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## **Impact of Aid for Trade to Agricultural Development and Trade**

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## **Abstract**

Aid for Trade (AfT) has emerged as a significant mechanism for development of developing countries by helping them to participate in the global value chain. Grants on agricultural part in AfT has been gradually increased since 2002 and invested in various ways from agrarian reform, agricultural education and training to plant and post-harvest protection and pest control. In spite of the increase, there were only few researches on significance between AfT and agricultural development.

This research aims to evaluate whether AfT has significant relation with agricultural development and trade. It also examines whether there is heterogeneity in the response to AfT across recipient countries with different national characteristics. We conducted a subgroup analysis using a panel tobit model. Also, UN COMTRADE(PC-TAS) for the export data, the World Bank data for agricultural GDP, OECD QWIDS for AfT data from 2002 to 2013 were used. Our results show that AfT in agriculture has increased both agricultural GDP and exports of the recipient countries. This study also found the most effective form of AfT in agriculture which differs from country to country depending on the characteristics of each country.

## **1. Introduction**

Under the flooding trade liberalization movement, lesser-developed countries are more isolated in the global trading system (M. Huchet-Bourdon et al., 2009). In terms of exports, their competitiveness is falling further behind in the global market (M. Huchet-Bourdon et al., 2009), while facing further costs like loss of tariff income and increase of import competition (M. Cali et al., 2010). The World Trade Organization (WTO) recognized the problems that lesser-developed countries have structure- and supply-related constraints to participate in international trade (M. Busse et al., 2011). As a response to this problem, WTO had launched Aid for Trade (AfT) initiative at the ministerial conference held in Hong Kong in December 2005. The objective of AfT was to assist lesser-developed countries to build the supply-side capacity and trade-related infrastructure that they need to assist them to implement and benefit from WTO Agreements and more broadly expand their trade (WTO, 2005).

Aid for trade is a way of ODA supporting trade related area in lesser-developed countries for them to be integrated into the world trading system. According to the WTO task force of AfT, it is mentioned that AfT is about assisting lesser-developed countries to increase exports of goods and services, to integrate into the multilateral trading system, and to benefit from liberalized trade and increased market access (WTO, 2006).

It has been more than a decade since AfT was initiated and a number of studies were conducted to evaluate effectiveness of AfT. Empirical studies have proven that aid cause growth of the recipient countries (Oliver Morrissey, 2001 and Michael A. Clemens et al., 2011). In addition, some studies indicate that AfT has positive impact on exports (M. Cali et al., 2010 and David H, Bearce, 2013). In contrast, several studies argued that aid has been ineffective in promoting economic development (W. Easterly, 2007 and Claudia R. Williamson, 2009) and even some factors of AfT are insignificant when it comes to exports

(M. Vijil and L. Wagner, 2012). These opposed results might be derived from two reasons; (1) The range of studies is too broad which covers the general trade market and the whole economic growth, and (2) Impact of AfT may vary depending on countries, characteristics, sub-categories of AfT etc. Many recipient countries heavily depend on agriculture thus agriculture has been the driving force of their economies (Braun and Kennedy, 1994). So it would bring implications if the scope of study is narrowed down to agricultural sector. More specifically, the effect of AfT related to agriculture on agricultural development and exports is important to examine contribution of AfT to recipients' economic growth and alleviate poverty.

Therefore, this study aims to examine impact of agricultural AfT to agricultural development and exports by undertaking a subgroup analysis of recipient countries with different national characteristics. In addition, our results suggest the most effective form of AfT which differs from country to country depending on the characteristics of each country.

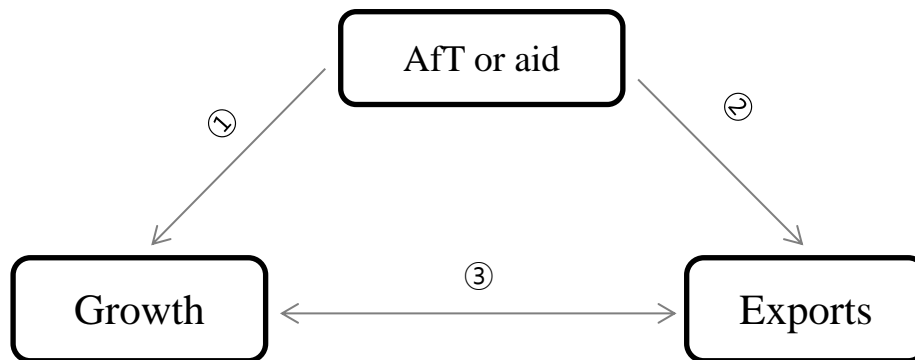
The structure of this paper is as follows: in the next section, key findings are reviewed from the related literature on AfT-growth and –export relationship. Also, section 2 discusses the relation of AfT with agricultural development and exports. Section 3 provides characteristics of AfT as well as overview of historical AfT flows, showing agricultural development data of recipient countries. Section 4 develops the empirical framework and explains the data used for the test. Section 5 presents the results on impact of AfT in terms of agricultural growth and exports and section 6 concludes.

## **2. The relationship of AfT or aid with growth and exports**

There are a vast number of empirical studies on impact of AfT as well as aid and most

of the literatures generally have drawn results by estimating changes in economic growth and trade. In addition, some studies focus on correlation of economic growth and exports. Collecting these research results, Figure 1 represents the relationship of AfT or aid with growth and exports.

Figure 1. The relationship of AfT or aid with growth and exports



As seen in the picture 1-①, aid promotes economic growth by increasing productive investment contributing to domestic savings (Bacha, 1990 and Morrissey, 2001). Moreover, aid has a positive impact on growth under good fiscal, monetary and trade policies (Burnside and Dollar, 2000). On the one hand, AfT has helped lesser-developed countries trade more efficiently (Picture 1-②), by increasing aid in infrastructure channel, reducing trade costs, facilitating reforms of trade policy and regulation (Vijil and Wagner, 2012, Cali and Te Velde, 2011, Helbe, Mann and Wilson, 2009). In terms of trade and economic growth as shown in Picture 1-③, some papers assert that exports have a positive impact on growth by causing productivity and increasing per capita GDP growth (Dollar, 1992, Jeffrey A. Frankel et al., 1999). In the opposite direction, growth may cause exports (Henriques and Sadorsky, 1996).

While these literatures brought positive results from AfT or aid, growth and trade, there are some studies which show these relationships are insignificant. Researches on aid and

growth note that aid has negative impact on economic growth by worsening democracy, bureaucratic quality, the rule of law and corruption (Djankov et al., 2006 and Knack, 2001). Other studies assert that AfT or aid does not increase exports. For instance, aid can cause increase of domestic prices by increased demand, reducing price competitiveness of local goods in international markets (Suwa-Eisenmann and Verdier, 2007). Morrissey (1993) also argued that there is reverse effect from aid to trade since donor's self-interests.

Apart from these previous literatures, the relationship of AfT with growth (①) and exports (②) in agricultural sector is examined in this study. In particular, this study also considers the relationship between growth and exports (③) which the existing literatures have overlooked.

AfT in agriculture has more than tripled in volume over the period from 2002 to 2013, with particularly strong growth since 2007. Figure 2 shows the historical AfT flows with the portion of volume by continent. Asian and African countries received \$0.9 billion and \$0.7 billion in 2002 separately then the amount increased into \$1.8 billion and \$3.3 billion in 2013. Percentage change in amount shows that Asian region was the biggest recipient in 2002 with 48.5%, followed by Africa with 38.0%. On the other hand, African continent has become the first recipient in total amount in 2013 with 55.7%, followed by Asia with 30.2%. The list of countries belonged to each continent in the graph is slightly different since not all the countries have steadily received AfT, but totally 158 countries are counted from 2002 to 2013 with 58 countries in Africa, 38 in Asia, 34 in America, 12 in Europe and 16 in Oceania.

Figure 2. Flows of Aid for Trade in agriculture by continent (2002-2013)

Unit: USD billion

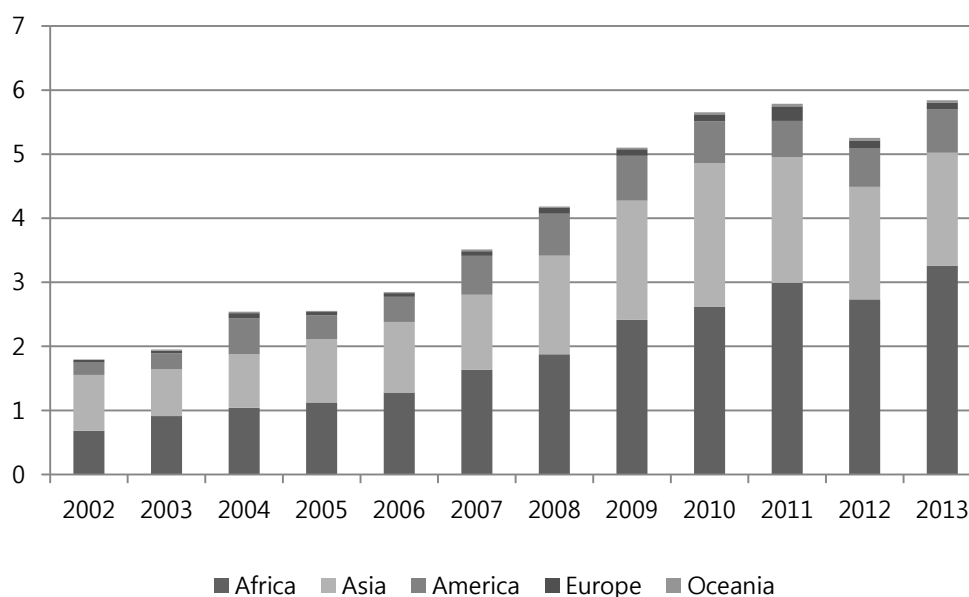


Table 1 shows a comparison of recipients classified according to the amount of AfT. It shows that India, one of the Asian countries, received more than \$2.0 billion in 2002. In 2013, the recipients who received over \$2.0 billion were Ethiopia in African region and Afghanistan, Pakistan, India in Asian region. While the total amount spent for AfT has increased a lot as shown in Figure 2, the number of recipients increased from 2002 to 2013 with the increased amount of AfT, which means the more countries have received the more aid.

Table 1. Number of recipient countries according to the amount of AfT in agriculture

Amount of AfT in agriculture	2002		2013	
	# of countries	countries	# of countries	countries
2 billion~	1	India	4	Ethiopia, Afghanistan, Pakistan, India
1~1.99 billion	1	China	13	Morocco, Viet Nam, Kenya, Uganda, Mozambique etc.
0.5~0.99 billion	3	Viet Nam, Pakistan, Cote d'Ivoire	17	Colombia, Bolivia, Haiti, Egypt, Indonesia
~0.49 billion	130	Egypt, Ethiopia, Philippines, Indonesia, Mali etc.	111	Myanmar, Nepal, Cameroon, Cote d'Ivoire, China
Total # of countries	135		145	
Total amount	\$17.1 billion		\$52.4 billion	



Especially in 2002, India has received the largest amount of money, followed by Cote d'Ivoire in Africa, Nicaragua in America, Moldova in Europe, Papua New Guinea in Oceania. Compared to 2002, the largest recipients in each continent have received more aid in 2013 while the amount has shrunk in Asia. The representative countries in each continent are Ethiopia, Afghanistan, Colombia, Moldova and Papua New Guinea (Table 2).

Table 2. Major recipient countries by continent

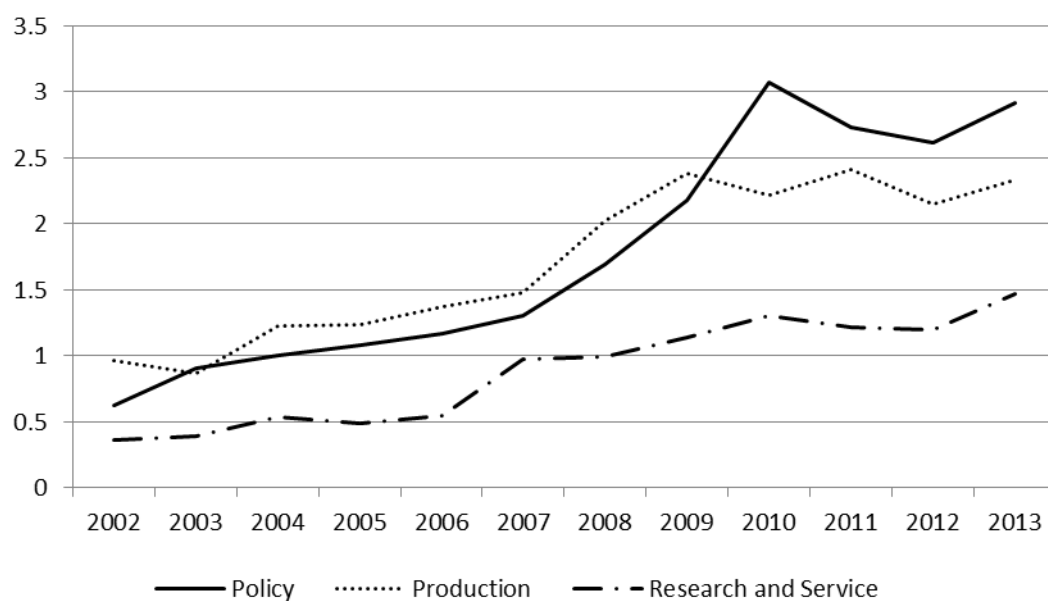
Unit: USD million

Continent	2002		2013	
	Country name	Amount	Country name	Amount
Africa	Cote d'Ivoire	70.2	Ethiopia	266.9
Asia	India	270.4	Afghanistan	239.0
America	Nicaragua	32.0	Colombia	92.4
Europe	Moldova	13.7	Moldova	38.0
Oceania	Papua New Guinea	3.7	Papua New Guinea	12.7

Most of the researches distinguish AfT into five categories (Martinez-Zarzoso et al, 2014 and vijil et al, 2012); (1) technical assistance for trade policy and regulations; (2) trade-related infrastructure; (3) productive capacity building; (4) trade-related adjustment; (5) other trade-related needs. However, since we have focused on agriculture, we distinguish 18 detailed sectors into 3 categories by characteristics; (1) agricultural policy; (2) agricultural production; (3) agricultural research and services (Figure 3).

Figure 3. Three categories of AfT in agriculture

Unit: USD billion



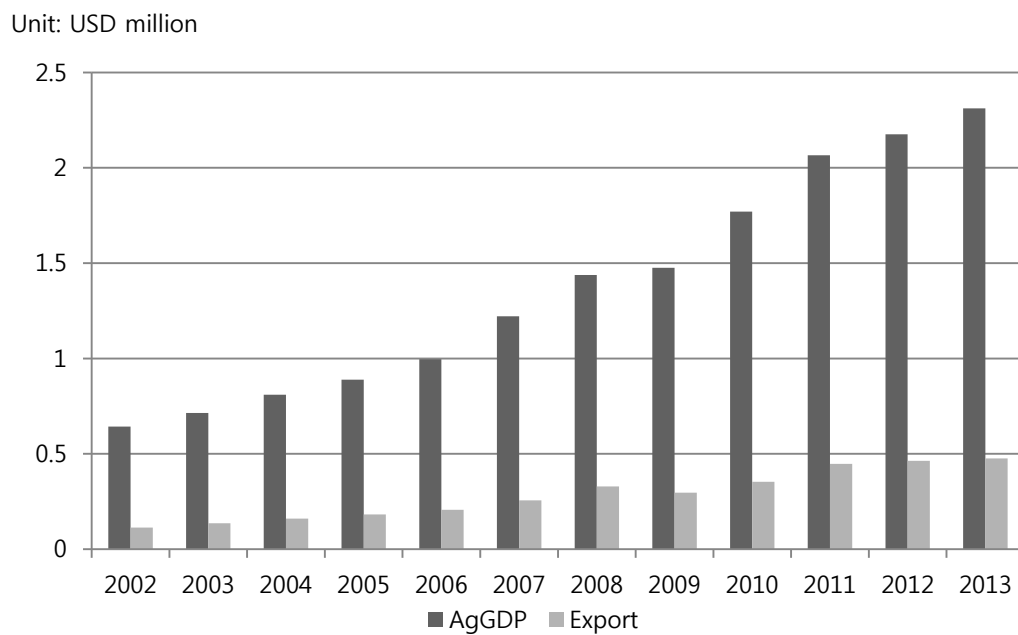
Agricultural policy includes agricultural policy and administrative management, agricultural development. Figure 3 represents the amount of aid used for agricultural policy which was sharply increased after 2007. Aid on agricultural policy has jumped from \$0.6 billion in 2002 to \$2.9 billion in 2013. Agricultural production also has steadily increased since 2002 even though there was a decrease in 2010 and 2012. This part has risen from \$1.0 billion in 2002 to \$2.3 billion in 2013 and it covers agricultural land resources, agricultural water resources, agricultural inputs, food crop production, industrial crops and export crops, livestock, agrarian reform agricultural alternative development as well as agricultural extension.

Aid with the purpose of Agricultural research and service shows expansion from \$0.4 billion in 2002 to \$1.5 billion in 2013. AfT used for agricultural research and service part consist of agricultural education and training, agricultural research, agricultural services, plant and post-harvest protection and pest control, agricultural financial services, agricultural co-operatives as well as livestock and veterinary services.

Agricultural sector in AfT recipients has been developed during 2002 to 2013. Figure 4 supports the development of agriculture with increased GDP and exports of recipient countries.<sup>1</sup> According to this graph, agricultural GDP has constantly increased during that period. In the same period, the amount of agricultural export performance shows remarkable growth, despite the decrease recorded at the time of 2009. Compared to 2002, the total export amount has risen more than quadruple in volume in 2013.

As represented in Figure 2 and 4, AfT in agriculture as well as agricultural GDP and exports show the similar tendency which means the amount of AfT in agriculture, agricultural GDP and exports has increased in total value. Therefore, this study notes that AfT in agriculture might have influenced the agricultural development and exports.

Figure 4. Agricultural GDP and Export Trends of recipient countries



### 3. Data and empirical framework

<sup>1</sup> 71 countries are selected by existence of data from 2002 to 2013 and the list of countries is attached in Appendix 1.

In this section, data and their descriptions as well as sources are introduced. The period of the panel dataset used in this empirical framework includes from 2002 to 2013 and it covers 71 countries. The number of countries is decided by limited data availability of the panel. AfT data before 2002 were unavailable and the most recent data were those of 2013. According to Table 3, variables used in the empirical framework are described with the sources of the data.

Data for AfT are taken from the OECD Creditor Reporting System (CRS). The system provides commitments and disbursements of official development assistance (ODA) by detailed and broad sector. This study limits the data to disbursements spent in agriculture and uses the data by the 18 distinguished purposes. The purposes are categorized into 3 sectors depending on their characteristics and following the order of purpose code.

Data on the export stems from the United Nations COMTRADE (PC-TAS) database. Data on GDP and Agricultural GDP, which are the key indicators for development of the recipients, are calculated with population data in the World Bank's World Development Indicators (WDI). Agricultural GDP is also regarded as an index for agricultural production. Data on freedom are derived from the website of Freedom House and these data tell on each country's freedom status. As the number gets smaller, the citizens of a certain country do not feel free. Data on Control of Corruption (CC), which measures the level of public power whether it can control corruption within the countries, come from the World Bank's Worldwide Governance Indicators (WGI). For CC, the number indicates the percentage of controlling corruption of a certain country. Data on Government Effectiveness (GE), which implies quality of public service, the civil service as well as the degree of its independence from political pressures, the quality of policy formulation and implementation, the credibility of the government's commitment to such policies are also taken from WGI, presented in percentage. Data on Political Stability and Absence of Violence and Terrorism (PV), which

show the likelihood of political instability and politically-motivated violence and terrorism, are provided from WGI in percentage. Data on Regulatory Quality (RQ), which are the ability of the government to formulate and implement sound policies and regulations permitting and promoting private sector development, come from WGI. Data on Rule of Law (RL), a measurement of the rule of society and Voice and Accountability, which implies whether a country's citizens can participate in selecting their government with freedom of expression, are also from WGI in percentage. All these data from WGI represent each country's characteristics on governance status.

This research is to examine the relationship of AfT with growth and exports in agricultural sector. As indicated in the researches (Martin, 1992, Dollar, 1992, Jeffrey A. Frankel et al., 1999), growth can be influenced by exports. This study used the autocorrelation test suggested by Cumby-Huizinga (1992) on agricultural GDP, agricultural exports, AfT in agriculture. The test result indicates that those variables have autocorrelations, thus first order difference equations are used. Since there is time lag between AfT implementation and its effectiveness, Busse et al. (2011) used 1 year lagged AfT variable while Bearce (2013) used 2 years lagged AfT variable. Considering the correlations of dependent variable and AfT values in lagged periods, this study also used 1 year lagged independent variables. With all these relations, an equation for estimating the impacts of AfT on agricultural GDP is defined as 1).

$$\Delta AGGDP_{it} = \beta_0 + \beta_1 \Delta AfT_{it-1} + \beta_2 \Delta AGEX_{it-1} + u_i + \varepsilon_{it} \quad 1)$$

Where  $\Delta AGGDP_{it} = AGGDP_{it} - AGGDP_{it-1}$  and  $AGGDP_{it}$  indicates agricultural GDP of country  $i$  in period  $t$ .  $\Delta AfT_{it-1} = AfT_{it-1} - AfT_{it-2}$  and  $AfT_{it-1}$  is the main variable of this research which is AfT in agriculture invested in country  $i$  in period  $t-1$ .  $\Delta AGEX_{it-1} = AGEX_{it-1} - AGEX_{it-2}$  and  $AGEX_{it-1}$  is agricultural exports of country  $i$  in

period  $t-1$ .  $u_i$  means the country fixed-effect and  $\varepsilon_{it}$  is error term.

Agricultural exports can be affected by agricultural development (Henriques and Sadorsky, 1996). In accordance with these relations, an equation for estimating the impacts of AfT on agricultural exports is defined as 2).

$$\Delta AGEX_{it} = \gamma_0 + \gamma_1 \Delta AfT_{it-1} + \gamma_2 \Delta AGGDP_{it-1} + \alpha_i + \varepsilon_{it} \quad 2)$$

Since AfT in agriculture might have different effects according to the characteristics of aid, this study divides AfT in agriculture into 3 categories. Using the split AfT variables, the equations 1) and 2) are converted into 3) and 4).  $\Delta AP_{it-1} = AP_{it-1} - AP_{it-2}$  and  $AP_{it-1}$  is AfT related to agricultural policies of country  $i$  in period  $t-1$ .  $\Delta APR_{it-1} = APR_{it-1} - APR_{it-2}$  and  $APR_{it-1}$  indicates AfT related to agricultural production and resources of country  $i$  in period  $t-1$ . Lastly,  $\Delta ARS_{it-1} = ARS_{it-1} - ARS_{it-2}$  and  $ARS_{it-1}$  is AfT related to agricultural research and services of country  $i$  in period  $t-1$ .

$$\begin{aligned} \Delta AGGDP_{it} = \lambda_0 + \gamma_1 \Delta AP_{it-1} + \gamma_2 \Delta APR_{it-1} + \gamma_3 \Delta ARS_{it-1} + \gamma_4 \Delta AGEX_{it-1} + \\ + \kappa_i + \varepsilon_{it} \end{aligned} \quad 3)$$

$$\begin{aligned} \Delta AGEX_{it} = \eta_0 + \eta_1 \Delta AP_{it-1} + \eta_2 \Delta APR_{it-1} + \eta_3 \Delta ARS_{it-1} + \eta_4 \Delta AGGDP_{it-1} + \\ + \mu_i + \varepsilon_{it} \end{aligned} \quad 4)$$

Table 3 shows the variables statistics used in this study. The average amount of AfT in agriculture given to the recipient countries is \$37.7 million with the maximum amount being \$410.1 million. Since AfT is divided into 3 categories, the statistics also show the average amount of each category. First, the average amount of AfT used for agricultural policy is \$12.6 million with the maximum amount \$170.2 million. Second, the average amount of AfT used for agricultural production and resource is \$16.4 million with the maximum amount \$327.7 million, which indicates the largest sum among the three categories. Lastly, the

average amount of agricultural research and service is \$8.1 million with the maximum \$217.0 million.

The average amount of agricultural exports is \$4.0 billion million with the lowest export value \$0.1 million and the highest value \$84.7 billion. The mean of agricultural GDP indicates \$19.1 billion, with the highest value of \$892.9 billion. The average population is 66.5 million with the least population of 0.1 million to the largest 1.4 billion. According to the freedom index, the sample countries vary from “low level of freedom” to “high level of freedom” and the mean indicates almost the middle value of the index. Control of corruption, Government effectiveness, Political stability, Regulatory quality, Rule of law as well as Voice and accountability represent the similar level of means under 50.0%, which implies the sample countries relatively exposed to vulnerable environment of governance.

Table 3. Summary of variables statistics

Variables	Unit	Mean	Std. Dev.	Min	Max
Aid for Trade in agriculture, Total	USD million	37.747	50.222	0.000	410.083
Agricultural Policy	USD million	12.597	18.416	-0.011	170.186
Agricultural Production and Resource	USD million	16.439	28.803	0.000	327.731
Agricultural Research and Service	USD million	8.061	16.474	0.000	217.029
Agricultural Exports	USD million	4,013.004	9,236.242	0.061	84,665.180
Agricultural GDP, Total	USD billion	19.070	68.268	0.038	892.891
Freedom(1: Low 7: High)	Number	3.761	1.433	1.000	6.500
Control of Corruption(100%: good)	Percentage	37.391	20.169	1.435	91.707
Government Effectiveness(100%: good)	Percentage	40.597	18.859	1.435	87.805
Political Stability(100%: good)	Percentage	33.246	20.378	0.472	92.823
Regulatory Quality(100%: good)	Percentage	41.962	17.268	0.980	93.301
Rule of Law(100%: good)	Percentage	36.873	18.068	0.474	89.474
Voice and Accountability(100%: good)	Percentage	38.729	18.479	4.739	89.423

To examine the sample’s environment of governance, correlations are calculated among the characteristics variables. The results indicated that some of the country characteristics are highly correlated with other characteristics and the others are not. Freedom

index has negative correlations with the other characteristics and control of corruption is highly correlated with government effectiveness, regulatory quality as well as rule of law. Government effectiveness has strong correlations with regulatory quality and rule of law and regulatory quality has a high correlation to rule of law.

Table 4. Correlation matrix of indices for environment of governance

	Freedom	Control of Corruption	Government Effectiveness	Political Stability and Absence of Violent/Terrorism	Regulatory Quality	Rule of Law	Voice of Accountability
Freedom	1.0000						
Control of Corruption	-0.5250	1.0000					
Government Effectiveness	-0.4516	0.8050	1.0000				
Political Stability and Absence of Violent/Terrorism	-0.4561	0.5771	0.4407	1.0000			
Regulatory Quality	-0.5024	0.7294	0.8155	0.4191	1.0000		
Rule of Law	-0.4758	0.8369	0.8214	0.5866	0.7359	1.0000	
Voice of Accountability	-0.9362	0.6199	0.5536	0.5235	0.5866	0.5867	1.0000

#### 4. Result

To control country-specific effects, fixed-effects models are used for estimation and the result shows that there are positive impacts of the lagged AfT on agricultural GDP and exports. There are previous researches which underline a positive relationship of AfT and growth (Bacha, 1990, Burnside and Dollar, 2000 and Morrissey, 2001) and some studies draw negative effects of AfT on growth (Djankov et al., 2006 and Knack, 2001). More specifically, this study estimates the relations of AfT and growth focused on agriculture. Growth can be caused by exports (Martin, 1992, Dollar, 1992, Jeffrey A. Frankel et al., 1999), thus, when estimating the relations of AfT and growth in agriculture, agricultural export variable should be considered. The result indicates that AfT in agriculture has increased agricultural GDP of



recipient countries. This finding implies that AfT with the specific purposes has impacts on the target fields although there are controversial issues in literatures related to the effects of AfT on growth in broader scope. An increase in agricultural exports also has positively influenced on agricultural growth.

In column 2), the result shows that AfT in agriculture draws positive effects on agricultural exports which the finding is in line with Vijil and Wagner (2012), Cali and Te Velde (2011) and Helbe et al. (2009) in a big picture. The relationship of AfT in agriculture and agricultural exports is in accordance with the fundamental purpose of AfT to facilitate trade in recipient countries. Moreover, agricultural exports have an important role in development of recipient countries. In that sense, agricultural GDP variable is considered and it turns out to have a positive impact on agricultural exports.

According to the characteristics and projects of AfT in agriculture, the coefficient values are drawn differently. In column 3), AfT related to agricultural policies and management has a positive impact on agricultural development. Also, AfT related to agricultural education/training, research and services, plant and post-harvest protection and pest control, agricultural financial services, agricultural co-operatives, livestock/veterinary services is statistically significant to agricultural GDP. On the other hand, agricultural production and resources which contains food crop production, industrial crops/export crops, livestock, agrarian reform, agricultural alternative development, agricultural extension, agricultural land resources, water resources and inputs are negative and statistically insignificant. For agricultural exports, the same coefficients as column 3) have shown significance while agricultural production and resources are not significant. These results bring out that AfT invested in agricultural production and resources is not effective although the amount used under the purpose of agricultural production and resources is high. According to the outcome, rather than investing on agricultural production in less developed

countries which recipient countries are, AfT used for agricultural policy as well as agricultural research and services has more beneficial.

This study has an implication that AfT needs to be used for agricultural policy, research and services and this will drive the recipients to increase of agricultural GDP and exports.

Table 5. Impacts of AfT on agricultural GDP and exports

Independent Variables	Dependent Variables			
	$\Delta AGGDP_{it}$	$\Delta AGEX_{it}$	$\Delta AGGDP_{it}$	$\Delta AGEX_{it}$
	1)	2)	3)	4)
$\Delta AfT_{it-1}$	19.850** (8.042)	4.034** (2.040)		
$\Delta AP_{it-1}$			43.684*** (15.551)	6.945* (3.999)
$\Delta APR_{it-1}$			-4.076 (9.875)	2.157 (2.542)
$\Delta ARS_{it-1}$			61.726*** (13.200)	6.289* (3.397)
$\Delta AGGDP_{it-1}$		0.213** (0.009)		0.022** (0.009)
$\Delta AGEX_{it-1}$	1.310*** (0.155)		1.290*** (0.153)	
Observations	710	710	710	710
Countries	71	71	71	71
R <sup>2</sup>	0.178	0.102	0.172	0.103

Notes: \* significant at 10% level; \*\* significant at 5% level; \*\*\* significant at 1% level; standard errors.

The heterogeneity in AfT effects with respect to political environments in recipient countries might exist. To verify this assumption, recipient countries are divided into sub-groups using mean values of indices for environment of governance through k-means clustering and sub-sample analyses was conducted. Dividing the sample into two groups is found as the optimal k-means cluster solution using the proportional reduction of error

coefficient as suggested by Makles (2012) (Appendix 2). First, the results of the clustering method indicate that a recipient country would be included in the high level of freedom group if its value is at least 4, and in the low level of freedom group if it is less than 4. Second, a recipient country's value of control of corruption index is at least 41 would be included in the high level of control of corruption group, and if less than 41 in the low level of control of corruption group.

Third, a recipient country's value of government effectiveness index is at least 43 would be included in the high level of government effectiveness group, and if less than 43, in the low level of government effectiveness group. Fourth, a recipient country's value of political stability and absence of violent/terrorism index is at least 35 would be included in the high level of political stability and absence of violent/terrorism group, and if less than 35, in the low level of political stability and absence of violent/terrorism group. Fifth, a recipient country's value of regulatory quality index is at least 43 would be included in the high level of regulatory quality group, and if less than 43, in the low level of regulatory quality group.

Sixth, a recipient country's value of rule of law index is at least 42 would be included in the high level of rule of law group, and if less than 42, in the low level of rule of law group. Seventh, a recipient country's value of voice of accountability index is at least 35.5 would be included in the high level of voice of accountability group, and if less than 35.5, in the low level of voice of accountability group. Table 6 and Table 7 present estimates of the effect of Aft in agriculture on agricultural GDP and exports across these different sub-groups.

Table 6. Effect of Aft in agriculture on Agricultural GDP in Sub-Groups

Group	Freedom			Control of Corruption			Government Effectiveness			Political Stability and Absence of Violent/Terrorism			
	High	Low		High	Low		High	Low		High	Low		
$\Delta AP_{it-1}$	40.281 (36.138)	44.473 (14.249)	***	0.641 (9.169)	61.585 (22.916)	***	56.986 (33.073)	*	5.186 (6.714)	-0.551 (8.745)	50.365 (23.555)	**	
$\Delta APR_{it-1}$	-22.269 (15.694)	27.017 (12.116)	**	-1.822 (6.915)	-6.024 (13.797)		6.050 (25.902)		-7.728 (3.339)	**	-5.826 (8.863)	-4.512 (13.23)	
$\Delta APS_{it-1}$	28.557 (35.728)	76.151 (11.02)	***	1.365 (6.861)	94.897 (20.631)	***	86.201 (23.722)	***	9.034 (6.545)		-0.347 (8.427)	81.277 (18.798)	***
$\Delta AGEX_{it}$	2.444 (.386)	0.884 (.13)	***	1.338 (.071)	1.352 (.259)	***	1.297 (.23)	***	0.644 (.185)	***	1.052 (.055)	1.902 (.323)	***
constant	2498.717 (446.883)	852.143 (209.337)	***	149.780 (108.747)	2356.218 (353.834)	***	2810.248 (495.974)	***	604.993 (83.345)	***	175.896 (95.462)	* 2301.116 (373.506)	***
$R_2$	0.31	0.28		0.72	0.18		0.16		0.08		0.72	0.25	
N	280	430		280	430		320		390		290	420	

Group	Regulatory Quality			Rule of Law			Voice of Accountability			
	High	Low		High	Low		High	Low		
$\Delta AP_{it-1}$	8.118 (31.028)	52.089 (15.156)	***	70.481 (30.509)	16.758 (8.415)	**	47.126 (14.058)	***	41.641 (35.982)	
$\Delta APR_{it-1}$	-26.819 (22.991)	2.932 (9.031)		7.592 (23.327)	-7.998 (4.555)	*	29.675 (12.507)	**	-21.761 (15.442)	
$\Delta APS_{it-1}$	-2.664 (24.677)	91.837 (13.481)	***	87.004 (21.244)	14.576 (8.768)	*	75.346 (10.926)	***	28.295 (36.234)	
$\Delta AGEX_{it}$	2.065 (.245)	0.575 (.176)	***	1.626 (.254)	0.775 (.097)	***	0.882 (.13)	***	2.444 (.386)	***
constant	1622.598 (366.873)	1280.200 (241.79)	***	2066.409 (421.66)	799.365 (116.401)	***	822.177 (209.359)	***	2526.620 (446.455)	***
$R_2$	0.22	0.16		0.18	0.24		0.28		0.31	
N	350	360		370	340		430		280	

Notes: \* significant at 10% level; \*\* significant at 5% level; \*\*\* significant at 1% level; standard errors.

Table 7. Effect of Aft in agriculture on Agricultural Exports in Sub-Groups

Group	Freedom		Control of Corruption		Government Effectiveness		Political Stability and Absence of Violent/Terrorism	
	High	Low	High	Low	High	Low	High	Low
$\Delta AP_{it-1}$	-0.334 (5.886)	15.182 *** (5.248)	14.700 * (8.258)	3.701 (4.491)	13.456 (8.457)	-1.627 (1.907)	28.410 *** (9.779)	4.404 (3.744)
$\Delta APR_{it-1}$	1.667 (2.554)	3.702 (4.451)	3.086 (6.227)	2.140 (2.704)	5.919 (6.635)	1.527 (.958)	3.885 (9.987)	1.692 (2.105)
$\Delta APS_{it-1}$	3.202 (5.816)	10.519 *** (4.086)	18.179 *** (6.069)	-0.346 (4.055)	9.522 (6.08)	-1.709 (1.858)	39.292 *** (9.199)	-2.303 (2.995)
$\Delta AGGDP_{it-1}$	-0.021 ** (.009)	0.125 *** (.017)	0.017 (.037)	0.021 ** (.009)	0.026 * (.013)	-0.052 *** (.015)	0.098 ** (.045)	0.016 ** (.007)
constant	390.971 *** (74.482)	355.147 *** (77.35)	527.509 *** (98.551)	348.218 *** (71.216)	789.819 *** (127.472)	159.262 *** (24.594)	374.040 *** (109.441)	395.615 *** (59.48)
R2	0.09	0.26	0.05	0.16	0.10	0.00	0.17	0.18
N	280	430	280	430	320	390	290	420

Group	Regulatory Quality		Rule of Law		Voice of Accountability	
	High	Low	High	Low	High	Low
$\Delta AP_{it-1}$	14.964 ** (7.113)	6.132 (4.442)	-1.129 (6.597)	13.798 *** (4.877)	15.155 *** (5.178)	-0.605 (5.858)
$\Delta APR_{it-1}$	1.700 (5.307)	1.892 (2.636)	-0.950 (5.037)	2.543 (2.682)	4.154 (4.595)	1.587 (2.512)
$\Delta APS_{it-1}$	18.327 *** (5.604)	2.704 (3.986)	3.126 (4.601)	11.511 ** (5.108)	10.762 *** (4.051)	3.534 (5.896)
$\Delta AGGDP_{it-1}$	-0.018 (.011)	0.122 *** (.016)	0.017 (.01)	0.085 *** (.031)	0.125 *** (.017)	-0.021 ** (.009)
constant	611.309 *** (83.432)	151.707 ** (73.191)	622.729 *** (89.672)	148.682 ** (73.592)	355.736 *** (77.28)	392.691 *** (74.489)
R2	0.01	0.28	0.12	0.11	0.26	0.09
N	350	360	370	340	430	280

Notes: \* significant at 10% level; \*\* significant at 5% level; \*\*\* significant at 1% level; standard errors.

The results demonstrate that AfT in agriculture is effective in the recipient countries with low level of freedom leading to increase of agricultural GDP. All of the fields are significant, in particular, agricultural policy, research and services have greatly increased in the recipients with low freedom. For the recipients which are lack of corruption control, AfT have driven to increase of agricultural development, especially AfT in agricultural policy, research and services is effective. AfT used under the name of agricultural policy, research and services shows positive impacts on recipient countries with effective governments. Regarding political stability and absence of violence/terrorism, AfT in both agricultural policy and research and services is significant in lower group which means that AfT in these fields helps the recipients with unstable politics and violence/terrorism, leading to agricultural growth. For regulatory quality, lower group indicates that AfT in agricultural policy, research and services is effective for agricultural development. Regardless of the level of rule of law settlement, both groups show significant results that AfT in agricultural policy as well as research and services is effective to agricultural development. Lastly, the recipient countries with higher level of voice and accountability have more impacts on AfT in agricultural policy, research and services. In summary, the recipients with low freedom, low level of corruption control, ineffective government, unstable politics, low regulatory quality, high level of voice and accountability are influenced by AfT leading to agricultural GDP.

The estimation on agricultural exports shows that when freedom level is low, AfT in agricultural policy, research and services positively affects agricultural exports. However, control of corruption works the other way around since the recipients which can control corruption, AfT used for agricultural policy, research and services affects agricultural exports. Regarding government effectiveness, AfT in both groups is ineffective. In the recipient countries with stable politics and absence of violent/terrorism, AfT in agricultural policy, research and services is effective causing increase of agricultural exports. In the recipients

with higher level of regulatory quality, AfT in agricultural policy as well as research and services works significantly. The recipients with unsettled rule of law tend to have significant effects on agricultural exports by AfT in agricultural policy, research and services. For the last factor, voice and accountability, higher group has significance in AfT in terms of agricultural policy, research and services. To put it briefly, the recipients with low freedom, high level of corruption control, high level of political stability and absence of violence/terrorism, high regulatory quality, low level of rule of law as well as high level of voice and accountability are influenced by AfT leading to agricultural exports.

AfT on both agricultural development and exports is seen as working in more vulnerable recipients in governance system while some factors such as control of corruption, political stability and absence of violence/terrorism show the opposite results.

## **5. Conclusion**

As time goes by, the globalization of market deepens and lesser-developed countries lagged behind in the global market. This issue has been regarded as one of the reasons that the lesser-developed countries have difficulty in economic development, escaping the poverty trap. To reduce such problems, AfT has appeared to help them participate in the world trade system and a growing number of studies have put efforts to examine the effectiveness of AfT. Apart from most of the studies on AfT, this study focused on AfT in agriculture and its impact on agricultural development and exports. Since there is a limitation in getting resources of AfT amount, agricultural GDP, exports as well as the governance index, the number of sample countries has been shrunk.

This study finds that AfT in agriculture increases agricultural GDP and exports leading to agricultural development. However, the effects vary depending on the purpose of AfT in

agriculture. AfT used for agricultural policy, research and services is presented as more effective than AfT invested on agricultural production and resources to agricultural GDP and exports of the recipients. This finding may be partly explained by the characteristic of the industrial structure of recipient countries that highly dependent on agriculture.

According to the subgroup analysis results, it finds that AfT in agriculture increases agricultural development and exports especially in relatively weak recipients in governance system. On the other hand, AfT works more effectively in those recipient countries which can control corruption within their countries, with stable political environment and absence of violence/terrorism. Some factors such as government effectiveness and rule of law are found that they do not affect agricultural exports. Therefore, this study suggests that the characteristics of recipient countries should be considered when deciding the purpose and type of AfT in agriculture to raise effectiveness.



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## Appendix 1. The list of recipient countries

	Africa	Asia	America	Europe	Oceania
1	Algeria	Afghanistan	Anguilla	Albania	Cook Islands
2	Angola	Armenia	Antigua and Barbuda	Belarus	Fiji
3	Benin	Azerbaijan	Argentina	Bosnia and Herzegovina	Kiribati
4	Botswana	Bangladesh	Barbados	Croatia	Kiribati
5	Burkina Faso	Bhutan	Belize	Former Yugoslav Republic of Macedonia	Marshall Islands
6	Burundi	Cambodia	Bolivia	Kosovo	Micronesia
7	Cabo Verde	China (People's Republic of)	Brazil	Moldova	Nauru
8	Cameroon	Democratic People's Republic of Korea	Chile	Montenegro	Niue
9	Central African Republic	Georgia	Colombia	Serbia	Palau
10	Chad	India	Costa Rica	Slovenia	Papua New Guinea
11	Comoros	Indonesia	Cuba	States Ex-Yugoslavia	Samoa
12	Congo	Iran	Dominica	Ukraine	Solomon Islands
13	Cote d'Ivoire	Iraq	Dominican Republic		Tokelau
14	Democratic Republic of the Congo	Jordan	Ecuador		Tuvalu
15	Djibouti	Kazakhstan	El Salvador		Vanuatu
16	Ethiopia	Kyrgyzstan	Grenada		Wallis and Futuna
17	Egypt	Lao People's Democratic Republic	Guatemala		
18	Equatorial Guinea	Lebanon	Guyana		
19	Eritrea	Malaysia	Haiti		
20	Gabon	Maldives	Honduras		
21	Gambia	Mongolia	Mexico		
22	Ghana	Myanmar	Montserrat		
23	Guinea	Nepal	Nicaragua		
24	Guinea-Bissau	Oman	Panama		
25	Jamaica	Pakistan	Paraguay		
26	Kenya	Philippines	Peru		
27	Lesotho	Saudi Arabia	Saint Kitts and Nevis		
28	Liberia	Sri Lanka	Saint Lucia		
29	Libya	Syrian Arab Republic	Saint Vincent and the Grenadines		
30	Madagascar	Tajikistan	Suriname		

31	Malawi	Thailand	Trinidad and Tobago
32	Mali	Timor-Leste	Turks and Caicos Islands
33	Mauritania	Turkey	Uruguay
34	Mauritius	Turkmenistan	Venezuela
35	Mayotte	Uzbekistan	
36	Morocco	Viet Nam	
37	Mozambique	West Bank and Gaza Strip	
38	Namibia	Yemen	
39	Niger		
40	Nigeria		
41	Rwanda		
42	Saint Helena		
43	Sao Tome and Principe		
44	Senegal		
45	Seychelles		
46	Sierra Leone		
47	Somalia		
48	South Africa		
49	South Sudan		
50	Sudan		
51	Swaziland		
52	Tanzania		
53	Togo		
54	Tonga		
55	Tunisia		
56	Uganda		
57	Zambia		
58	Zimbabwe		

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## Appendix 2. The optimal number of groups k

Using the method suggested by Makles (2012), the optimal number of groups k was found for clustering. The results indicate that, the optimal number of groups is 2. When number of groups is 2, there is conspicuous kinks in the within sum-of-squares (WSS),  $\log(\text{WSS})$ , and  $\eta^2$ . When number of groups is 2, the proportional reduction of error (PRE) points to a reduction of the WSS by 42.1% compared with the case when number of groups is 1.

Table A1. The calculated statistics for k-mean clustering

k	WSS	$\log(\text{WSS})$	$\eta^2$	Proportional reduction of error
1	5957	8.692	0.000	.
2	3449	8.146	0.421	0.421
3	2620	7.871	0.560	0.240
4	2200	7.696	0.631	0.160
5	1866	7.532	0.687	0.152
6	1722	7.451	0.711	0.077
7	1525	7.330	0.744	0.115
8	1461	7.287	0.755	0.042
9	1395	7.241	0.766	0.045
10	1256	7.135	0.789	0.100
11	1207	7.096	0.797	0.039
12	1191	7.083	0.800	0.013
13	1146	7.044	0.808	0.038
14	1032	6.939	0.827	0.099
15	1064	6.969	0.821	-0.031
16	1035	6.942	0.826	0.027
17	954	6.860	0.840	0.079
18	981	6.889	0.835	-0.029
19	876	6.775	0.853	0.108
20	847	6.742	0.858	0.033

Figure A1. WSS, log (WSS),  $\eta^2$ , and PRE for all K cluster solutions

