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Trade Creation and Diversion Effects Under the Free Trade Agreement Between Peru and the United States: A Gravitational Analysis

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Abstract

This paper is oriented to quantify the trade creation and diversion effects in the Free Trade Agreement (FTA) between Peru and the United States. For that purpose, using a disaggregated database at the 10-digit level for Peruvian goods with intervals of 3-years between 2002 and 2018, this article adopts a three-dummy variable methodology that allows the identification of intra-bloc and extra-bloc effects. Besides, a theoretically-founded gravity equation is employed with the incorporation of country-time and time-invariant fixed effects to solve common econometric specification problems, such as lack of multilateral resistance terms in modelling, heteroscedasticity of trade data, the inclusion of zero trade flows, and endogeneity of trade policy. Estimating with the PPML method for the complete sample and among types of goods (group 1: raw materials and intermediate goods, and group 2: consumer and capital goods), the main results show that the Peru-US FTA generates intra-bloc trade creation for the entire sample and two groups of goods separately. Also, the FTA produces export trade diversion for the complete sample and group 2, while import trade creation for both groups. Overall, the Peru-USA FTA is an "intra-bloc trade creation agreement" that boosted bilateral trade flows. These effects are considered to formulate some policy recommendations for improving the results of this Peruvian FTA.

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1. Introduction

At the end of 1990, considering the situation of a complex multilateral trading environment, countries stimulated the reduction of trade barriers and strengthened the liberalization of trade flows through the negotiation of Regional Trade Agreements (RTA). Nowadays, the World Trade Organization (WTO) recognizes the existence of 490 RTAs, where 303 agreements have come into force around the world.

Particularly, Free Trade Agreements (FTA) were the most popular among the types of RTA and led the trade liberalization process in the last decades. In that sense, Peru has not been out of this trend and began its trade insertion with the signature of the Peru-United States FTA in 2006, which entry into forced in 2009.[1] Since that milestone, Peru has achieved the signature of 20 RTAs with different trade partners, such as China, the European Union, Singapore, Chile, among others.

This research contributes with the quantification of the trade creation and diversion ex-post effects derived from the Peru-United States FTA under the gravity equation framework to obtain empirical results and policy recommendations derived from this FTA.

Viner (1950) introduced the trade creation and trade diversion terms. On the one hand, intra-bloc trade creation emerges when new trade flows were generated due to the reduction of trade barriers. On the other hand, trade diversion materializes when a country replaces its imports origin from a non-FTA member (with low production costs) to an FTA member, because of the preferential access (with lower tariffs) given by the FTA. In addition, Panagariya (2000) contended that the trade creation and diversion effects are associated with welfare gains and losses, respectively. Also, considering a product-level analysis, there are always dissimilar results: some goods show trade creation effects, while others trade diversion.

Particularly, the "three-dummy variables" methodology used by Carrere (2006), MacPhee and Sattayanuwat (2014), and Yang and Martínez-Zarzoso (2014) allows the distinction between intra-bloc and extra-bloc effects. Thereby, this methodology is applied for quantifying the effects of interest. Moreover, the addition of different fixed effects (exporter-time, importer-time, and country-pair) is widely accepted as a theory-consistent specification of the gravity equation. I use the Poisson Pseudo-Maximum-Likelihood (PPML) estimator (Santos Silva and Tenreyro, 2006) to solve econometric problems identified in prior research, such as biased coefficients, the presence of heteroscedasticity in trade flows, endogeneity of trade policy, and the use of "zero trade" in the sample, that led to misinterpretation of the results. Considering the previous description, the estimations will not only be for the total of trade flows but also, will be expanded to two groups of goods: "raw materials and intermediate goods" and "consumer and capital goods".

In order to estimate those effects, I use data for Peruvian and 30 trading[2] partners' exports at the most disaggregate level of the harmonized system (Peruvian National Tariff Line–10 digits) between 2002 and 2018 in 3-year intervals that covers approximately 95% of the total Peruvian trade. Besides, some variables associated with trade costs (such as distance, contiguity, and use

[1] In Appendix A, some information regarding the Peru-United States FTA and its tariff elimination schedules are presented.

[2] Appendix B shows the list of trading partners selected for this study.

of common language) are considered in preliminary estimations.

Among the main results, in terms of intra-bloc trade, not only the estimation with the entire sample but also sectoral sample, coefficients showed positive signs that are interpreted as intra-bloc trade creation effects. In general, the complete sample shows an effect of 38.5% more trade between members in comparison with the situation without FTA. Related to sectorial estimations, the group of "raw materials and intermediate goods" has the largest effect (231.7% on average for products from this group).

Considering the remaining variables, this model identifies the existence of export trade diversion effect for the entire sample and the group "consumer and capital goods", with effects of -52.2% and -2.4%, respectively. These effects should be translated into the reduction of the levels of exports to the rest of the world to replace the destination into the United States due to tariff reductions and liberalization process. On the other hand, the group of "raw materials and intermediate goods" shows an export trade creation effect in the sense of increasing these flows to other countries outside the preferential bloc.

Finally, in terms of imports, the estimation in the complete sample suggests that 98.4% of new imports of Peru from the United States were based on the reduction of imports from control countries (i.e. an import trade diversion effect). At the sectorial assessment, import trade creation effects were identified for "raw materials and intermediate goods" and "consumer and capital goods" in the magnitude of 206.8% and 21.3%, respectively.

The remaining of this study is organized as follows. In Section 2, I present the literature review related to trade agreements and trade creation and diversion effects through theoretical and empirical articles. In Section 3, I address the theoretical gravity equation, the econometric specifications, the methodology of three-dummy variables, and the PPML estimation method. Furthermore, in Section 4, the data is presented. After the estimation, the results will be discussed in Section 5. Finally, Section 6 shows final remarks and some policy recommendations related to trade policy to take advantage of this and the future Peruvian FTAs.

2. Literature Review

RTAs are reciprocal preferential trade agreements between two or more partners that do not necessarily belong to the same geographical region (WTO, 2020). Particularly, considering the multilateral baseline, these agreements deepen in the construction of trade rules to contribute to trade liberalization and facilitation process. From the institutional perspective, the RTAs are considered "special exceptions" under the Article XXIV of the General Agreement on Tariffs and Trade (GATT), the Enabling Clause, and the Article V of the General Agreement on Trade in Services (GATS) (WTO, 2015) in terms of the principles of non-discrimination[3] due to the establishment of preferential rules.

Along the time, the degree of deepening of RTAs has been increased substantially in terms of covered topics and content. Contemporary trade agreements go beyond "at-the-border" issues mainly associated with tariffs (Rodrik, 2018), and consider the inclusion of "behind-the-border"

[3]The most-favoured-nation treatment and the national treatment obligation.

rules related to investment, intellectual property rights, health and safety regulations in goods, competition, labour, environment, development, corruption, and among others. Particularly, the level of comprehensiveness in trade agreements is heterogeneous and related to the phase of economic development of members: the more developed a country is, the more deepen the agreement (Kohl et al., 2015).

Apart from the effects of the reduction of tariffs and the market access gains, more reasons explain why countries decide to participate in RTAs, such as the neutralization of "beggar-thy-neighbour" effects, the increase of the market size to exploit scale economies (WTO, 2011), and help to the process of internalizing externalities, such as international production relocations (Ossa, 2011). In addition, countries negotiate RTAs to take advantage of the terms of trade for boosting their welfare level (Bagwell and Staiger, 1999). From the political economy branch that explains the interaction between agents considering policy commitments, trade agreements contribute with the increase of government creditability associated to the policies' fulfilment (Grossman and Helpman, 1994; Gawande and Bandyopadhyay, 2000), governments may be able to foreclose political pressures in the country through free trade committing in agreements (Maggi and Rodriguez-Claire, 1998), generate governmental gains from commitment in constraining tariffs even if they use less efficient non-tariff barriers (Limão and Tovar, 2011), and allow the reduction of uncertainty levels in trade policy through compromises in RTAs (Limão and Maggi, 2015).

Considering the importance of RTAs in the trading and economic performance of a country, methodological improvements in the use of the gravity equation, known as the "workhorse" in the international trade field, have turned into one of the most valued tools for researchers.

The use of gravity equations initiated with Tinbergen (1962) and Pöyhönen (1963) who were the pioneers of this methodology in trade issues. Particularly, these studies considered that trade flows were explained by the gross domestic product of each country and transport costs, measured by the distance between two countries in a bilateral trade framework. Theoretical extensions from this model are shown in Anderson (1979) who claimed that the gravity equation could be derived from the expenditure system based on differentiated goods produced by origin countries (known as the Armington assumption) and using Constant Elasticity of Substitution (CES) preferences.

Approximately twenty years later, Anderson and van Wincoop (2003) considered that previous empirical studies based on gravity equations did not have a theoretical foundation that led to biased estimations by omitted variables, especially of multilateral resistance terms (barriers that each country faces in trade with all their partners). In that sense, these authors contributed with the inclusion of these terms and the solution of the McCallum's (1995) border puzzle.

Baier and Bergstrand (2007), following Trefler (1993), suggested that trade policy (in particular defined as FTA dummy) is not an exogenous variable and tend to underestimate the effects of trade liberalization. In that sense, they solve the endogeneity of FTAs adopting a panel approach that differs with instrumental-variable and control-function methodologies in cross-section gravity models (Baier and Bergstrand, 2002; Magee, 2003). From the empirical results, these authors showed that in a theoretically-motivated gravity equation with panel data and bilateral fixed and

country-time effects, on average, "an FTA approximately doubles two members' bilateral trade after ten years". Besides, findings with the new methodology have demonstrated that traditional estimates of FTAs impacts on bilateral trade are underestimated by as much as 75%-85%.

As previous studies have shown, the addition of other variables is fundamental to get unbiased estimates. In particular, fixed effects have been used to handle problems related to omitted variables bias: not only Baier and Bergstrand (2007) but also Egger and Nigai (2015) and Agnosteva et al. (2014) identify that the inclusion of bilateral pair-fixed effect is the best tool for capturing invariant-time bilateral trade costs, such as distance, common language, contiguity, among others. On the other hand, the use of country-time fixed effects to account multilateral resistance terms (Anderson and van Wincoop, 2003) has properly demonstrated in cross-section data (Feenstra, 2016) and a dynamic-gravity estimation with panel data (Olivero and Yotov, 2012).

Following the theoretical improvements in the gravity equation, there is a considerable number of empirical studies that attempt to quantify different effects produced by this kind of agreements, in particular, trade creation and diversion ex-post effects. Moreover, the availability of extended data has supported the proliferation of these studies around the world.

Endoh (1999) introduced a methodology that considers differences between types of effects: trade creation, import trade diversion, considering Balassa's (1967) definition, and export trade diversion. He introduces, for the first time, three dummy variables for each economic organization (European Economic Community, Latin American Free Trade Association, and Council of Mutual Economic Assistance) to assess the trade creation and diversion effects between 1969 and 1994. Using the OLS estimation method, he shows that the results for each organization differ from each other. Despite his relevant empirical results, the econometric specification does not consider the inclusion of fixed effect to control the bias for omitted variables.

To fulfil the correct identification of the effects of interest, Carrere (2006) specifies a gravity model but, in comparison to Endoh (1999), this specification controls non-observable characteristics for each country pair using bilateral fixed effects in a panel data model that differs from a cross-section framework. Additionally, she defines three dummy variables to measure the intra-bloc trade, exports and imports creation/diversion. Taking into consideration trade flows between 1962–1996 and seven agreements (European Union, Andean Community, Association of Southeast Asian Nations, Central American Common Market, Latin American Integration Association, North American Free Trade Agreement, and MERCOSUR), econometric estimations show that, on average, the intra-bloc trade has increased. Another study that followed this methodology is Martínez-Zarzoso et al. (2009).

Yang and Martínez-Zarzoso (2014), based on the Carrere's (2006) three-dummy methodology, studied the ASEAN-China Free Trade Agreement (ACFTA) effects on exports, using aggregated data and disaggregated data at the sectoral level, such as agricultural raw materials, manufactured goods, chemical products, machinery, and transport equipment. This research shows that significant and positive coefficients for aggregated data confirm the reduction of ACFTA's trade barriers, which promote the expansion of trade flows, not only for bloc members but also between FTA members and non-members. In addition, similar to Magee (2008), this study models the

gravity equation with the inclusion of fixed effects on bilateral, importer-year, and exporter-year for controlling non-observable variables in the estimation.

In the same line, studies such as MacPhee and Sattayanuwat (2014), Sattayanuwat and Tangvitoontham (2017), and Sun and Reed (2010) are particular in the literature due to they used the Poisson Pseudo-Maximum-Likelihood (PPML) method to handle heteroscedasticity problems from trade data. In case of the first study, they found that the studied agreements (South Asia Preferential Trade Agreement, Gulf Cooperation Council, Pan Arab Free Trade Area, and the West African Economic and Monetary Union) do not produce net trade creation effects. In the second document, researchers show that some of the ASEAN's RTAs displayed intra-bloc trade creation, such as the Regional Comprehensive Economic Partnership (RCEP). Finally, in the third study, authors identify that for some agreements (ASEAN-China FTA, European Union-15, European Union-25, and Southern African Development Community), the agricultural intra-bloc trade has increased.

Despite that empirical studies have not used the three dummy methodology for measuring the effects of interest, some of them consider that trade creation and diversion effects are underestimated when aggregated data (total exports or trade by country) is considered due to different patterns among products and sectors that were found when disaggregated data is used. Some evidence related to this idea is shown by Urata and Okabe (2007, 2014) for various RTAs, Korinek and Melatos (2009) for agricultural trade of MERCOSUR, Shinyekwa and Othieno (2013) for East African Community, Kwentua (2006) for European Union-South Africa FTA, Ekanayake et al. (2010) for developing Asian countries, and Gauto (2012) for Paraguayan trade.

Last but not least, regarding the measuring of some possible effects of the Peru-USA FTA, some ex-ante studies used the general equilibrium model framework.

First, Durán et al. (2007) using the GTAP (Global Trade Analysis Project) database and three simultaneal agreements (Colombia, Peru, and Ecuador), estimated that the FTA between the United States and the Andean Countries will have generated trade diversion and this will affect the trade among Andean partners due to the reduction of import and export flows. In particular, at the sectoral level, these authors stated that if the FTA would not be negotiated, the Peruvian light manufactured goods will experiment the most important export decrease. While in terms of import flows, Peru will import more chemical, machinery and equipment goods, in other words, capital goods.

In the same line, Morón (2005) used the Dynamic Stochastic General Equilibrium (DSGE) model for the Peru-USA FTA and predicted exchanges of machinery and inputs that previously were imported from other countries for American goods due to the FTA. Finally, Tello (2004) exhibited that the Peru-USA FTA will cause trade diversion from the rest of the world to the American markets.

3. The Model

3.1 Gravity Equation

According to Carrere (2006), the gravity equation is the workhorse to analyse ex-post effects of a trade agreement because it represents "a relevant counterfactual". In fact, with a correct econometrical specification, this could give the possibility to isolate trade creation and diversion effects from an FTA.

In order to understand the real dimension of the factors that affect trade flows, it is fundamental to consider, as the starting point, the theoretical gravity model (in its multiplicative form) captured from different empirical studies:

$$X_{ijtp} = \beta Y_{it}^{\beta_1} Y_{jt}^{\beta_2} Dist_{ij}^{\beta_3} OBF_{ijtp}^{\theta_k}, \tag{1}$$

where X_{ijtp} shows bilateral exports from country i to country j in year t for good p. Y_{it} is GDP for country i in year t, and Y_{jt} the same, but for country j. $Dist_{ij}$ is the distance between country i and j. Finally, OBF_{ijtp} is a vector formed by other bilateral factors that affect trade, such as FTAs, tariffs, languages, common border, exchange rates, among others.

Considering the equation (1), other authors upgraded the conditions and econometric specifications applied to panel data framework to retrieve theoretical-founded results.

As previously discussed in the literature review section, the adoption of Anderson and van Wincoop's (2003) multilateral resistance terms for avoiding the well-known Baldwin and Taglioni's (2006) "Gold Medal Mistake", the Baier and Bergstrand's (2007) strategy for handling "endogeneity of the trade policy variables", and Olivero and Yotov's (2012) bilateral and country-time fixed effects will lead to unbiased coefficients.

3.2 Econometric Specification

Intending to trade creation and diversion effects, it is important to consider the use of an augmented gravity equation, which adds more independent variables in comparison with the classic gravity equation (that consider only origin GDP, destination GDP and geographical distance).

As the first step, logs are taken from equation (1) and an error term[4] is added:

$$lnX_{ijtp} = \beta + \beta_1 lnY_{it} + \beta_2 lnY_{jt} + \beta_3 lnDist_{ij} + \sum_{k=1}^{n} \theta_k OBF_{ijtp} + \varepsilon_{ijtp}. \tag{2}$$

Equation (2) shows the logarithmic form of the gravity equation. Generally, in various empirical studies, academicians used this specification to measure the FTA effects on trade; however, under this specification, zero trade flows were simply dropped due to logs when OLS method is applied. In that sense, Santos Silva and Tenreyro (2006) recommend that the gravity equation should be estimated in its multiplicative form to avoid the drop of zeros in exports data. This point is extremely important. As Yang and Martínez-Zarzoso (2014) point out, the log-form of

[4] According to Santos Silva and Tenreyro (2006, p. 643), the form of error term could be additive or multiplicative. There are no differences when it is applied to a gravity equation that will be estimated using the PPML method.

the gravity model will be only correct if the zeros o missing data are randomly distributed, but it will provide biased estimates if zeros are related to a systematic pattern, such as large fixed costs of exporting.

Considering these recommendations and the theoretical improvements to handle different problems of specification, Santos Silva and Tenreyro (2006) proposed the PPML estimator to account for heteroscedasticity for a gravity model expressed in a multiplicative form. In that sense, to take advantage of this PPML's feature, it is important to reformulate the gravity equation for a correct specification, the function of e number (inverse of natural logarithm or exp) should be used as follows:

$$X_{ijtp} = \exp[\Pi_{it} + \Omega_{jt} + \beta_1 lnDist_{ij} + \theta_1 Contig_{ij} + \theta_2 ComLang_{ij} + \theta_3 Intra_{ijtp} + \theta_4 Exp_{ijtp} + \theta_5 Imp_{ijtp} + \varepsilon_{ijtp}], \quad (3)$$

where X_{ijtp} is the export level from country i to j in the year t for good p. Π_{it} is the country-time fixed effect for country i in year t and Ω_{jt} is the country-time fixed effect for country j in year t. Both fixed-effects replace all variables that change by year but are inherent to a country, such as GDPs and the unobservable multilateral resistance terms as stated by Olivero and Yotov (2012). $lnDist_{ij}$ is the geographical distance between country i and j (in logs). Other variables to capture trade costs are added, such as contiguity ($Contig_{ij}$) that takes a value of 1 when countries i and j share the same frontier, and common language ($ComLang_{ij}$) that takes the value of 1 if both countries have the same language.

In this study, the variables of interest for capturing the trade creation and diversion effects for Peruvian trade flows are also included in equation (3).

First of those variables, $Intra_{ijtp}$ takes a value of 1 when a product p is traded by countries i and j that are part of the FTA in the year $t = [2009, 2018]$. This variable quantifies the average trade effect at the product-level produced by the FTA, in other words, the intra-bloc trade effect. A positive and statistically significant sign in the coefficient indicates that the trade level has increased; on the contrary, it has diminished.

Second, Exp_{ijtp} helps to find the effects on exports of good p from members of the trading bloc to other countries that are not part of the FTA among the years $t = [2009, 2018]$. This variable takes the value of 1 if the exporter i is a member of the Peru-USA FTA, but the importing country j is not. This variable helps to capture export trade creation and diversion effects.

Third, Imp_{ijtp} is a dummy variable that measures the effects on imports of FTA members from countries that are not part of the FTA. In this case, this variable will take the value of 1 if the importer j is a member of the FTA in $t = [2009, 2018]$, but the exporting country i is not. If not, it would take a value of zero. Through this variable, the model could assess the import trade creation and diversion effects.

Table 1
Trade creation and diversion effects.

N°	Expected sign			Absolute values differences	Typology
	Intra	*Exp*	*Imp*		
1	+	+	+		ITC, XTC and MTC
2	+	+	−	$intra > \|imp\|$	ITC, XTC and MTD
3	+	+	−	$intra < \|imp\|$	XTC, MTD
4	+	−	+	$intra > \|exp\|$	ITC, XTD, MTC
5	+	−	+	$intra < \|exp\|$	XTD, MTC
6	+	−	−	$intra > \|exp + imp\|$	ITC, XTD, MTD
7	+	−	−	$intra < \|exp + imp\|$	XTD and/or MTD

Note: This table does not present the negative effects of Intra variable. ITC (Intra Trade Creation), XTC (Export Trade Creation), XTD (Export Trade Diversion), MTC (Import Trade Creation), MTD (Import Trade Diversion).
Source: Taken from MacPhee and Sattayanuwat (2014).

Taking into consideration the methodology, we could identify five effects (that are summarized in Table 1):

(i) Intra-bloc Trade Creation (ITC), identifies the FTA effect on the bloc members' trade level.

(ii) Export Trade Creation (XTC), identifies the increase of the bloc members' exports to the rest of the world.

(iii) Export Trade Diversion (XTD), identifies the diversion of exported goods after the FTA's entry into force. In other words, considering the new trade preferential status under the FTA, the destination of the exported goods will be diverted from the rest of the world countries (destination before the FTA) to the bloc members (new destination with the FTA entry into force).

(iv) Import Trade Creation (MTC), identifies the increase of bloc members' imports from the rest of the world.

(v) Import Trade Diversion (MTD), identifies the import diversion of goods after the FTA. In other words, considering the new trade preferential status under the FTA, the origin of the imported goods will be diverted from the rest of the world countries (origin of imports before the FTA) to the bloc members (new origin of imported products).

Therefore, in the same line that Carrere (2006), MacPhee and Sattayanuwat (2014), and Yang and Martínez-Zarzoso (2014), the combination of signs and estimated coefficients allow the identification of the trade creation and diversion effects (for exports and imports) that allows the understanding of this methodology (see Table 1).

Equation (3) adds some recommendations from a theoretical-founded gravity equation; however, to ensure unbiased and consistent estimators, it is important to add symmetric country pairs fixed effects that group all the time-invariant variables that were specified at the equation

(3) and other non-observable factors:

$$X_{ijtp} = \exp\left[\Pi_{it} + \Omega_{jt} + \ \Phi_{ij} + \theta_1 Intra_{ijtp} + \theta_2 Exp_{ijtp} + \theta_3 Imp_{ijtp} + \varepsilon_{ijtp}\right], \tag{4}$$

where X_{ijtp} is the export level from country i to j in the year t for good p. Π_{it} is the country-time fixed effect for country i in year t and Ω_{jt} is the country-time fixed effect for country j in year t. Φ_{ij} are the country pair fixed effects and will absorb time-invariant bilateral variables that are not the main interest of this research. Finally, $Intra_{ijtp}$, Exp_{ijtp}, and Imp_{ijtp} are the variables of interest.

3.3 Poisson Pseudo-Maximum-Likelihood (PPML)

On the development of empirical studies related to the assessment of trade creation and diversion effects that use gravity equations, different econometric problems were identified.

The first (and common problem) is the logarithmic transformation of the dependent variable that conducts to biased coefficients and misunderstandings based on the "logarithm of trade". This situation could lead to incorrect decisions and trade policies by policymakers due to inconsistent results. Regarding the second problem, different estimations methods used to deal with heteroscedasticity problems have not been convenient,[5] this complication produces biased and inconsistent results. Finally, the third problem is called "zero trade flows", which occurs when observations equal or near zero are considered in the sample. These observations should be taken into consideration because there are some cases when countries do not always exchange some goods with other countries, especially, when the sample covers disaggregated data.[6]

Santos Silva and Tenreyro (2006) solved these problems with the creation of an estimation method called Poisson Pseudo-Maximum-Likelihood (PPML), which helps to retrieve consistent and unbiased results in comparison to classical methods for estimations of gravity equations (such as OLS, Fixed Effects, Random Effects, Tobit, and Non-Linear Least Squares). The authors discovered that estimated models using the above-mentioned methods (especially OLS) and specifying a log-linear equation (with the dependent variable in log-form) drives to biased coefficients that distort the model results.

According to Shepard (2016), for PPML results, the parameter's interpretation is similar to OLS. In other words, taking into consideration that Y (dependent variable) and X (a regressor) are in levels, therefore "If X differed by one unit, Y will vary by (the value of found coefficient) unities of Y, on average". While, if the independent variable is in its logarithmic form ($\ln X$), so "for each change of 1% in X, the dependent variable (Y) will vary (coefficient's value/100) unities of Y, on average".

[5] According to Santos Silva and Tenreyro (2006), a researcher could use estimation methods for gravity equations with the presence of heteroscedasticity and dependent variables in log-form that distort coefficients due to the existence of inconsistent estimators related to elasticities. Furthermore, the conventional econometric techniques (OLS, Fixed Effects, Random Effects, Tobit, among others) showed that estimated coefficients are not robust with the existence of different types of heteroscedasticity from trade data.

[6] Some researchers faced this problem dropping all the zero values or near zero. Others just added a unit to get positive trade values. However, these kinds of solutions will lead to inconsistent results.

On the other hand, throughout the literature review, a special formula was used to interpret estimated coefficients of dummy variables. Yotov et al. (2016) argued that those coefficients should be transformed to obtain elasticities and the percentage effect on the trade level, following the next equation: $\left(e^{\beta}-1\right) x\,100\%$, where β is the estimated coefficient in the model.

4. Data

In preparation for an estimation of the trade creation and diversion effects for Peru of the bilateral FTA with the United States, I use a panel data model that considers the bilateral exports to and from Peru with 30 trade partners (the United States and 29 control countries) between 2002 and 2018 in 3-year intervals.[7] It is important to mention that the entire dataset is representative because it considers more than 90% of the total Peruvian trade with the world.

The data used to build the dependent variable—exports to and from Peru—have been gathered from Aduanas - Peru (2020) database disaggregated at the 10-digit product level based on HS 2002 classification and measured in US$ millions.

In case of time-invariant variables, such as distance, contiguity and common language were taken from CEPII (2020) database for gravity models.

The dummy variables were based on the information of the Peruvian Free Trade Agreement. Moreover, the classification of goods follows the UNCTAD Standard Product Groups at six-digit goods found in World Integrated Trade System (WITS, 2020): group 1 (raw materials and intermediate goods) and group 2 (consumer and capital goods) that differ in the degree of the production stage, while the first group is related to inputs, the second groups is based on final goods.

A complete summary of the variables used in this research will be found in Appendix C.

5. Results

The first and second estimation (columns 1 and 2 of Table 2), based on equation (3) in Section 3.2, consider theoretical multilateral resistance terms as country-time fixed effects for importers and exporters but do not include country pair fixed effects.

The first column of Table 2 estimates the gravity equation using the OLS method that drops an important quantity of observations since OLS does not handle zero values of trade. Variables such as distance show a negative and statistically significant coefficient according to the empirical literature. Trade costs, in terms of geographical costs, affect exports levels in the Peru-United States FTA framework. Regarding the results associated with the three variables of interest, each shows negative and statistically significant effects at 1%.

The second column differs from the first one in terms of the estimation method used. In this case, the PPML method tries to solve some problems related to the previous zero trade exclusion and the existence of heteroscedasticity. In terms of time-invariant variables, as the

[7] Olivero and Yotov (2012), considering Cheng and Wall's (2005) criticism, recommend that panel data should be estimated considering time intervals instead of pooled data to allow adjustment in trade flows and other variables in response to trade policy.

Table 2
Estimates of gravity equations.

Dependent variable: X_{ijtp}					
		Complete sample		Group 1	Group 2
Columns	(1)	(2)	(3)	(4)	(5)
Estimation Method	OLS	PPML	PPML	PPML	PPML
Gravity Model	Augmented	Augmented	Augmented	Augmented	Augmented
$\ln Dist_{ij}$	-0.299***(0.00)	-1.115***(0.00)	Omitted	Omitted	Omitted
$Lang_{ij}$	-0.284***(0.00)	-0.356***(0.00)	Omitted	Omitted	Omitted
$Border_{ij}$	-0.904***(0.00)	-1.629***(0.00)	Omitted	Omitted	Omitted
$\boldsymbol{Intra_{ijtp}}$	-0.294***(0.00)	-2.859***(0.00)	0.326***(0.00)	1.199***(0.00)	0.937***(0.00)
$\boldsymbol{Exp_{ijtp}}$	-0.315***(0.01)	-6.028***(0.00)	-0.697***(0.00)	1.385***(0.00)	-0.024***(0.00)
$\boldsymbol{Imp_{ijtp}}$	-0.747***(0.00)	-3.268***(0.00)	-4.138***(0.00)	1.121***(0.00)	0.193***(0.00)
Constant	10.820***(0.01)	6.465***(0.00)	-2.379***(0.00)	-10.967***(0.00)	-8.857***(0.00)
Obs.	410,366	2,335,407	2,335,407	1,123,814	1,198,488
Country Pair F.E.	No	No	Yes	Yes	Yes
Importer-Time F.E.	Yes	Yes	Yes	Yes	Yes
Exporter-Time F.E.	Yes	Yes	Yes	Yes	Yes
R2	0.09	0.59	0.59	0.72	0.39

Note: Standard Errors in parenthesis. ***, **, and * significant at the 1%, 5% and 10%, respectively. Fixed effects (country pair, exporter-time and importer-time) are not reported in this table.
OLS: Ordinary Least Squares; PPML: Poisson Pseudo-Maximum-Likelihood; F.E: Fixed Effects.

previous estimation, results are the same in terms of signs (negative and statistically significant). In overall, the results are extremely different from the first column when variables of interest are analysed.

Both (1) and (2) columns in Table 2 display results affected by the omitted variable bias in the sense that it is not included the bilateral time-invariant fixed effect for measuring the coefficients of interest following an adequate econometric specification.

In the third column of Table 2, a correct and advisable econometric specification (equation (4) in Section 3.2) adding country-time and bilateral fixed effects is estimated using PPML method. This estimation uses the complete sample (without differencing by groups of products) in a panel data with 3-year intervals. Marginal effects from this estimation are shown in the column (1) of Table 3.

Particularly, the three coefficients of interest are statistically significant at 1%. In regards to the first variable *Intra*, the bilateral trade between Peru and United States—intra-regional trade creation—, considering the use of 10-digit product level as part of the database, was 38.5%, on average, above than natural levels of trade in the case that this FTA had never been signed. The second variable *Exp* shows the existence of export diversion that reduced the levels of trade with the rest of the world to change the destination to the United States due to tariff reductions and liberalization from others topics, such as non-tariff measures: the effect was approximately 50.2%. Finally, in terms of the variable *Imp*, 98.4% of new imports produced by Peru and United States were based on the changes of the origin of imports from the rest of the world (or control countries). Considering these results, with the entire sample, the Peru-United States FTA shows significant creation and diversion effects that contribute to the bilateral trade numbers in a

Table 3

Marginal effects of the estimates of gravity equations.

Dependent variable: X_{ijtp}			
	Complete sample	Group 1	Group 2
Columns	(1)	(2)	(3)
Estimation Method	PPML	PPML	PPML
Gravity Model	Augmented	Augmented	Augmented
$\boldsymbol{Intra_{ijtp}}$	38.5%***	231.7%***	155.2%***
$\boldsymbol{Exp_{ijtp}}$	-50.2%***	299.5%***	-2.4%***
$\boldsymbol{Imp_{ijtp}}$	-98.4%***	206.8%***	21.3%***
Obs.	2,335,407	1,123,814	1,198,488
Country Pair F.E.	Yes	Yes	Yes
Importer-Time F.E.	Yes	Yes	Yes
Exporter-Time F.E.	Yes	Yes	Yes

Note: Standard Errors in parenthesis. ***, **, and * significant at the 1%, 5% and 10%, respectively. OLS: Ordinary Least Squares; PPML: Poisson Pseudo-Maximum-Likelihood; F.E: Fixed Effects.

positive trend.

In terms of the analysis by products taking into consideration the groups previously defined (group 1: raw materials and intermediate goods, and group 2: consumer goods and capital goods), results reveal that when disaggregated data is used, estimated coefficients differs from the entire sample outcomes.

Regarding group 1 "raw materials and intermediate goods", there are positive and statistically significant coefficients in the three variables of interest. For intra-bloc trade, it is shown that the bilateral trade among FTA members increased, on average, more than 231.7% for goods at this group, in comparison with the situation without the FTA. Moreover, in the case of Exp, export flows from the trading bloc to non-bloc countries were boosted, on average, 299.5% at the product level. Finally, for variable Imp, the coefficient reported an expansion of the member bloc's imports from countries that are not part of the FTA, on average, of 206.8%. Taking into consideration the methodology, it was identified the existence of intra-bloc trade creation, export and import trade creation that are related with a net-trade creation agreement in terms of goods related to inputs for production activities.

Some products that are considered and contributed with the great performance of the Free Trade Agreement in this group are seafood, pacific sardines, tunas, some vegetables and fruits for processing products that are part of the non-traditional sector of Peruvian exports, cotton, raw minerals, and inputs based on minerals for manufacturing. These kinds of products, with exception of raw minerals, were part of the liberalizing offer in the negotiation process to confirm the access to the American market, as could be noticed in the increase of trade between two members.

For group 2 "consumer and capital goods", the three dummy coefficients of interest were statistically significant at the 1%. In terms of the $Intra$ variable, trade between members of the FTA has enhanced, on average, 155.2% compared with the situation without FTA. This

result is based on the results of the other variables: *Exp* showed diverted export flows from the rest of the world to the United States explained by the reduction of transport costs and tariffs in this kind of products (-2.4%, in average at the product level). For *Imp*, import trade creation was identified in terms that the imports from the rest of the world continued increasing despite the bilateral trade agreement with the United States, this will be associated to the sign of other FTAs with important exporters of this kind of groups, such as China, the top exporter in manufactured goods considered in this group: cell phones, computers, medicines, textiles, radios, electric conductors, among others.

It is important to consider that those results should be analysed as average effects of FTA at the product-level trade flows as were used in the sample. Besides, some literature showed that the use of disaggregated data at the product level leads to higher magnitudes of effects in comparison to the aggregated data of trade, such as presented by Gauto (2012) or Urata and Okabe (2007, 2014).

Finally, in comparison to previous ex-ante studies related to the effects of Peru-USA FTA, the results of the entire sample showed the evidence of export and import trade creation effects as were expected by the three above-mentioned studies of Durán et al. (2007), Morón (2005) and Tello (2004). However, at the sectoral level, those ex-ante studies estimated trade diversion effects. An important critique on the ex-ante studies is that this kind of methodologies does not account for Peruvian FTA with other countries, such as China or the European Union entered into force in 2010 and 2013, respectively, that nowadays are important Peruvian trade partners. In that sense, those new ambitious agreements in terms of goods liberalization and other changes in the Peruvian trade patterns (such as reductions in trade costs or elimination of non-tariff barriers) contributes with the obtention of extra-bloc trade creation (in exports and imports) effects in group 1 and group 2, with exception of the lower trade creation effect in exports of the group 2 (2.4%).

6. Conclusions and Policy Recommendations

The Peru-United States FTA has become one of the main pillars of the Peruvian trade policy. Throughout this study, a broad literature that studied ex-post effects of trade agreements around the world were developed, especially in case of trade creation and diversion effects. For this reason, the current research is aimed to contribute with the measuring of the effects of this particular trade agreement and showing the first evidence in the study of these effects for Peruvian FTAs, through the use of disaggregated data (10-digit for Peruvian subheadings).

The chosen methodology was developed by Carrere (2006), MacPhee and Sattayanuwat (2014), and Yang and Martínez-Zarzoso (2014). This research is focused on analysing the effects of interest in terms of an overall effect and differentiate by different types of goods (group 1: raw materials and intermediate groups, and group 2: consumer and capital goods) that differs in the sense of the degree of production stage.

Moreover, the augmented gravity equation was used as a theoretical framework that considers solutions for typical problems related to the application of trade data in the measure of FTA

effects, such as the heteroscedasticity of trade flows, endogeneity of trade policy, inclusion of multilateral resistance terms in the econometric specification, the use of zero trade flows, among others. It is proposed a three-dummy methodology for a sample of exports at the 10-digit product level for a period between 2002 and 2018 in 3-year intervals for panel data with exporter-time, importer-time and bilateral fixed effects for a correct specification. Furthermore, to estimate different specifications of the model, Santos Silva and Tenreyro's (2006) PPML method is used.

In regards to the results of this study, following the estimations with the complete and sectorial samples, the Peru-United States FTA shows an overall positive trade effect in terms of trade creation effects for the bilateral relationship. The correct specification with all the sample shows that the Peru-United States trade increased by 38.5% more than a non-FTA situation. In the same line, the group 1 (raw materials and intermediate goods) accounted for the largest effects with 231.7% and group 2 (consumer and capital goods) with 155.2% more trade than the non-FTA situation. These positive results are mainly based on the reductions of trade costs, tariff and non-tariff measures between countries due to the liberalization process. Other effects from this FTA to the Peruvian performance with the rest of the world showed that in some cases create trade, such as more exports of "raw materials and intermediate goods" (an export trade creation effect) and incentive imports of both types of goods from the rest of the world (import trade creation effects on disaggregated estimations). However, it is also important to mention that the Peru-USA FTA led to deviations of imports in terms of destination: some products that were bought from other countries, now are imported from the United States due to preferential access to imported goods (import trade diversion).

Given those results, it is fundamental to discuss some policy recommendations to maintain or boost the trade flows between Peru and the United States taking advantage of this preferential agreement and future agreements that will be negotiated.

First of all, it is necessary to continue adopting these schemes of bilateral liberalization for expanding the Peruvian trade flows. Particularly, enterprises are favoured with market access to export their goods and import cheaper inputs for production activities. Considering these positive externalities, the Peruvian government should focus its policies to support different enterprises to reach high levels of competitiveness to compete against local and foreign firms in the American market. The more competitive a firm is, the larger positive effect from trade preferences will be. This positive effect will be reflected in the overall FTA effect on trade flows.

Second, considering the advantages of preferential treatment, Peru should develop a strategy focused on the impulse of firms' participation in different global value chains. In this study, it was identified significant results in terms of trade creation at the group of "raw materials and intermediate groups"; however, it will be important to settle a structural plan to keep trade flows constantly and not only sporadic and intermittent trade. For example, United States, as an important manufacturer in the world, need inputs for production of different goods, in that sense, more direct contracts between Peruvian and American enterprises are needed to ensure trade flows. In this task, the trade promotion office in Peru has a prominent role.

The results show that intra-bloc trade creation in "consumer and capital goods" was lower than "raw materials and intermediate goods" group. This result will be based on the Peruvian

production and export structure that is focused on lower value-added products, such as "raw materials and intermediate goods". In that sense, the negotiation of other chapters, such as investment issues, will contribute to the liberalization of that sector to become an attractive destination for American enterprises' investment that could establish some stages of its production system in Peruvian territory. These steps could benefit our country in the sense of stimulating the production of mid-high and high value-added goods that are part of the "consumer and capital goods" group.

Despite that this research is focused on the FTA effects on trade of goods, other negotiated chapters in the agreement, such as trade facilitation, services, e-commerce, intellectual property rights, labour and environmental issues could lead to the increase of these trade flows. Nowadays, there are minor efforts in terms of quantifying the effects of these provisions on trade, for that reason, it is advisable to continue expanding these assessments and methodologies to capture transversal effects different from tariffs matters.

Finally, from an institutional view, all these policies and initiatives should be settled under an intersectoral framework that allows the adequate development of trade policy and flows. It is well-known that if enterprises want to export goods, first they have to produce. In that sense, productive policies should take into consideration the evolution of international demand for goods and the capacity of Peruvian enterprises for access to other markets to create sustainable internationalized enterprises. For example, initiatives such as National Strategic Export Plan 2025 and the National Plan for Productive Diversification should be oriented through the increase of their goods' productivity and competitiveness, and the diversification of production and trade goods and exports destinations.

These policies recommendations highlight the idea that FTAs are not "the solution for all the problems", but these agreements should be treated as tools that should be an impulse in parallel with other transversal policies (infrastructure and productive investment, trade facilitation, among others) to obtain the best results from these preferential schemes.

Appendix A - Information about Peru-United States Free Trade Agreement

Taking into account reports about Peru-United States FTA (MINCETUR, 2014), we can observe that 60% of the products negotiated (6,417 tariff lines) have been liberalized by the United States to favour the Peruvian exports with immediate access (with a tariff of 0%). Then, category F (which was 100% free of tariffs with the previous preferential processes among those countries) represents 38% of the negotiated tariff line universe. In addition, it should be noted that 10,634 negotiated tariff lines represent 99.5% of the existing American total lines at the 8-digit level. Among the goods that fall into the category of immediate access (A) are birds (chickens, ducks, turkeys), frozen fish meat, salmon, crab meat, some dairy products (cream, milk, cheese, and butter), belts for plastics machinery or with textile bras, cotton for garments, clothing (t-shirts and hand-woven sweaters), steel, iron, aluminium, titanium, zinc, among others. In case of category B, there are found only three tariff lines that are related to wool products, and finally, in category Q there are only four tariff lines that are part of the group of dairy products.

Table A.1

Tariff elimination categories - United States.

Category	N° Tariff lines	Share
Immediate Access	6,417	60%
B (2 years)	3	0%
C (10 years)	21	0%
D (15 years)	51	0%
Q (17 years)	4	0%
Quotas	129	1%
F	3,991	38%
R	1	0%
S	17	0%
Total	**10,634**	**100%**

Source: Peru-United States FTA.

Referring to the Peruvian tariff elimination schedule, it can be indicated that 5,590 tariff lines have had immediate access, representing 76% of products negotiated under the Peruvian tariff universe for American exports. Then category B (which registers 5 years for full liberalization) registered 12% of participation in total tariff lines. Taking into account the categories C and D, there are 634 and 20 tariff lines, respectively. In the case of the category C stand out: Edible flour and powder, corn flour, almond oil, clays, tapioca, unsprayed cement, soaps, gunpowder, explosives, plates, and sheets of plastics for cellular, boxes, hides and skins of goats, bricks, mirrors and glasses. In the case of category D, bovine meat is highlighted. Unlike the American schedule, in Peruvian case, there are more tariff elimination categories (15), which would reflect the sensitiveness of some Peruvian products that need more time to strengthen and increase their competitiveness, which would allow Peruvian industries to compete, on equal terms, with American producers. Moreover, continuing with the analysis of the Peruvian supply, the FTA would continue to allow Peru to apply a special agricultural safeguard for 36 sensitive products, including mild, cheese, meat bovine and rice.

Table A.2
Tariff elimination categories - Peru.

Category	N° Tariff lines	Share
A (Immediate Access)	5,590	76%
B (5 years)	864	12%
C (10 years)	634	9%
D (15 years)	20	0%
F	126	2%
G (2 years)	4	0%
H (3 years)	12	0%
J	1	0%
K (7 years)	56	1%
L (8 years)	11	0%
M (9 years)	1	0%
N (12 years)	3	0%
17 + 10 years	22	0%
17 + 4 years	4	0%
Quotas	12	0%
Total	**7,360**	**100%**

Source: Peru-United States FTA.

Appendix B - Selected Trading Partners

In this study, there were used 30 countries (the United States and control countries), which were the main Peruvian trading partners in 2008.

Table B.1
Selected trading partners.

United States	Rep. of Korea
China	Netherlands (*)
Switzerland	Taiwan
Brazil	Angola
Japan	India
Chile	Bolivia
Canada	Panama
Ecuador	United Kingdom (*)
Colombia	Belgium (*)
Germany (*)	France (*)
Italy (*)	Finland (*)
Argentina	Sweden (*)
Mexico	Thailand
Venezuela	Russian Federation
Spain (*)	Paraguay

Notes: Ordered by importance of trade partner for Peru.
European Union countries are identified with the use of (*).

Appendix C - Variables

Table C.1

Variables.

Variable	Definition	(+/−)	Source
X_{ijtp}	Bilateral Exports, in US$ million (2002–2018)		Aduanas - Peru (2020)
$Dist_{ij}$	Distance from capital city (country i) to capital city (country j), in logarithms (kms.)	−	CEPII (2020)
$ComLang_{ij}$	Common language between countries i and j. 1 if both countries have the common language, 0 otherwise.	+	CEPII (2020)
$Contig_{ij}$	Common border. 1 if i and j share the same frontier; 0 otherwise.	+	CEPII (2020)
$Intra_{ijtp}$	1 if countries i and j are members of Peru-USA FTA for year t=[2009,2015], 0 otherwise.	+/−	Own elaboration
Imp_{ijtp}	1 if importer j is member of Peru-USA FTA, but not the exporting partner i since 2009, 0 otherwise.	+/−	Own elaboration
Exp_{ijtp}	1 if exporter i is member of Peru-USA FTA, but not the importing partner j since 2009, 0 otherwise.	+/−	Own elaboration

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