wei (2014). Columns (1) and (4) report the estimates of the model when the traditional OLS method is used. Unlike previous estimations, the dependent variable is in logs, but one is added to all zero values before taking logs as the logarithm of zero is not defined and using the truncated approach, i.e. simply ignoring the zero flows, would entail the loss of information. The coefficient for total AfT is positive and significant at the 1% level along the extensive margin only. This may indicate AfT is ineffective in boosting export performance at the intensive margin, but the empirical literature on the gravity model suggests that the coefficients in OLS results are biased due to the sample selection bias caused by the improper treatment of zero trade flows. Silva and Tenreyro (2006) also point out, the use of log-linear OLS in the presence of heteroscedasticity changes the property of the error term generates inefficient estimates, and the t-values cannot be trusted.

The recent literature on gravity estimation recommends the use of nonlinear methods. In particular, the PPML method, first suggested by Santos Silva and Tenreyro (2006), has become the workhorse estimation model in gravity trade studies. To generate the baseline estimation, the Flex estimator, a variant of the PPML was employed. The results are reported in columns (2) and (5), to gauge the sensitivity of the results. The Gamma Pseudo-Maximum Likelihood (GPML) is also used as an alternative estimator following Martínez-Zarzoso (2013). The results are shown in columns (3) and (6) for the extensive and intensive margins, respectively.

However, the coefficients' significance, signs and magnitudes of the AfT variable from both these estimators are very similar to the baseline estimates. The results demonstrate that a 10% increase in the total AfT increases the extensive margin by 1.1% and the intensive margin by 0.8%, other things remaining equal.

Table 5: Robustness Checks Using Alternative Estimators

	HK Extensive Margin			**HK Intensive Margin**		
	OLS	*PPML*	*GPML*	*OLS*	*PPML*	*GPML*
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
lnGDP_exporter	0.810***	0.555***	0.555***	0.344***	0.083***	0.083***
	(0.020)	(0.025)	(0.025)	(0.018)	(0.022)	(0.022)
lnGDP_importer	0.201***	0.147***	0.147***	-0.333***	-0.059	-0.059
	(0.041)	(0.044)	(0.044)	(0.041)	(0.052)	(0.052)
lnPOP_exporter	-0.234***	-0.188***	-0.188***	0.046**	0.161***	0.161***
	(0.019)	(0.023)	(0.023)	(0.020)	(0.027)	(0.027)
lnPOP_importer	0.497***	-0.052	-0.052	0.832***	-0.447***	-0.447***
	(0.138)	(0.135)	(0.135)	(0.112)	(0.155)	(0.155)
lnAfT_total (1yr lag)	**0.063*** **	**0.109*** **	**0.109*** **	**0.019**	**0.077*** **	**0.077*** **
	(0.012)	(0.013)	(0.013)	(0.013)	(0.015)	(0.015)
MRDIST	-0.831***	-0.353***	-0.353***	-0.225***	-0.125***	-0.125***
	(0.049)	(0.046)	(0.046)	(0.043)	(0.040)	(0.040)
MRBORDER	0.989***	1.044***	1.044***	0.691***	0.482***	0.482***
	(0.120)	(0.096)	(0.096)	(0.102)	(0.111)	(0.111)
MRLANG	0.367***	0.535***	0.535***	0.152***	0.288***	0.288***
	(0.049)	(0.059)	(0.059)	(0.049)	(0.053)	(0.053)
MRCOLONY	0.887***	0.074	0.074	0.208	-0.121	-0.121
	(0.156)	(0.172)	(0.172)	(0.199)	(0.355)	(0.355)
Landlocked	-0.368***	-0.347***	-0.347***	-0.068*	-0.128***	-0.128***
	(0.034)	(0.043)	(0.043)	(0.040)	(0.045)	(0.045)
RTA	0.824***	0.425***	0.425***	0.660***	0.206***	0.206***
	(0.058)	(0.061)	(0.061)	(0.056)	(0.074)	(0.074)
Observations	90,008	177,869	177,869	90,008	177,869	177,869
R^2	0.43	0.40		0.35	0.48	

Notes: As of Table 1

5.5.3 Results with additional control variables

We further include additional control variables in the model specification to capture some further time-variant exporter characteristics that influence the intensity of trade between country pairs. These include proxy indices for the quality of physical infrastructure (PI), Information and Communication Technologies (ICT), the state of the business regulatory environment (BREV), and the efficiency of border and transport procedures (BTE). These indicators are constructed following the methodology of Portugal-Perez and Wilson (2012). The non-inclusion of these country-specific characteristics from the specified model can lead to biased estimates (Kalirajan, 2008). Thus, Equation (1) is further estimated with alternative specifications and additional controls. For each trade margin, these additional controls are introduced one at a time before including all in one specification, and in each case, the sensitivity of the coefficient of the variable of interest is noted. Besides, the economic and statistical significance of the coefficients accompanying the additional controls is compared with those obtained in previous studies. The results are not reported here to save space, however, these results are reassuring and robust to the inclusion of most of the additional controls. The coefficients on total AfT remain positive, statistically significant, and seemingly in the same range as the baseline results. Also, the coefficients of the additional controls are in most cases consistent with a priori expectations, as well as the findings of previous studies in terms of their economic and statistical significance. This confirms the appropriateness of the model specification.

6. Conclusion

This article investigates the effectiveness of the AfT initiative in achieving export diversification in SSA decomposed into the intensive and extensive margins. Using HS 6-digit product disaggregated trade data from the BACI database over the period 1995 to 2019, the two export margins are constructed using the Hummels-Klenow (2005) methodology. An augmented gravity model specification is employed for the analysis and estimated using the Flex method of Santos Silva, Tenreyro, and Wei (2014). The results reveal that the extensive margin diversification effects are larger than the intensive diversification effects in most of the specifications. The extensive export margin elasticity to total AfT is positive and ranges between 1.2% and 1.4% over the whole sample. This elasticity is larger when the estimation is run on intra-African trade. The

sign of the intensive export margin elasticity to total AfT is also positive, but the magnitude is lower and varies between 0.7% and 0.9% when the whole sample is used.

Concerning which type of AfT is driving the results and is working better in delivering positive outcomes, the empirical results suggest that this varies across the two margins. At the extensive export margin, *AfT for trade facilitation* is more effective in the short run while *AfT for productive capacity-building* appears to be having a bigger impact in the long run. In most of the specifications, however, *AfT for economic infrastructure* is serving to promote exports only at the intensive margin, while a statistically insignificant coefficient is observed along the extensive margin. This finding may imply that AfT for economic infrastructure is flowing towards existing (primary) export sectors and is only helping to diversify the share of products that are already being exported to the rest of the world. The exception is when the sample is restricted to include only SSA importing countries, where the impact of AfT for economic infrastructure is statistically significant and positive only along the extensive margin, implying that such aid is helping to diversify the share of new products in the intra-African export portfolio.

These findings suggest that the AfT initiative has contributed to export diversification in SSA, with the combined effect being more pronounced along the extensive margin than on the intensive margin. Such results are encouraging given the continent's longstanding overconcentration on a few unprocessed primary exports and the potential for export product diversification to boost economic growth. Increasing AfT funds by the donor community to promote further export product diversification is thus implied. This, in turn, would help SSA leverage its growth potential through trade by contributing to reduce trade costs and to spur export diversification. Although it is total AfT that ultimately matters when capturing its impact on export diversification, it is worth highlighting the effectiveness of the smallest AfT category (AfT for trade facilitation) in promoting exports, particularly at the extensive margin. A key policy implication for the donor community, therefore, is that providing new and additional resources to trade facilitation could deliver the highest immediate returns in terms of aid effectiveness.

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APPENDIX 1: Standard descriptive statistics on the variables used in the analysis

Variables	Obs.	Mean	Standard Deviation	Min	Max
HK extensive margin	199,500	0.0227	0.102	0	1
HK imtensive margin	199,500	0.0258	0.0842	0	1
Aft_infrastructure (US$m)	199,500	24.81	47.55	0	413.8
Aft_productive capacity (US$m)	199,500	34.70	47.68	0	283.8
Aft_trade facilitation (US$m)	187,150	0.544	2.502	0	34.60
Aft_total (US$m)	191,710	62.87	86.75	0	546.2
Aft_other trade policy (US$m)	187,150	0.779	2.419	0	36.22
GDP_exporter (US$)	190,570	2.817e+10	7.427e+10	7.223e+07	5.685e+11
GDP_importer (US$)	193,620	3.041e+11	1.293e+12	1.103e+07	2.143e+13
POP_exporter	199,500	1.836e+07	2.713e+07	75,304	2.010e+08
POP_importer	199,164	3.510e+07	1.318e+08	9,230	1.398e+09
Distance (km)	199,500	7,672	4,334	8.023	19,904
Common Border	199,500	0.0175	0.131	0	1
Common Official Language	199,500	0.256	0.436	0	1
Common Colony	199,500	0.00541	0.0733	0	1
Landlockedness	199,500	0.286	0.452	0	1
Regional Trade Agreement	199,500	0.0731	0.260	0	1
Physical Infrastructure_exp	35,964	0.328	0.142	0.00116	0.697
ICT_exp	35,964	0.346	0.149	0.00913	0.744
Business Regulatory Env._exp	35,964	0.242	0.116	0.0223	0.548
Business Regulatory Env._imp	35,964	0.535	0.165	0.134	0.904
Physical Infrastructure_imp	40,404	0.497	0.230	0.00116	1
ICT_imp	40,404	0.536	0.234	0.00802	1
Business Regulatory Env._imp	40,404	0.401	0.249	0.0123	1
Border Transport Efficiency_imp	40,404	0.721	0.193	0.0147	1

Note: The summary statistics are conditional on AfT being non-negative. Net AfT flows which are negative following the repayment of ODA loans are removed.

APPENDIX 2: List of SSA countries used in the analysis

Benin	Gambia	Sao Tome and Principe
Burkina Faso	Ghana	Senegal
Burundi	Guinea	Seychelles
Cabo Verde	Guinea-Bissau	Sierra Leone
Cameroon	Kenya	Somalia
Central African Rep.	Liberia	South Africa
Chad	Madagascar	Sudan
Comoros	Malawi	Togo
Congo	Mali	Uganda
Côte d'Ivoire	Mauritania	United Rep. of Tanzania
Djibouti	Mauritius	Zambia
Equatorial Guinea	Mozambique	Zimbabwe
Eritrea	Niger	
Ethiopia	Nigeria	
Gabon	Rwanda	