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Impacts of Bilateral Trade Agreements between the United States and Latin American Countries on Agri-Food Trade

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Between 2004 and 2012, the United States enacted bilateral trade agreements with Chile, Peru, Panama, and Colombia. Using bilateral trade panel datasets of agri-food commodities, we estimate a structural gravity model to analyze the trade creation and trade diversion effects of these agreements. The agreements resulted in substantial increases in intramember trade for aggregate agri-food trade among member countries, ranging from 53.73% for the Chilean agreement to 354.03% for the Peruvian agreement. Substantial heterogeneity exists when the aggregate commodity is disaggregated and when US exports to and imports from the four Latin American countries are considered.

Key words: gravity, Poisson pseudo maximum likelihood, trade creation, trade diversion

Introduction

With the continued stall of the World Trade Organization's Doha Development Round, which was originally launched in 2001, many countries have relied on bilateral and multilateral trade agreements to expand access to international markets. Between 2004 and 2012, the United States signed bilateral trade agreements (BTAs) with four Latin American countries: Colombia, Panama, Chile, and Peru. In 2012, when both the Colombia BTA and the Panama BTA came into force, over half of all agricultural exports became duty-free, with the remaining tariffs and other trade barriers phased out over 15 years (Office of the US Trade Representative, 2011a). The Chile BTA entered into force at the start of 2004 and all qualifying products were duty-free as of January 2015. An important focus of this agreement was to expand access to agricultural products such as pork, beef, wheat, and processed food items. In early 2009, the Peru BTA entered into force when over two-thirds of agricultural commodities became duty-free, with the remaining tariffs on the majority of agricultural commodities phased out over the next 15 years.

Trade creation and trade diversion are well-known phenomena of bilateral agreements. Trade creation can lead to improved efficiency as production shifts from high- to low-cost producers. However, a primary concern of BTAs is the possibility of trade diversion, where high-cost producers within the agreement replace low-cost nonmember producers. Though tariff reduction is central to these trade agreements, the extent of liberalization and phase-out periods varies. Also, while these agreements target and reduce nontariff measures (NTM), tariff reduction can cause the unintended consequence of governments shifting to sanitary and phytosanitary measures (SPS) to protect

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domestic producers (Orefice, 2017). Thus, whether a bilateral agreement leads to trade creation or trade diversion effects and the extent of these effects is an empirical question. This study analyzes the trade creation and trade diversion impacts of these four bilateral agreements on agri-food trade at various levels of aggregation: an aggregate commodity, two broad agri-food commodities (primary agricultural and processed food), and highly disaggregated commodities.[1] With tariff phase-out periods of 15 years or more and firms having a lagged response to the change in market conditions from trade liberalization, this study also considers the dynamic trade creation and trade diversion effects of these BTAs.

Using the gravity equation, this study quantifies the impacts of the four US–Latin American BTAs on intramember trade and members' imports and exports with nonmember countries. Anderson and van Wincoop (2003) revolutionized applied gravity analyses by showing the importance of inward and outward multilateral resistance terms for theoretically consistent estimates. Subsequently, the gravity literature has also developed methods to address sample selection bias due to zeros in trade data, heteroskedasticity bias in log-linear regressions, and endogeneity bias due to potential reverse causality. In an influential study, Santos Silva and Tenreyro (2006) show that log-linear gravity models often suffer from heteroskedasticity and, because of Jensen's inequality, heteroskedasticity in log-linear estimations leads to both bias and inconsistent parameter estimates. To address heteroskedasticity bias, Santos Silva and Tenreyro (2006) propose the Poisson pseudo-maximum likelihood (PPML) estimator, which also allows for zero trade flows and simultaneously addresses sample selection bias.[2] Gravity analyses of free trade agreements (FTA) have been plagued with endogeneity issues due to potential reverse causality between higher trade volumes and FTAs, as countries might establish an FTA because of existing higher levels of trade. Unobservable linkages between countries could also lead to higher trade and increase the probability of a BTA. The trade literature has established that these endogeneity issues lead to the underestimation of trade policies (Trefler, 1993; Lee and Swagel, 1997; Yotov et al., 2016). A well-established method for addressing endogeneity is to account for unobservable links by estimating gravity equations with a robust set of country-pair, importer-time, and exporter-time fixed effects (Magee, 2003; Baier and Bergstrand, 2007; Sun and Reed, 2010; Egger and Nigai, 2015). In addition to addressing the endogeneity issues, country-pair, importer-time, and exporter-time fixed effects are required for theoretically consistent gravity model estimation (Yotov et al., 2016). This literature is central to the estimation strategy of this study.

The agricultural trade literature has investigated the impacts of trade policies and regional trade agreements on agricultural trade. For instance, Zahniser et al. (2002) examine the impacts of the Southern Common Market (MERCOSUR) and the North American Free Trade Agreement (NAFTA) on US agricultural exports for the 1980–1999 period using a Tobit regression to include zero trade flows and incorporating time and importing country fixed effects. The results show that the Regional Trade Agreements (RTAs) do benefit US agricultural exports, though without country-pair fixed effects the results are likely biased. Using log-linear models with country-pair and country-time fixed effects, Grant and Lambert (2008) find differential impacts of RTAs (NAFTA, European Union [EU], MERCOSUR, Andean Pact, Association of Southeast Asian Nations [ASEAN], and the Australia–New Zealand Closer Economic Relations Trade Agreement) for agricultural versus nonagricultural sectors. On average, the RTAs increase trade for the agricultural sector by as much as 72% compared to only 27% for nonagricultural sectors. Koo, Kennedy, and Skripnitchenko (2006) and Lambert and McKoy (2009) implement traditional log-linear gravity model with standard friction variables (e.g., gross domestic product, distance, population, land, currency) without any fixed effects. Their results indicate that, in general, multilateral trade agreements (i.e., ASEAN Free Trade Agreement, Andean Community, EU, MERCOSUR, NAFTA) have a positive and statistically significant impact on trade. Implementing a log-linear gravity model with exporting and importing

[1] Table 1 lists the commodities.

[2] In addition to developing a gravity model to account for firm-level heterogeneity, Helpman, Melitz, and Rubinstein (2008) use the Heckman sample selection approach to address bias due to omitted zeros in log-linear gravity models.

regional fixed effects, Sarker and Jayasinghe (2007) and Jayasinghe and Sarker (2008) examine, respectively, the impact of the European Union and NAFTA on agri-food trade. The results show that intramember trade increased at the expense of trade with the rest of the world. However, the above studies suffer from heteroskedasticity bias in the log-linear cases, endogeneity bias in the cases without country-pair fixed effect, or both.

Using the PPML estimation method and country-pair, importer-time, and exporter-time fixed effects to account for endogeneity, Sun and Reed (2010) examine the trade creation and trade diversion effects of the ASEAN–China (ASEAN–China), 15-nation European Union (EU-15), 25-nation European Union (EU-25), and Southern African Development Community (SADC) multilateral agreements. Their results reveal that PPML is preferred to ordinary least squares (OLS) and that the impacts of FTAs on agricultural trade depend on whether zero trade flows are included in the model. Furthermore, all four agreements expand intramember trade. However, the impact on trade with nonmember countries was mixed. For example, EU-15 resulted in export and import diversion, NAFTA caused only export diversion, and SADC enhanced exports to nonmember countries.[3]

The agricultural trade literature has also examined the impacts of NTM, SPS measures, and tariff reduction independent of trade agreements. For example, Disdier, Fontagné, and Mimouni (2008) examine the impact of SPS and technical barriers to trade on agricultural trade within the context of World Trade Organization (WTO) rules. Utilizing a log-linear gravity model with importer and exporter fixed effects, the results reveal that these measures hamper developing countries' exports to OECD (Organisation for Economic Co-Operation and Development) countries but do not impact trade within the OECD. Raimondi and Olper (2011) implement PPML estimation with exporter, importer, and industry fixed effects to analyze tariff reduction of developing and developed countries' agricultural trade. As expected, the results indicate that tariff reduction expands agricultural trade and that PPML generates lower tariff effect (-1.158) compared to OLS (-1.557), a Heckman sample selection model (-1.577), and the Eaton–Tamura Tobit approach (-1.422). Grant, Peterson, and Ramniceanu (2015) study the effects of foreign SPS measures on US exports of fresh fruit and vegetables. Implementing the PPML method with year, country, and commodity fixed effects, their gravity results show that, while SPS measures lower trade, the trade-reduction effect of heightened SPS barriers is eliminated after 2–3 years as exporters become adept at implementing the SPS measures. This provides evidence of a delayed impact of NTM on trade. The current study builds on this literature by considering the simultaneous impact of tariff reduction and alignment of NTMs through BTAs.

To the best of our knowledge, no previous study has conducted detailed structural gravity analyses of the *ex post* impacts of the four US–Latin American BTAs enacted between 2004 and 2012 on agri-food trade. To achieve this goal, this study implements a structural gravity model of agri-food trade based on the PPML estimator to deal with heteroskedasticity and zero trade observations and a robust set of fixed-effects (bilateral country-pair, importer, export, and time) to mitigate endogeneity bias. This study contributes to the agricultural trade literature in two key ways. First, it provides a detailed analysis of the static and dynamic trade creation and trade diversion effects on aggregate food trade of the bilateral agreements that the United States enacted with Colombia, Panama, Chile, and Peru between 2004 and 2012. Second, it examines heterogeneity in the effects of these four trade agreements on several dimensions: (i) a two-commodity model where food trade split into agricultural commodities and processed food products, (ii) a two-commodity model that separates US exports to and US imports from the four Latin American countries, and (iii) the impact of the four agreements at the individual commodity level.

[3] Several studies have also implemented computable general equilibrium models to perform *ex ante* analyses of multilateral and bilateral agreements (Brown, Deardorff, and Stern, 2000; Harrison, Rutherford, and Tarr, 2002; Brown, Deardorff, and Stern, 2003). The current study differs by performing *ex post* analysis of bilateral agreements.

US–Latin American BTA

The trade agreements between the United States and Colombia, Panama, Chile, and Peru enhanced market access for US farmers and food processors in these countries. The Colombia BTA and Peru BTA primarily pertained to US agricultural exports to Colombia and Peru because of the Andean Trade Preference Act (ATPA),[4] enacted in 1991, reduced or eliminated tariffs that the United States imposed on eligible agricultural commodities (e.g., flowers, fruits, vegetables) from Bolivia, Colombia, Ecuador, and Peru (US Customs and Border Patrol, 2020). Of the total US imports from these four countries, ATPA impacted only $699.0 million, just 10% of the value of imports between 1995 and 1999 (Congressional Research Service, 2002). Therefore, ATPA gave duty-free access to a relatively small proportion of trade, and trade liberalization under the Colombia BTA and the Peru BTA could have far-reaching benefits. With the enactment of these bilateral agreements, Colombia and Peru were removed from ATPA eligibility in 2010 and 2012, respectively. In 2010, before the enactment of the Colombia BTA, US exports to Colombia were the second highest in South America at $832 million, with wheat, corn, cotton, soybeans, and corn gluten feed topping the list (Office of the US Trade Representative, 2011b). US products that became duty-free with the enactment of the agreement include wheat, barley, soybeans, soybean meal and flour, high-quality beef, bacon, fruits, vegetables, peanuts, whey, cotton, and most processed foods. Tariff-rate quotas (TRQs) were implemented on certain US products (e.g., standard grade beef cuts, chicken leg quarters, pork, corn, sorghum, animal feeds, rice, soybean oil, dairy products). A far-reaching NTM of this agreement was providing US exporters "equal or preferential treatment vis-à-vis third-party competitors" on important agricultural products (Office of the US Trade Representative, 2011b). Furthermore, the agreement aligned and eliminated unnecessary technical barriers to trade and created a standing committee for addressing SPS measures (Organization of American States, 2021).

The United States is Peru's largest single-country trading partner, accounting for approximately 29% of Peru's exports and imports. Before the BTA, just over 20% of Peruvian products entered the United States duty-free and less than 10% of US products entered Peru duty-free. After the 2012 enactment of the Peru BTA, these numbers jumped to about 90% and 56%, respectively (see Figure 2-1, US International Trade Commission, 2006). After the 17-year tariff reduction period ends, 90% of all agricultural products (combined US and Peru) will be duty-free. A small percentage of tariffs were removed over a 10- to 17-year period, including 56 agricultural tariff lines imposed by the United States[5] and 78 tariff lines imposed by Peru.[6] In addition to tariffs, the BTA also reduced NTMs that impede agricultural trade with Peru, including local-content requirements, variable levies, price stabilization mechanisms, and SPS measures (Organization of American States, 2021). Important agricultural commodities for US–Peruvian trade include wheat, paper, cotton, fertilizers, rubber, corn, animal and vegetable fats, and oils. Sugar duties are excluded from the Peru BTA and the chicken trade was reviewed 9 years after enactment.

Exports from the United State are of particular importance for Panama due to the Panama Canal's strategic location as a major shipping route and proximity to the United States: Around two-thirds of ships that go through the canal are headed to or from US ports (Office of the US Trade Representative, 2011a). US exports doubled, from about $225 million to $550 million, in the 5 years prior to the enactment of the Panama BTA in October 2012 (Office of the US Trade Representative, 2011c). This BTA primarily benefits US agricultural producers because over 99% of Panamanian agricultural products already enter the US market duty-free due to the Caribbean Basin Initiative (CBI). Before the Panama BTA, fewer than 40% of US products entered Panama duty-free, with an average tariff of 15%, but with some tariffs as high as 260% (Office of the US Trade Representative,

[4] The ATPA was enacted to help mitigate drug production and trafficking in Bolivia, Colombia, Ecuador and Peru by enhancing production and employment in legitimate sectors (US International Trade Commission, 2006).

[5] These 56 tariff lines are from HS chapters 02, 04, 12, and 18–24 (primarily bovine, dairy products, peanuts, cocoa/chocolate, & tobacco).

[6] These 78 tariff lines are from HS chapters 02, 04, 10–12, 15–17, 19–23, 35, 38, 41, 43, and 50–51.

2011c). US products that became duty-free with the enactment of this agreement include high-quality beef, frozen turkeys, soybeans, soybean meal, crude soybean and corn oil, almost all fruit and fruit products, wheat, peanuts, whey, cotton, and many processed products. While the bilateral agreement allows Panama to implement TRQs on standard-grade beef cuts, chicken leg quarters, pork, corn, rice, and dairy products, most will be eliminated after 15 years.[7]

Prior to the implementation of the Chile BTA, US imports from Chile were dominated by agricultural products and tariff rates between the two countries were relatively low due to open market philosophies (US International Trade Commission, 2003).[8] Prior to the Chile BTA, about 14% of US imports from Chile were duty-free. Based on WTO commitments, Chile's tariffs are upper bounded at 25% *ad valorem* on all but a few sensitive agricultural products, which are upper bounded at 31.5% and include dairy products, cereals, wheat gluten, oil seeds, animal and vegetable fats and oils, and animal feed (US International Trade Commission, 2003). However, several commodities (e.g., wheat, wheat flour, edible vegetable oils, sugar) were subject to the price band system, which leads to particularly high (often prohibitive) tariffs for these products. After the Chile BTA entered into force in 2004, 80% of all traded commodities were duty-free and TRQs on all remaining sensitive products were phased out by 2015. Specific to agriculture, avocados, oilseeds, and wheat flour are key Chilean exports, with TRQs that were notched down to 0 over 12 years. A crucial aspect of the agreement was to reduce and align NTMs and SPS impediments (International Trade Administration, 2015). For example, US beef producers gained market access as the agreement aligned health and inspection standards.

With all four Latin American BTAs reducing tariffs and NTMs, implementing gravity methods that consider the reduction of tariffs, NTMs that promote business opportunities, and endogeneity is important to accurately analyze the impacts of these BTAs on agri-food trade.

Gravity Model

We implement a structural gravity model to estimate the trade creation and trade diversion effects of US BTAs with Colombia, Panama, Chile, and Peru. Using a PPML specification to account for both heteroskedasticity and sample selection biases, for each BTA $k \in$ (Colombia BTA, Panama BTA, Chile BTA, Peru BTA) and each commodity level,[9] the gravity equation for the aggregate model is specified as

$$(1) \quad X_{ijt} = \exp\Big(\beta_0^k + \beta_1^k y_{it} + \beta_2^k y_{jt} + \beta_3^k FTA_{ijt}G_{ij} + \beta_4^k B_{ijt}^k G_{ij} + \beta_5^k I_{ijt}^k G_{ij} + \beta_6 E_{ijt}^k G_{ij} + \lambda_{ij} + \lambda_i + \lambda_j + \lambda_t\Big) + \varepsilon_{ijt},$$

where X_{ijt} is the nominal value of agri-food exports from country i to j in time t; βs are coefficients; y_{it} is total value of agri-food production of the exporter; y_{jt} is total value of agri-food consumption by the importer; FTA_{ijt} is an indicator variable that takes the value of 1 if both the importer, j, and exporter, i, are members of an FTA other than one of the four Latin American bilateral agreements, and 0 otherwise; G_{ij} is an indicator variable that takes the value of 1 for domestic sales, and 0

[7] Notable extended TRQs on US products include a 20% tariff on refined soybean oil and a 40% tariff on corn. For these lines, the 15-year phase out period begins 5 years after enactment. Starting 10 years after enactment, a 90% tariff on rice will be phased out over 20 years.

[8] For example, between 2000 and 2016 (the span of the data sample), Chile entered 17 and the United States entered 12 multilateral and bilateral trade agreements. Furthermore, as of 2018, the maximum tariff Chile imposes on any product is 6%, with an trade-weighted average tariff of 0.49% (World Bank, 2021). Although the maximum tariff the United States imposes is 3,000%, the 2018 trade-weighted average tariff is only 1.59%. For comparison, China's trade-weighted average tariff is 3.39%.

[9] To provide a broad picture on how these BTA impacted trade, we consider both an aggregate commodity and heterogeneity across a two-commodity model (primary vs. processed food) and a model for each commodity. For notational simplicity, the commodity subscripts are suppressed.

otherwise; B^k_{ijt} is an indicator variable that takes the value of 1 if both countries, i and j, belong to the same BTA k in period t, and 0 otherwise, I^k_{ijt} is an indicator variable that is 1 if the importing country, j, belongs to bilateral agreement k but the exporting country, i, does not in period t, and 0 otherwise; E^k_{ijt} is an indicator variable that is 1 if the exporting country, i, belongs to bilateral agreement k but the importing country, j, does not in period t, and 0 otherwise; λ_{ij} are country-pair fixed effects; λ_i and λ_j are importer and exporter fixed effects; λ_t is a time fixed effect; and ε_{ijt} is an error term (Sun and Reed, 2010; Bacchetta et al., 2012; Head and Mayer, 2014). To examine heterogeneity across member countries (i.e., directional effects), each of the indicator variables—B^k_{ijt}, I^k_{ijt}, E^k_{ijt}—is divided into two indicator variables based on whether the United States is the exporter or importer.

Recent developments in empirical gravity estimation require a robust set of fixed effects (Yotov et al., 2016). By absorbing unobserved country-pair characteristics (e.g., infrastructure, factor endowments, unobserved country-specific shocks) that are constant over time, country-pair fixed effects address endogeneity in policy variables and capture all variables that vary in the ij dimension, including all standard trade friction variables (e.g., distance, contiguous border, colonial relationship, common currency, common language).[10] Because all of the BTAs start in the middle of our sample, multicollinearity arises between importer-time and exporter-time fixed effects and the policy variables of interest—B_{ijt}, I_{ijt}, and E_{ijt}—which causes convergence issues in the PPML estimators. Consequently, the regressions include total value of agri-food production of the exporter, total value of agri-food consumption by the importer, and importer country, exporting country, and time fixed effects.[11]

With the BTAs phasing out tariffs over a period of time and trade flows taking time to adjust to NTM policy shocks, the gravity equation is modified to account for the phase-in effect (Baier and Bergstrand, 2007; Grant and Lambert, 2008; Sun and Reed, 2010). Specifically, equation (1) is modified as

$$X_{ijt} = \exp\Bigg(\beta_0^k + \beta_1^k y_{it} + \beta_2^k y_{jt} + \beta_3 FTA_{ijt}G_{ij} + \sum_t \beta_{4t} D_t^k B_{ijt}^k G_{ij} + \sum_t \beta_{5t} D_t^k I_{ijt}^k G_{ij} + \sum_t \beta_{6t} D_t^k E_{ijt}^k G_{ij} + \lambda_{ij} + \lambda_i + \lambda_j + \lambda_t\Bigg) + \varepsilon_{ijt}, \tag{2}$$

where D_t^k are indicator variables identifying the year, t, and are specified every 2 years from the start of bilateral agreement k. For instance, for the Peru BTA, D_t^{Peru} are specified as D_{2009}^{Peru}, D_{2011}^{Peru}, D_{2013}^{Peru}, and D_{2015}^{Peru}, which take the value 1 for the year indicated, and 0 otherwise.

Data

Bilateral trade values for 227 countries for the years 2001–2016 are collected from the ITPD-E database published by the US International Trade Commission (Borchert et al., 2020). The dataset is balanced as all missing observations are filled in with zeros. the ITPD-E includes domestic sales data for each commodity, calculated as the (gross) values of total production minus total exports. Because trade flows do not instantaneously adjust BTAs, the data for the static analysis based on equation (1) is in 3-year intervals (2001, 2004, ..., 2013, 2016) (Trefler, 2004; Baier and Bergstrand, 2007; Olivero and Yotov, 2012). The US International Trade Commission also provides data for standard gravity friction variables (e.g., distance, common language, colonial relationship, contiguous border, and FTAs). Domestic production is constructed as domestic sales plus total exports, and domestic consumption is constructed as domestic sales plus total imports.

To provide a broad set of results, the analysis is run at three levels of aggregation: (i) an aggregate agri-food commodity, (ii) agricultural commodities aggregated into to subcategories

[10] For comparison, the results include regressions that drop the country-pair fixed effects and utilize the standard trade friction variables.

[11] The implication is that the multilateral resistance terms are constant over time.

Table 1. List of Commodities

Agricultural Commodity		Processed Food	
Code	**Description**	**Code**	**Description**
1	Wheat	34	Processing/preserving of meat
2	Rice (raw)	35	Processing/preserving of fish
3	Corn	36	Processing/preserving of fruit & vegetable
4	Other cereals	37	Vegetable & animal oils and fats
5	Cereal products	38	Dairy products
6	Soybeans	39	Grain mill products
7	Other oilseeds (excluding peanuts)	40	Starches and starch products
8	Animal feed ingredients and foods	41	Prepared animal feeds
9	Raw and refined sugar	42	Bakery products
10	Other sweeteners	43	Sugar
11	Pulses and legumes, dried, preserved	44	Cocoa chocolate and sugar confectionery
12	Fresh fruit	45	Macaroni noodles & similar products
13	Fresh vegetables	46	Other food products nec
14	Prepared fruits and fruit juices	47	Dist. rectifying & blended spirits
15	Prepared vegetables	48	Wines
16	Nuts	49	Malt liquors and malt
17	Live cattle	50	Soft drinks; mineral waters
18	Live swine	51	Tobacco products
19	Eggs		
20	Other meats, livestock products, etc		
21	Cocoa and cocoa products		
22	Beverages, nec		
23	Cotton		
24	Tobacco leaves and cigarettes		
25	Spices		
26	Other agricultural products, nec		

Notes: Commodity categories are from the ITPD-E database. “Ne” stands for “not elsewhere classified.”

(primary agricultural and processed food), and (iii) all individual commodities. For the aggregate agri-food commodity, all commodities in Table 1 are aggregated into one commodity. The sample for the agri-food commodity contains 309,174 (= 227 × 227 country pairs × 6 years) observations. For the two-commodity model, the agricultural commodities in the first column of Table 1 are aggregated and the processed food commodities in the second column are aggregated. The data for the two-commodity model are stacked to create one large panel dataset that contains 618,348 (= 227 × 227 country pairs × 6 years × 2 commodities) observations. For the individual commodity analysis, each commodity is run separately, implying that each regression has a sample size similar to the aggregate model of 309,174. However, with a very large number of fixed effects and some bilateral trade values very close to others, the regression drops observations to avoid multicollinearity issues.[12] Total observations for each regression are reported in Tables 3–6.

Table 2 provides descriptive statistics of trade values for the two-commodity model for the sample mean, minimum, maximum, and standard deviation and for average trade values before and after the respective BTAs were enacted. Over the full sample, US exports of agricultural products to the four countries range from $193.5 million (Panama) to $407.4 million (Colombia) and US imports range from $95.5 million (Panama) to $1,623.9 million (Chile). US exports of processed food to the four countries range from $141.7 million (Panama) to $810.9 million (Colombia) and US imports range from $31.3 million (Panama) to $1,818.3 million (Chile). Average trade values for both agricultural commodities and processed food increased after the respective trade

[12] The PPML regression is carried out in R using the “femlm” function from the “fixest” package.

Table 2. Descriptive Statistics of Trade Values for the Two-Commodity Model (Millions)

Panel A. Agricultural Commodities

	Full Sample				Subsamples		
	Mean	**Min.**	**Max.**	**Std. Dev.**	**Before**	**After**	**Percentage Change**
US exports to							
Colombia	407.3	97.2	1,112.6	344.0	214.2	870.6	306.4
Panama	193.5	93.1	446.7	112.0	230.5	104.6	−54.6
Chile	249.2	40.0	624.8	232.6	43.4	312.6	620.0
Peru	214.3	62.4	518.7	157.1	88.4	356.0	302.7
US imports from							
Colombia	368.2	212.2	549.0	113.8	319.4	485.2	51.9
Panama	95.5	67.0	130.6	19.8	85.2	120.2	41.1
Chile	1,623.9	770.4	2,754.6	658.2	869.8	1,855.9	113.4
Peru	408.7	66.3	781.1	264.2	193.2	651.0	237.0

Panel B. Processed Food

	Full Sample				Subsamples		
	Mean	**Min.**	**Max.**	**Std. Dev.**	**Before**	**After**	**Percentage Change**
US exports to							
Colombia	810.9	319.9	1,589.7	427.0	661.3	1,169.8	76.9
Panama	141.7	69.6	226.5	55.4	125.2	181.2	44.7
Chile	209.6	53.9	418.6	125.7	87.5	247.1	182.4
Peru	383.8	108.3	844.9	246.0	207.1	582.6	181.3
US imports from							
Colombia	1,624.3	819.4	2,304.8	480.6	1,432.9	2,083.5	45.4
Panama	31.3	17.6	42.3	9.1	34.4	24.0	−30.2
Chile	1,818.3	890.7	2,884.2	620.4	1,010.1	2,067.0	104.6
Peru	700.8	187.8	1,510.1	418.9	384.8	1,056.2	174.5

agreements for Colombia, Chile, and Peru, ranging from a 45.4% increase in US processed food imports from Colombia to a 620.0% increase in US agricultural commodity exports to Chile. However, following the US–Panamanian BTA, although trade expanded by 41.1% for US imports of agricultural commodities and by 44.7% for US processed food exports, average trade values *declined* by 54.5% for US exports of agricultural commodities and by 30.2% for US imports of processed food commodities.

Next, we provide statistics on the main agri-food commodities traded between the United States and the four Latin American countries studied here. In 2016, the top five US exports to Colombia were corn (code 2, $841.33 million), vegetable and animal oils and fats (code 37, $335.04 million), soybeans (code 6, $197.74 million), processed/preserved meat (code 34, $192.43 million), and wheat (code 1, $162.60 million); to Panama were corn (code 2, $97.96 million), distilled, rectified, and blended spirits (code 47, $45.1 million), wheat (code 1, $30.4 million), soybeans (code 34, $ 19.68 million), and fresh fruit (code 12, $14.47 million); to Peru were corn (code 2, $546.71 million), vegetable and animal oils and fats (code 37, $159.60 million), wheat (code 1, $85.4 million), distilled, rectified, and blended spirits (code 47, $81.5 million), and other food products not elsewhere classified (nec) (code 46, $76.17 million); and to Chile were processed/preserved meat (code 34, $174.24 million), corn (code 3, $165.95 million), other food products nec (code 46, $112.81 million), wheat (code 1, $84.5 million), and animal feed ingredients and pet foods (code 8, $66.47 million).

In 2016, the top five US imports from Colombia were beverages (code 22, $1,112.2 million), other agricultural products (code 26, $876.3 million), fresh fruit (code 12, $197 million), other food products (code 46, $156 million), and processed/preserved fish (code 35, $75.6 million); from Panama were processed/preserved fish (code 35, $68.4 million), sugar (code 43, $28.7 million), cocoa, chocolate, and sugar confectionery (code 44, $11.79 million), fresh fruit (code 12, $8.02 million), and beverages (code 22, $7.15 million); from Peru were fresh fruit (code 12, $656.56 million), fresh vegetables (code 13, $434.70 million), processed/preserved fruit & vegetables (code 36, $330.56 million), beverages (code 22, $234.58 million), and processed/preserved fish (code 35, $214.07 million); and from Chile were fresh fruit (code 12, $2,662.77 million), processed/preserved fish (code 35, $1,742.84 million), processed/preserved fruit & vegetables (code 36, $351.76 million), wine (code 48, $314.72 million), and processed/preserved meat (code 34, $182.02 million).

Results

All regressions are estimated using the PPML method and include country-pair, importer, exporter, and time fixed effects, unless otherwise specified. We present and discuss results for both static (equation 1) and dynamic (equation 2) gravity models for the four BTAs. For the static results, we first analyze aggregate agri-food models with standard gravity variables (e.g., distance, common language, colonial relationship, contiguous board) and then with country-pair fixed effects, which absorb the time-invariant bilateral friction variables. Then, we consider heterogeneity in the effects of the trade agreements on several dimensions: (i) a two-commodity model where the categories are split into agricultural commodities and processed food products, (ii) a two-commodity model that separates US exports to and US imports from the specified country, and (iii) the impact of the four BTAs at the individual commodity level. For the dynamic results, we examine how the four agreements impact trade over time for the aggregate and two-commodity models. Positive and significant coefficient estimates for intramember trade (B_{ijt}), nonmember importing (I_{ijt}), and nonmember exporting (E_{ijt}) indicate trade creation, while a positive estimate on B_{ijt} but negative estimates on I_{ijt} and E_{ijt} reveals trade diversion.

Static Results for Aggregate Food Trade

Table 3 reports the parameter estimates and robust standard errors for the two sets of aggregate gravity models for all four US–Latin American BTAs. As seen in Panel A, distance, common language, colonial relationship, production, and consumption all have expected signs and are statistically significant. However, the significant estimated coefficient for contiguous border and other *FTA* conflict with intuition. As established in the literature (Magee, 2003; Baier and Bergstrand, 2007; Sun and Reed, 2010), this model fails to control for unobserved characteristics between importing and exporting countries, causing endogeneity bias. Given the known bias, we refrain from interpreting the results for the Latin American BTAs for this set of regressions.

The second set of regressions Panel B of Table 3 corrects for endogeneity bias by including country-pair fixed effects, which absorb the standard gravity variables. The results reveal that the coefficient estimates for production and consumption are similar to those from the standard gravity (except for the coefficient estimate for consumption for Chile, which is about half the magnitude with country-pair fixed effects). Importantly, after controlling for endogeneity bias, the coefficient estimate on *FTA* is now positive and highly statistically significant, indicating that membership in an FTA increased aggregate agri-food trade by 32.84%–44.20%.[13] This result is comparable to the findings of Grant and Boys (2012), who use the World Bank's Trade, Production, and Protection dataset for the years 1980–2004 to estimate that WTO/GATT (General Agreement on Tariffs and

[13] Percentage changes in bilateral trade flows for indicator variables are calculated as $100 \times (\exp(\beta_n) - 1)$, for $n = 3, 4, 5, 6$.

Table 3. Static Trade Effects of Bilateral Trade Agreements: Aggregate Commodity Model

Panel A. Without Country-Pair Fixed Effect

Variable	Colombia BTA	Panama BTA	Chile BTA	Peru BTA
log(dist)	−1.761***	−1.762***	−1.760***	−1.768***
	(0.072)	(0.072)	(0.073)	(0.072)
Common language	1.234***	1.232***	0.593***	1.226***
	(0.156)	(0.156)	(0.103)	(0.155)
Colonial relationship	1.279***	1.279***	1.287***	1.291***
	(0.160)	(0.160)	(0.161)	(0.159)
Contiguous border	−0.735***	−0.732***	−0.740***	−0.749***
	(0.137)	(0.137)	(0.141)	(0.140)
y_{it}	0.605***	0.610***	0.553***	0.607***
	(0.069)	(0.067)	(0.073)	(0.048)
y_{jt}	0.565***	0.565***	1.233***	0.589***
	(0.039)	(0.038)	(0.155)	(0.063)
FTA	−0.209*	−0.208*	−0.207*	−0.208*
	(0.124)	(0.124)	(0.125)	(0.123)
Intramember trade	0.010	0.556**	0.615**	−0.033
	(0.339)	(0.271)	(0.276)	(0.266)
Nonmember imports	0.797***	0.825***	0.351**	0.733***
	(0.163)	(0.156)	(0.173)	(0.213)
Nonmember exports	0.766***	0.787***	0.275*	0.759***
	(0.124)	(0.113)	(0.148)	(0.248)
Fixed effects: i, j, t	Y	Y	Y	Y
Fixed effect: ij	N	N	N	N
No. of obs.	199,873	199,873	199,873	199,873
Pseudo-R^2	0.961	0.962	0.962	0.963

Panel B. With Country-Pair Fixed Effect

Variable	Colombia BTA	Panama BTA	Chile BTA	Peru BTA
y_{it}	0.609***	0.607***	0.589***	0.617***
	(0.047)	(0.047)	(0.058)	(0.047)
y_{jt}	0.527***	0.530***	0.522***	0.549***
	(0.046)	(0.046)	(0.057)	(0.046)
FTA	0.305***	0.323***	0.366***	0.284***
	(0.043)	(0.044)	(0.045)	(0.045)
Intramember trade	0.912***	0.170	0.430***	1.513***
	(0.105)	(0.174)	(0.105)	(0.068)
Nonmember imports	0.919***	0.923***	0.666***	1.050***
	(0.088)	(0.088)	(0.074)	(0.112)
Nonmember exports	0.790***	0.818***	0.532***	0.949***
	(0.089)	(0.089)	(0.080)	(0.110)
Fixed effects: i, j, t	Y	Y	Y	Y
Fixed effect: ij	Y	Y	Y	Y
No. of obs.	175,297	175,297	175,297	175,297
Pseudo-R^2	0.995	0.993	0.995	0.993

Notes: All regressions are estimated using the Poisson pseudo-maximum likelihood method with country-pair, importer, exporter, and time fixed effects. Values in parentheses are robust standard errors clustered at the country-pair level. Single, double, and triple asterisks (*,**,***) indicate significance at the 10%, 5%, and 1% level, respectively.

Trade) increased aggregate agricultural trade by 39.10% based on the PPML estimation method with time and country-pair fixed effects. The results suggest that the Colombia, Chile, and Peru BTAs led to trade creation, as the estimated coefficients for B_{ijt}, I_{ijt}, and E_{ijt} are positive and highly statistically significant.[14] However, the magnitude varies as the increase in intra-member trade ranges from 53.73% for the Chile BTA to 148.93% for the Colombia BTA and 354.03% for the Peru BTA. Note that with the CBI eliminating tariffs on Panamanian products entering the United States, the coefficient estimate for intramember trade for the Panama BTA is positive but statistically insignificant. For comparison, Sun and Reed (2010) find increases of 41.91%, 71.60%, 56.83%, 166.45% in intramember agricultural trade for the ASEAN-China, EU-15, EU-25, and SADC multilateral agreements, respectively.

Notably, all four US–Latin American BTAs created large gains from trade beyond intramember trade as production shifted to efficient producers. That is, imports from nonmember countries expanded significantly, by 94.64% for the Chile BTA, 150.68% for the Colombia BTA, 151.68% for the Panama BTA, and 185.77% for the Peru BTA. Furthermore, exports to nonmember countries expanded by 94.64% for the Chile BTA, 150.68% for the Colombia BTA, 151.68% for the Panama BTA, and 185.77% for the Peru BTA. These import and export creation effects are substantially larger than those found for the multilateral trade agreement studied in Sun and Reed (2010), who find import creation of only 28.4% for the SADC multilateral agreement, no import creation for ASEAN, Common Market for Eastern and Southern Africa (COMESA), EU-25, and NAFTA multilateral agreements, and a reduction in imports from nonmember countries for the EU-15 FTA. The results in Table 3 show that trade with Peru generally experienced disproportionately large gains. This could occur because, prior to the Peru BTA, only about 20% of Peruvian products and less than 10% of US products were covered under ATPA.

These static results for the aggregate agri-food model provide evidence that these BTAs expanded agri-food trade for both member and nonmember countries. These observed *ex post* benefits are important for agricultural policy makers pursuing future BTAs in Latin American countries.

Static Results for the Two-Commodity Model

As seen in Table 4, the results reveal heterogeneity in the impacts of the BTAs when the aggregate commodity is split into an agricultural commodity and a processed food commodity. First, note that the coefficient estimates for production, consumption, and *FTA* remain positive and significant but are smaller in magnitude compared to those in Panel B of Table 3.

For the agricultural commodity, the Colombia BTA, the Chile BTA, and tge Peru BTA only expanded trade—as seen by the positive and significant coefficient estimate—for intramember trade, B_{ijt}, and imports from nonmember countries, I_{ijt}, because the positive coefficient estimates for exports to nonmember countries, E_{ijt}, is statistically insignificant. Furthermore, the impacts of these three bilateral agreements are less pronounced for the two-commodity model than for the aggregate model. For example, intramember agricultural trade expanded by only 24.35%, 43.91%, 127.28% for the Colombia BTA, the Chile BTA, and the Peru BTA, respectively, compared to 53.73%, 148.93%, 354.03%% in the aggregate model. Also, imports from nonmember countries increased by 43.04%, 44.34%, and 67.87%, respectively, compared to 94.64%, 151.68%, and 185.77% in the aggregate model. For the Panama BTA, the positive and significant coefficient estimate for I_{ijt} indicates that trade increased (by 43.48%) only for imports from nonmember countries.

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[14] While exports from member to nonmember countries can expand as efficient producers' production, and thus exports, expand, we generally expect imports to member countries from nonmember countries to decline as trade costs between member countries decline relative to nonmember countries. Thus, the positive coefficient for E_{ijt} is expected, but the positive coefficient for I_{ijt} does not follow *a priori* expectations. This counterintuitive results is also observed in Sun and Reed (2010), who find that the SADC expanded between-member agricultural trade by 166.4% and imports from nonmember countries by 28.4%.

Table 4. Static Trade Effects of Bilateral Trade Agreements: Two-Commodity Model

Variable	Colombia BTA	Panama BTA	Chile BTA	Peru BTA
y_{it}	0.372***	0.372***	0.361***	0.397***
	(0.053)	(0.053)	(0.051)	(0.055)
y_{jt}	0.193***	0.194***	0.196***	0.186***
	(0.059)	(0.059)	(0.057)	(0.065)
FTA	0.130***	0.133***	0.135***	0.119***
	(0.035)	(0.036)	(0.038)	(0.035)
Agricultural commodities				
Intramember trade	0.218***	0.145	0.364***	0.821***
	(0.083)	(0.148)	(0.078)	(0.175)
Nonmember imports	0.358***	0.361***	0.367***	0.518***
	(0.096)	(0.095)	(0.102)	(0.115)
Nonmember exports	0.107	0.114	0.204	0.201
	(0.126)	(0.128)	(0.131)	(0.157)
Processed food				
Intramember trade	0.721**	−0.610	0.410***	1.144***
	(0.334)	(0.454)	(0.114)	(0.097)
Nonmember imports	0.338***	0.335***	0.365***	0.464***
	(0.089)	(0.090)	(0.088)	(0.112)
Nonmember exports	0.218*	0.238**	0.070	0.243*
	(0.115)	(0.115)	(0.140)	(0.144)
No. of obs.	286,810	286,810	286,810	286,810
Pseudo-R^2	0.993	0.993	0.993	0.993

Notes: All regressions are estimated using the Poisson pseudo-maximum likelihood method with country-pair, importer, exporter, and time fixed effects. Values in parentheses are robust standard errors clustered at the country-pair level. Single, double, and triple asterisks (*,**,***) indicate significance at the 10%, 5%, and 1% level, respectively.

For the processed food commodity, the Colombia BTA and the Peru BTA led to trade creation, as the positive coefficient estimates for intramember trade, B_{ijt}, imports from nonmember countries, I_{ijt}, and exports to nonmember countries, E_{ijt}, are all statistically significant. In addition, intramember trade, imports from nonmember countries, and exports to nonmember countries increased by 105.65%, 47.40%, and 24.36% for the Colombia BTA and by 213.93%, 59.04%, and 27.51% for the Peru BTA. For the Panama BTA, the coefficient estimate for intramember trade is insignificant, while the positive and significant estimates for I_{ijt} and E_{ijt} indicate that imports from nonmember countries increased by 39.79% and exports to nonmember countries rose by 26.87%. Therefore, as with the aggregate model, the Panama BTA increased processed food trade only with outside countries.

The insignificance of intramember trade could be explained by the fact that, prior to the Panama BTA, over 99% of Panamanian agricultural products entered the US market duty-free because of the CBI and the reduction of the average tariff of 15% on US products entering Panama did not result in a statistically significant estimate. Therefore, even with small average tariff reductions and no intramember trade, this BTA resulted in trade creation, as resources are allocated more efficiently. For the Chile BTA, as with agricultural trade, the results indicate trade expanded only for intramember trade (50.68%) and imports from nonmember countries (44.05%), as the coefficient estimates for these variables are positive and significant; however, the coefficient estimate for exports to nonmember countries is positive but statistically insignificant. Again, the impacts of the BTA for processed food are less pronounced for the two-commodity model than for the aggregate model.

The results from Panel B of Table 3 and Table 4 indicate that when agricultural and processed food commodities are aggregated into a single agri-food commodity, the BTA's impacts are generally larger and differential impacts between the two classes of commodities are masked. In summary, although statistical significance is lost for agricultural exports to nonmember countries, the results for the two-commodity model show that US, Colombian, Panamanian, Chilean, and Peruvian consumers, farmers, and food producers still benefit greatly from these bilateral agreements.

Table 5 reports the differential impacts of these four BTAs on agricultural and processed food trade by distinguishing between the direction of trade (i.e., US exports to and imports from the member country). The results reveal additional heterogeneity on the impacts of these BTA based on the direction of trade. The coefficient estimates for production and consumption reported in Table 5 are generally in between those from Panel B of Table 3 and Table 4, while the coefficient estimates for *FTA* are similar to those in Table 4 and are highly statistically significant.

For the agricultural commodity, US exports to and imports from Colombia, Chile, and Peru rose. Thus, even though the US–Chilean trade already had low tariffs and Colombian and Peruvian agricultural products entering the United States faced low duties because of ATPA, the additional tariff reductions and enhanced market access through NTMs resulted in trade expansion in both directions. However, US exports to and imports from Panama declined. This unexpected finding could be due to the CBI prior to the Panama BTA and the dependence of the Panamanian economy on the the United States due to the Panama Canal.[15] The commodity-level analysis below indicates that the trade relationship with Panama is nuanced, which the two-commodity model fails to capture.

US agricultural imports from nonmember countries rose only for the Peru BTA, while Colombian and Peruvian imports from nonmember countries were unchanged. However, Panamanian and Chilean imports from nonmember countries declined. In contrast to the results that do not distinguish the direction of trade (Table 4), US exports to nonmember countries increased for all four BTAs, while Colombian exports expanded but Panamanian exports to nonmember countries fell. These results highlight the importance that both tariffs and NTMs can play in enhancing market access and trade.

For the processed food sector, the estimates show that US exports to Colombia, Chile, and Peru expanded, while US imports from and US exports to nonmember countries rose for all four BTAs. However, as with agricultural trade, US exports to Panama declined following the enactment of this FTA. Colombian exports to the United States fell, while Panamanian, Chilean, and Peruvian exports to the United States rose. Colombian, Panamanian, Chilean, and Peruvian imports from nonmember countries all increased, while Colombian exports to nonmember countries fell, Panamanian exports remained unchanged, and Chilean and Peruvian exports expanded.

Therefore, while the results generally show trade-expanding effects, breaking down the impacts by the direction of trade provides a more detailed analysis where trade did not necessarily rise in all cases and declined in a few cases, particularly when considering the Panama BTA. Thus, substantial heterogeneity in the impact of these four FTA exists depending on the level of aggregation and the direction of trade.

Static Results for Individual Commodities

The last analysis examining the static impacts of these four BTAs considers heterogeneity across individual commodities. For this analysis, the gravity model is run for each BTA and each commodity specified in Table 1. With the large number of results for four BTA, 26 agricultural commodities, and 18 processed food commodities, the coefficient estimates for B_{ijt}, I_{ijt}, and E_{ijt}

[15] Even after the United States returned the Panama Canal to Panama in 1977, around a third of all cargo passing through the canal is going to or coming from the United States (Hornbeck, 2012). Given the close ties to the United States and reliance on the canal, Panama has forgone participation in other regional agreements (e.g., Central American Common Market) that would benefit trade. Thus, even before the Panama BTA, the Panamanian economy was highly reliant on the US economy through the Panama Canal and the CBI.

Table 5. Static Trade Effects of Bilateral Trade Agreements Based on Trade Direction

Variable	Colombia BTA	Panama BTA	Chile BTA	Peru BTA
Two-commodity model				
y_{it}	0.511***	0.511***	0.497***	0.529***
	(0.030)	(0.030)	(0.045)	(0.027)
y_{jt}	0.371***	0.371***	0.373***	0.377***
	(0.048)	(0.048)	(0.049)	(0.052)
FTA	0.178***	0.179***	0.188***	0.151***
	(0.040)	(0.040)	(0.044)	(0.040)
US agricultural exports to				
Intramember trade	0.801***	−0.189**	1.117***	1.269***
	(0.098)	(0.094)	(0.065)	(0.101)
Nonmember imports	0.13	0.16	0.10	0.337*
	(0.167)	(0.161)	(0.169)	(0.173)
Nonmember exports	0.397**	0.403**	0.398***	0.572***
	(0.169)	(0.168)	(0.136)	(0.177)
US agricultural imports from				
Intramember trade	0.948***	−1.082***	0.516***	1.513***
	(0.072)	(0.068)	(0.071)	(0.053)
Nonmember imports	(0.12)	−1.36***	−0.656***	(0.20)
	(0.196)	(0.233)	(0.167)	(0.257)
Nonmember exports	0.16	−0.805***	(0.16)	0.01
	(0.133)	(0.253)	(0.204)	(0.257)
US processed food exports to				
Intramember trade	0.582***	−0.700***	1.196***	0.759***
	(0.098)	(0.094)	(0.065)	(0.101)
Nonmember imports	0.860***	0.844***	0.862***	1.043***
	(0.090)	(0.092)	(0.064)	(0.081)
Nonmember exports	0.413**	0.417**	0.352***	0.555***
	(0.166)	(0.165)	(0.135)	(0.169)
US processed food imports from				
Intramember trade	−0.582***	0.745***	0.321***	0.974***
	(0.072)	(0.068)	(0.071)	(0.053)
Nonmember imports	0.416**	0.325**	0.737***	0.589***
	(0.190)	(0.160)	(0.101)	(0.187)
Nonmember exports	−0.452**	0.166	0.380***	0.373***
	(0.213)	(0.212)	(0.101)	(0.076)
No. of obs.	303,832	303,832	303,832	303,832
Pseudo-R^2	0.969	0.969	0.969	0.969

Notes: All regressions are estimated using the Poisson pseudo-maximum likelihood method with country-pair, importer, exporter, and time fixed effects. Values in parentheses are robust standard errors clustered at the country-pair level. Single, double, and triple asterisks (*,**,***) indicate significance at the 10%, 5%, and 1% level, respectively.

(a) Intramember Trade (B_{ijt}) (b) Nonmember Imports and Exports (I_{ijt} and E_{ijt})

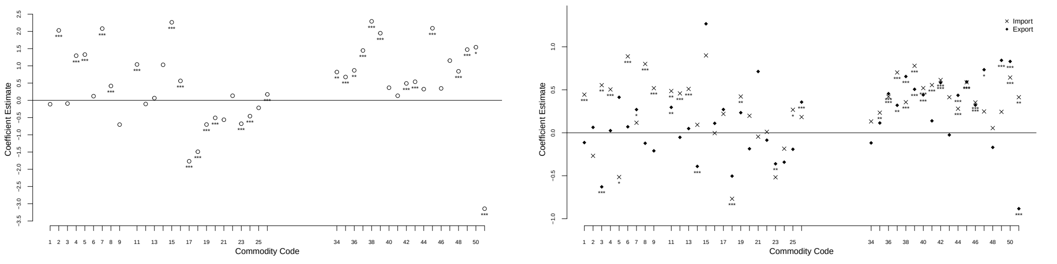

Figure 1. Heterogeneity across Commodities: Colombia

(a) Trade (B_{ijt}) (b) Nonmember Imports and Exports (I_{ijt} and E_{ijt})

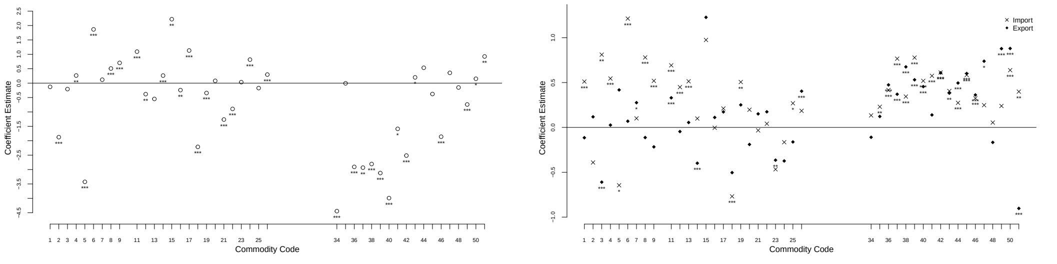

Figure 2. Heterogeneity across Commodities: Panama

(a) Intramember Trade (B_{ijt}) (b) Nonmember Imports and Exports (I_{ijt} and E_{ijt})

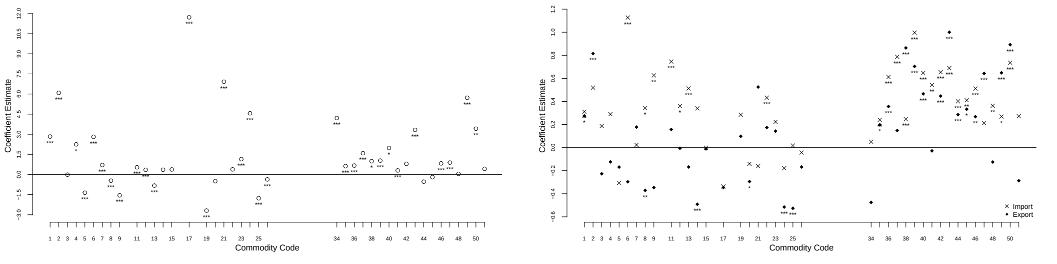

Figure 3. Heterogeneity across Commodities: Chile

(a) Intramember Trade (B_{ijt}) (b) Nonmember Imports and Exports (I_{ijt} and E_{ijt})

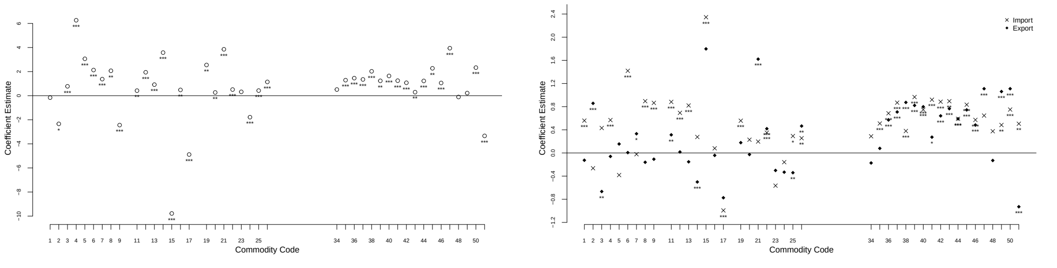

Figure 4. Heterogeneity across Commodities: Peru

Notes: All regressions are estimated using the Poisson pseudo-maximum likelihood method with country-pair, importer, exporter, and time fixed effects. Values in parentheses are robust standard errors clustered at the country-pair level. Single, double, and triple asterisks (*,**,***) indicate significance at the 10%, 5%, and 1% level, respectively.

with stars indicating significant coefficients are depicted graphically in Figures 1–4. (The appendix presents commodity-level results for production, consumption, and *FTA*.)[16]

These figures show substantial heterogeneity in the coefficient estimates of all four BTAs across commodities. For example, based on coefficient estimates for the Colombia BTA depicted in Figure 1, trade between member countries increased for nine agricultural commodities (ranging from 18.89% for commodity code 26 "other agricultural products, nec" to as much as 862.15% for code 15 "prepared vegetables") and 12 processed food commodities (ranging from 63.39% for code 42 "bakery products" to as much as 889.47% for code 38 "dairy products"), was unchanged (statistically insignificant) for 10 agricultural commodities and five processed food commodities, and declined for six agricultural commodities (ranging from −36.81% for 24 "tobacco leaves and cigarettes" to −82.93% for 17 "live cattle") and only one processed food commodity. Furthermore, imports from nonmember countries rose for 11 agricultural commodities and 13 processed food commodities, were statistically zero for 12 agricultural commodities and five processed food commodities, and fell for two agricultural commodities. In addition, exports to nonmember countries expanded for three agricultural commodities and 12 processed food commodities, were statistically zero for 19 agricultural commodities and five processed food commodities, and declined for three agricultural commodities and one processed food commodity. These results imply that, while results for aggregate commodities provide a general picture of the average impact of BTAs, commodity-level impacts can vary greatly and rise or fall depending on the BTA and specific commodity. Similar observations hold for Figures 2–4.

Next, the analysis focuses on top US exports to the four Latin American countries. For wheat (code 1), a top five US export to all four countries, trade creation occurred only for the Chile BTA, while intramember trade was unchanged and exports to nonmember countries expanded for the Colombia BTA, the Panama BTA, and the Peru BTA. Intramember trade and exports to nonmember countries also rose for soybeans (code 6) for the Colombia BTA, the Panama BTA, and the Peru BTA. Furthermore, trade creation occurred for processed meat (code 34) for the Chile BTA and the Peru BTA, while intramember trade expanded for the Colombia BTA and intramember trade and exports to nonmember countries increased for the Panama BTA.[17] Finally, intramember trade and exports to and imports from nonmember countries expanded for all four BTA only for soft drinks and mineral waters (code 50).[18]

As shown in the figures, some large coefficient estimates exist. Caution must be taken in interpreting the estimated coefficients as the analysis of the bilateral agreements becomes more focused on individual commodities because reporting errors in trade data or zero (or very small) trade values before a BTA and positive trade values after can create misleading interpretation of the percentage change in trade flows. That is, when trade between two countries of a particular commodity before an agreement is very low or zero, then small changes in the level of trade following the agreement can lead to large percentage changes. The wide heterogeneity across individual commodities is likely a result of differences in comparative advantage among individual commodities in each of the countries as trade costs are lowered.

Dynamic Results for Aggregate Food Trade

As discussed above, the impacts of BTAs on bilateral trade values likely have dynamic impacts because all four bilateral agreements contain phase-in periods for some agricultural commodities and firms do not instantaneously adjust to changes in market conditions following tariff reductions and new NTMs. Table 6 presents the dynamic gravity models for the aggregate commodity based

[16] Note that convergence was an issue for a few commodities, and the figures omit any coefficient estimate where convergence was not obtained. For example, the PPML regression did not converge for commodity 10 for all four BTAs; commodity 18 for the Chile BTA and Peru BTA; and commodity 16 for the Chile BTA.

[17] The results for top US imports show substantial heterogeneity with no clear pattern emerging.

[18] Excluding the Panama BTA, intramember trade and exports to and imports from nonmember countries increased for processed fruit and vegetables (code 36), dairy products (code 38), and grain mill products (code 39).

on equation (2). (Note that the Colombia BTA and the Panama BTA started in the same year, and these two BTA share the same variables.) The estimated coefficients show a strong dynamic effect of these agreements.

For the Colombia BTA, intramember trade did not increase in 2012, the first year the BTA was enacted, as the coefficient estimates for B_{ijt}-2012 are insignificant. However, despite a lack of intramember trade, for the first year of enactment, the results indicate a 56.0% expansion of imports from and a 58.4% increase in exports to nonmember countries. Furthermore, trade creation occurred after the initial year: Coefficient estimates for 2014 and 2016 for intramember trade and imports and exports from nonmember countries are all positive and significant. The results reveal that the trade creation effect strengthened over time. By 2016, intramember trade had expanded by 208.0% and imports from and exports to nonmember countries had increased by 149.2% and 135.6%, respectively. Note that the tariffs on some sensitive produce have a reduction schedule that extends to 2027. As the agreement calls for tariffs to be further reduced and eventually eliminated, the trade creation effects will likely continue. For the Panama BTA, intramember trade remains statistically zero for all years, while imports from and exports to nonmember countries all expanded from 2012 to 2016. (The coefficient estimates are similar in magnitude to those from the Colombia BTA.)

For the first 5 years after the agreement (2004–2008), the Chile BTA is the only one of the four agreements for which trade between member counties diminished by 35.1% in 2004, 24.5% in 2006, and 26.9% in 2008. Not only did US–Chilean trade fall, but imports from and exports to nonmember countries also decreased. This reduction in both US–Chilean trade and trade with nonmember countries could be partially attributed to enhanced competition in the Chilean market as Chile entered into trade agreements with the European Union in 2004, China in 2006, India and Japan in 2007, Panama in 2008, and Peru, Colombia, and Australia in 2009. However, starting in 2010, the first year of Chile's membership in the OECD, trade between the United States and Chile rose, and the impact of this BTA continued to grow through the end of the sample as trade expanded by 50.5% in 2010 and increased to 94.4% by 2016. Starting in 2010, trade creation is also observed through the end of the sample, as imports from and exports to nonmember countries also increased, with magnitudes similar to intramember trade. The delayed response for both member and imports from and exports to nonmember countries could also be because the main impetus of the Chile BTA was to implement NTMs and reduce SPS barriers, which take longer than tariffs for farmers, intermediaries, and food processors to adjust to and implement.

Unlike the other three BTAs, the Peru BTA experienced trade creation in the first year the agreement was enacted. For instance, in 2009, trade between the United States and Peru expanded by 61.3% and imports from and exports to nonmember countries increased by 54.8% and 55.9%, respectively. This result can be attributed to tariffs between US and Peru being fairly prevalent, despite ATPA, before the BTA (about 20% of Peruvian products entered the United States duty-free and less than 10% of US products entered Peru duty-free) (US International Trade Commission, 2006). Therefore, large gains in trade from tariff reduction were possible as 90% of US tariff lines and 56% of Peruvian tariff lines were duty-free when the BTA was enacted. Furthermore, trade creation became stronger over time as trade barriers were further reduced or removed. By 2015, US–Peruvian bilateral trade had expanded by a substantial 338.0%, while imports from and exports to nonmember countries had risen by 145.2% and 142.5%. The strengthening of the results over time is likely a result of producers and agri-businesses adjusting to the alignment of NTBs.

The dynamic effects further reinforce the findings from the static models that all four BTAs led to an expansion of trade with nonmember countries, and the Colombia BTA, the Chile BTA, and the Peru BTA all experienced trade creation by the end of the sample. In contrast to Sun and Reed (2010), whose dynamic analysis finds that trade creation for the SADC multilateral agreement remained fairly constant or disappeared over time, the results in Table 6 indicate that the trade creation effect for the Colombia BTA, the Chile BTA, and the Peru BTA, strengthened over time as trade liberalization progressed.

Table 6. Dynamic Trade Effect: Aggregate Model

	Colombia	Panama		Chile		Peru
Variable	**Estimate**	**Estimate**	**Variable**	**Estimate**	**Variable**	**Estimate**
B_{ijt}-2012	0.050	0.084	B_{ijt}-2004	−0.545***	B_{ijt}-2009	0.482***
	(0.098)	(0.180)		(0.089)		(0.057)
I_{ijt}-2012	0.441***	0.440***	I_{ijt}-2004	−0.379***	I_{ijt}-2009	0.437***
	(0.066)	(0.069)		(0.035)		(0.076)
E_{ijt}-2012	0.443***	0.469***	E_{ijt}-2004	−0.425***	E_{ijt}-2009	0.44***
	(0.078)	(0.079)		(0.030)		(0.074)
B_{ijt}-2014	0.536***	0.134	B_{ijt}-2006	−0.391***	B_{ijt}-2011	0.666***
	(0.154)	(0.093)		(0.035)		(0.058)
I_{ijt}-2014	0.707***	0.724***	I_{ijt}-2006	−0.339***	I_{ijt}-2011	0.456***
	(0.096)	(0.096)		(0.032)		(0.080)
E_{ijt}-2014	0.755***	0.809***	E_{ijt}-2006	−0.458***	E_{ijt}-2011	0.552***
	(0.082)	(0.076)		(0.040)		(0.098)
B_{ijt}-2016	1.129***	0.166	B_{ijt}-2008	−0.423***	B_{ijt}-2013	0.579***
	(0.174)	(0.122)		(0.031)		(0.066)
I_{ijt}-2016	0.906***	0.907***	I_{ijt}-2008	−0.356***	I_{ijt}-2013	0.555***
	(0.098)	(0.098		(0.030)		(0.080)
E_{ijt}-2016	0.839***	0.854***	E_{ijt}-2008	−0.225***	E_{ijt}-2013	0.542***
	(0.071)	(0.071)		(0.043)		(0.080)
			B_{ijt}-2010	0.308***	B_{ijt}-2015	1.481***
				(0.052)		(0.100)
			I_{ijt}-2010	0.366***	I_{ijt}-2015	0.89***
				(0.070)		(0.090)
			E_{ijt}-2010	0.349***	E_{ijt}-2015	0.866***
				(0.055)		(0.072)
			B_{ijt}-2012	0.221***		
				(0.058)		
			I_{ijt}-2012	0.381***		
				(0.062)		
			E_{ijt}-2012	0.373***		
				(0.072)		
			B_{ijt}-2014	0.484***		
				(0.075)		
			I_{ijt}-2014	0.657***		
				(0.098)		
			E_{ijt}-2014	0.703***		
				(0.079)		
			B_{ijt}-2016	0.566***		
				(0.065)		
			I_{ijt}-2016	0.843***		
				(0.099)		
			E_{ijt}-2016	0.764***		
				(0.071)		
No. of obs.				565,953		565,953
Pseudo-R^2				0.995		0.995

Notes: All regressions are estimated using the Poisson pseudo-maximum likelihood method and include country-pair, importer- time, and exporter-time fixed effects. Regressions include bilateral country-pair, importer-time, and exporter-time fixed effects. Values in parentheses are robust standard errors. Single, double, and triple asterisks (*,**,***) indicate significance at the 10%, 5%, and 1% level, respectively. For the dynamic analysis, the three-year interval data are note used (i.e., all years are included in the sample). B_{ijt}, I_{ijt}, E_{ijt} are for intramember trade, nonmember imports, and nonmember exports.

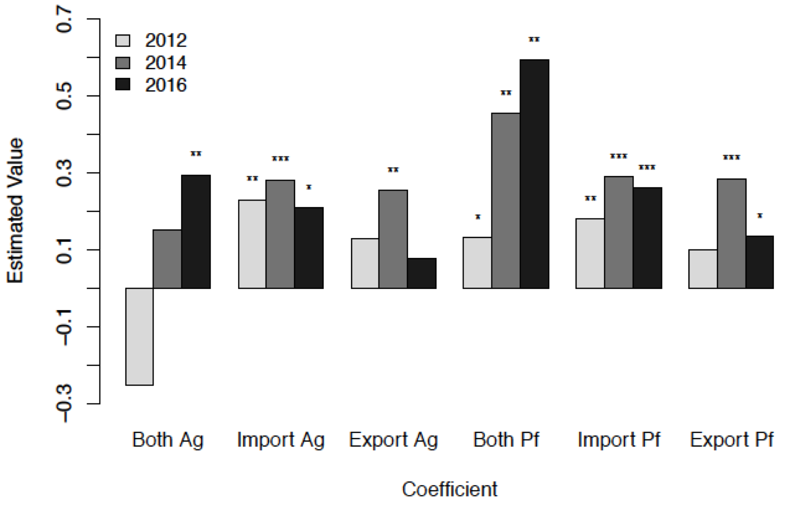

Figure 5. Dynamic Trade Effect for Colombia: Two-Commodity Model

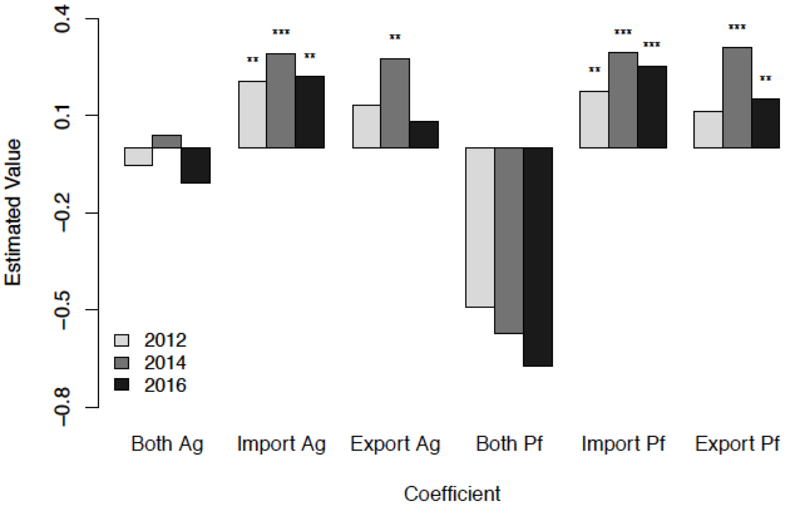

Figure 6. Dynamic Trade Effect for Panama: Two-Commodity Model

Dynamic Results for the Two-Commodity Model

Figures A1–A4 present the coefficient estimates, with stars indicating significance of coefficient estimates for intramember trade and imports from and exports to nonmember countries for the two-commodity dynamic gravity models. As with the static model, the results for the dynamic two-commodity model reveal differential impacts between the two commodities.

For the Colombia BTA, while the coefficient estimates for intramember trade for both the agricultural commodity and processed food increase over time, they are statistically zero for agriculture for 2012 and 2014 (Figure A1). Therefore, despite most of the tariff reductions on US products entering Colombia, the alignment of NTMs benefited both US and Colombian farmers and processed-food producers selling in each others’ markets, though the effect was delayed for agricultural commodities. Agricultural product trade could take longer to respond to the bilateral agreement because of longer production cycles compared to processed foods. While the estimated

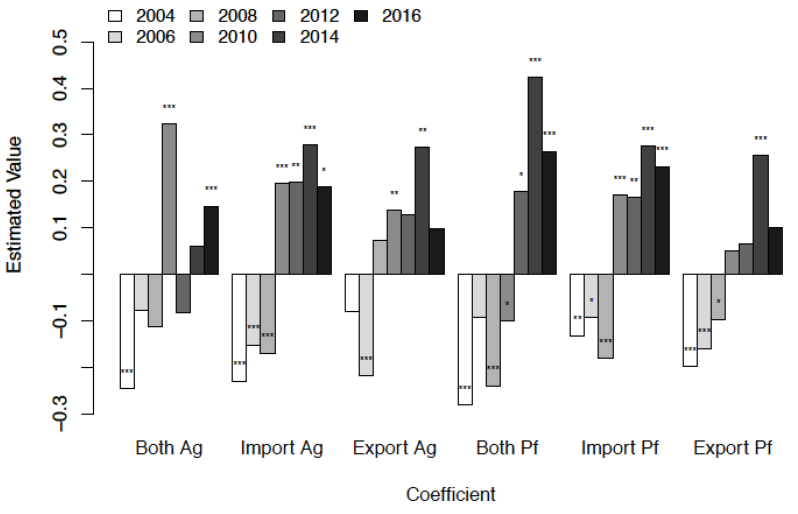

Figure 7. Dynamic Trade Effect for Chile: Two-Commodity Model

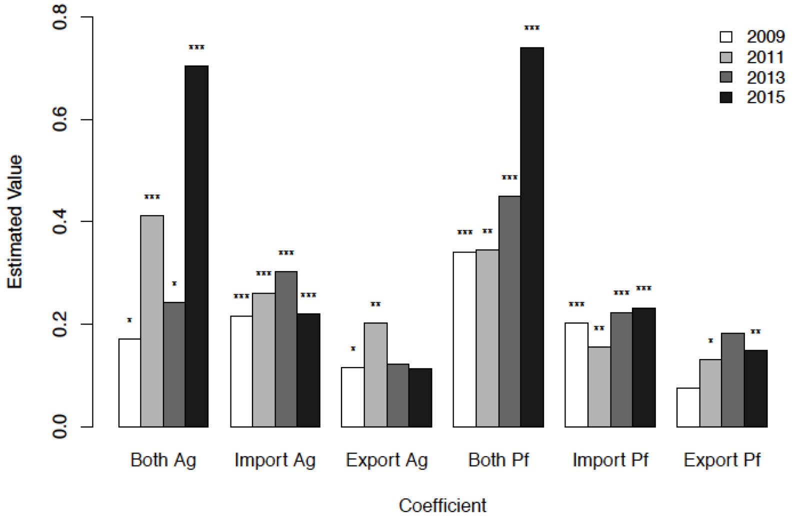

Figure 8. Dynamic Trade Effect for Peru: Two-Commodity Model

coefficient for imports from nonmember countries is positive and significant for all 3 years, the agricultural commodity did not experience trade creation as the coefficient estimate for export to nonmember countries, while positive, is only significant for 2014. For processed food, trade creation occurred for 2014 and 2016 as the coefficient estimates for intramember trade and imports from and exports to nonmember countries are positive and significant. For the Panama BTA, the results are similar to the aggregate model (Figure A2). For instance, the coefficient estimate for intramember trade is statistically insignificant for both the agricultural commodity and processed food for all years. However, imports from nonmember countries rose for both commodities and exports to nonmember countries increase for the agricultural commodity in 2014 and for the processed food commodity in 2014 and 2016.

For the Chile BTA, the directional impacts for both commodities in the two-commodity model are similar to that of the aggregate model (Figure A3); however, although increases in bilateral agricultural trade generally occurred starting in 2010, the trade creation effect is not as clear-cut as the coefficient estimates for intramember trade, imports from nonmember countries, and exports to nonmember countries, which are statistically significant only in 2010 for the agricultural commodity and in 2014 for processed food. For the Peru BTA, the results are similar to the aggregate model as bilateral US–Peruvian agricultural commodity and processed food trade expanded starting in 2009 and generally increased in magnitude through 2015 (Figure A4). However, the trade creation result is not as strong as in the aggregate model because the coefficient estimate for exports to nonmember countries is positive but statistically insignificant for the agricultural commodity in 2013 and for the processed food commodity in 2009.

Conclusion and Discussion

This study estimates the trade creation and trade diversion effects of bilateral free trade agreements between the United States and four Latin American countries (Colombia, Panama, Chile, and Peru). We estimate a structural gravity model using the Poisson pseudo-maximum likelihood (PPML) estimator to deal with heteroskedasticity and zero trade flows and a robust set of bilateral country-pair, importer, exporter, and time fixed-effects to mitigate endogeneity bias.

For the aggregate agri-food commodity, the results generally show trade creation effects through growth in both intramember trade and imports from and exports to nonmember countries for the US bilateral agreements with Colombia, Chile, and Peru. (Intramember trade was statistically insignificant for the Panama BTA.) Time appears to be important in understanding how these four BTAs unfolded. For the Colombia BTA, an expansion in intramember trade did not occur until 2 years after the agreements were enacted, after which this bilateral agreement resulted in trade creation. For the Panama BTA, intramember trade never increased, while imports from and exports to nonmember countries expanded. Therefore, US and Panamanian farmers and food processors benefited from this agreement, but only through expansions in trade with countries outside the agreement. The Chile BTA is the only agreement for which trade among member counties and imports from and exports nonmember countries declined immediately after the enactment of the agreement; however, trade creation became pronounced after about 7 years, as trade between the United States and Chile and imports from and exports to nonmember countries expanded. For the Peru BTA, strong growth in US–Peruvian trade and imports from and exports to nonmember countries occurred from the first year of enactment. These results suggest that US, Colombian, Panamanian, Chilean, and Peruvian farmers all benefit from these bilateral agreements. Therefore, continued liberalization of trade agreements in Latin American countries will likely bring similar benefits.

While the aggregate results provide strong evidence that these four BTAs expanded trade and led to trade creation for the Colombia BTA, the Chile BTA, and the Peru BTA, heterogeneity exists when the aggregate commodity is divided into an agricultural commodity and processed food; when US exports to and imports from Colombia, Panama, Chile, and Peru are separated; and when individual commodities are considered. While the main conclusions generally hold, there are some cases where trade declined, particularly when examining individual commodities. The heterogeneity in results in the individual commodities is likely a result of differences in comparative advantage among individual commodities in each of the countries.

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Appendix

This appendix presents graphically (Figures A1–A4) the coefficient estimates for production, consumption, and *FTA* for each of the commodities for each of the four BTAs.

(a) Production and Consumption (b) *FTA*

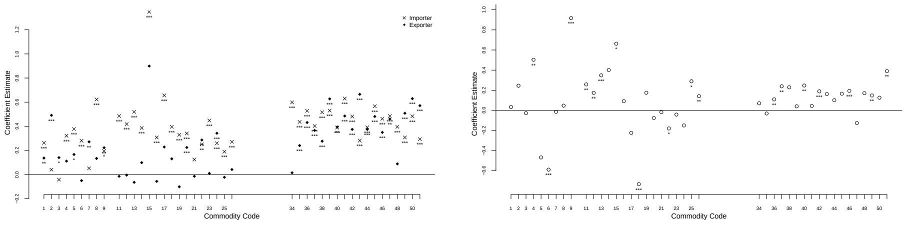

Figure A1. Heterogeneity across Commodities: Colombia

(a) Production and Consumption (b) *FTA*

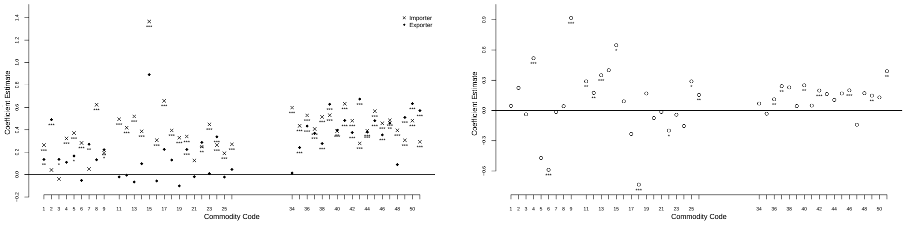

Figure A2. Heterogeneity across Commodities: Panama

(a) Production and Consumption (b) *FTA*

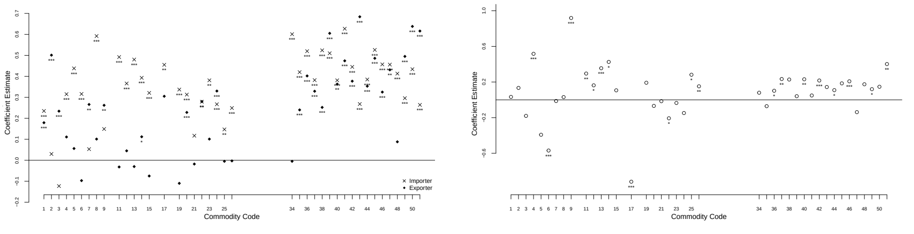

Figure A3. Heterogeneity across Commodities: Chile

(a) Production and Consumption (b) *FTA*

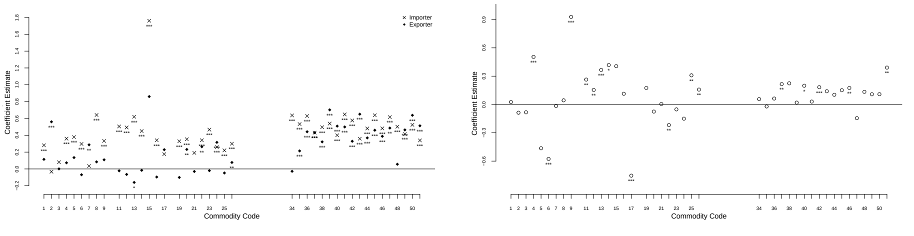

Figure A4. Heterogeneity across Commodities: Peru