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THE IMPACTS OF REGIONAL FREE TRADE AGREEMENTS AND EXCHANGE RATE VOLATILITY ON WORLD VEGETABLE AND FRUIT TRADE FLOWS

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Abstract

The study objectives are to identify determinants of commodity trade flows and analyze the effects of major Regional Free Trade Agreements on specific vegetable and fruit trade. The RFTAs are evaluated to identify the extent to which free trade associations lead to trade expansion. Using panel data from 1999 to 2008 covering 48 countries, the study found that per capita income, population, and per capita production capacity are significant determinants of fruits and vegetable trade flows. The results show that NAFTA and EU enhanced vegetable and fruit trade through trade creation and limited trade diversion. The ASEAN association generated insignificant trade expansion. The effects of the MERCOSUR association are inconclusive and generally commodity-specific. The findings reveal that the exchange rate uncertainty significantly impairs commodity flows. However, unlike previous findings, our study suggests that the negative impact is not uniform and may vary by sector, commodity, and exchange rate uncertainty measures.
Keywords: *exchange rate volatility, gravity models, trade creation and trade diversion, vegetable and fruit trade; ASEAN, EU, MERCOSUR, NAFTA.*
JELCodes*: F13, F15, F18*

1. Introduction

International trade flows and trade directions are normally based on the principles of comparative advantage under a free market system. However, commodity trade flows are often affected by government trade policies in both origin and destination countries, and by exchange rate volatilityand other factors. Therefore, factors affecting trade flows are subject to uncertainty. Studies by Anderson (1979), Summary (1989), Bergstrand (1985, 1989), Bacchetta and van Wincoop (2000), and Cho, Sheldon, McCorriston (2002), and Sheldon et al. (2013) used aggregate or semi-aggregate trade flows to identify and evaluate the determinants of trade flows. The use of aggregate trade flows assumes that the impact of trade factors is uniform across commodity trade sectors. This assumption ignores possible aggregation effects and characteristics of individual commodities. Previous research including studies by Koo, Karemera, and Taylor (1993), and Karemera et al. (2009), Jayasinghe and Sarker (2008), and Johnson (2010) empirically analyzed factors affecting single commodity trade flows. This study extends the commodity level trade flows analysis with application to specific fruits and vegetables. Commodities included in the analysis are listed in table 1 by name and commodity code.

A commodity-specific generalized gravity model is specified and applied to selected individual vegetables and fruits. The aim of the study is to identify and analyze factors affecting world trade of the commodities, discuss the impacts of regional free trade agreements and effects of exchange rate volatility on global fruit and vegetable trade flows.

Traditional gravity models have been revised and effectively reparameterized to identify and evaluate the determinants of specific trade flows such as countries' income, distance between countries, regional free trade agreements, exchange rate uncertainty, and other gravitational variables. Unlike traditional models that use cross section series alone, our models use panel data combining cross section and time series data to capture effects over time and country pairs.

Following Baier and Bergstrand (2007), Sun and Reed (2010), Cardamone (2011), Dal Bianco et al. (2017), Jean and Bureau (2016), and Estrella-Orrego et al. (2017), the effects of the Regional Free Trade Agreements (RFTAs)were specifically examined in this study. The RFTAs were examined to evaluate fruit and vegetable trade creation and trade diversion as well as the intra-group and inter-group trade effects. The results address the extent to which major world regional free trade blocs have expanded trade among trade block members and the possible impacts between members and non-member countries. Major RFTAs included in this study are the North American Free Trade Agreement (NAFTA), the European Union (EU), Association of Southeast Nations (ASEAN), and the agreement among South American nations (MERCOSUR).

Gravity models have been used to evaluate bilateral trade flows of aggregate trade flows between pairs of countries. Formal theoretical foundations of gravity model are provided in Anderson (1979) and Bergstrand (1985, 1989), Anderson, J.E., & van Wincoop, E. (2003). In this study, gravity models are respecified to include factors representing characteristics of agricultural commodities and examine the determinants of trade flows of vegetables and fruits. Gravity models contain the following three variable components: (1) Economic and non-economic factors affecting vegetable trade flows in the source country; (2) Economic and non-economic factors affecting vegetable trade flows in the destination; and (3) Natural or artificial factors enhancing or impairing vegetable trade flows between trading partners.

In this study, a generalized gravity model was specified and parameterized for application to time series and cross-sectional data to capture the impacts of the determinants of trade flows over time and countries. The model is applied to each selected commodity. The following section presents the specification of the commodity-specific gravity model. Section 3 explains the data and econometric issues related to estimation of the gravity models and pooling techniques. Empirical results are presented in section 4. The section 5 presents conclusions of this study.

2. Method: A Generalized Commodity-Specific Gravity Model

2.1 Commodity- Specific Gravity Model

This section provides a summary of the theoretical foundation of gravity models. The specification of a single-commodity gravity model follows the procedure established in the trade literature. According to Linneman (1966), Anderson, (1979) and Anderson and van Wincoop (2003), a gravity model is a reduced form equation from a general equilibrium model of demand and supply systems. The import demand model for a specific commodity is derived by maximizing a constant elasticity of substitution (CES) utility function subject to income constraints. The supply model is derived from the firms' profit maximization procedure in exporting countries with output allocated according to a constant elasticity of transformation function. Following Koo and Karemera (1991), a commodity specific gravity model was derived and respecified under the market equilibrium condition in which demand for a commodity equals supply of the commodity. Complete theoretical derivations of the gravity equation are available in Bergstrand (1985, 1989) with additional details in Koo et al (1991, 1993), Anderson and Van Wincoop (2003). Karemera et al (2009; 2011) offer more applications of single-commodity gravity models.

2.2 An Empirical Specification of a Generalized Commodity-Specific Gravity Model

In the empirical specification of our model, traditional gravity variables and pertinent to agricultural trade flows are included to analyze the effects of factors affecting global trade of individual fruits and vegetables. The variables representing regional free trade agreements and the exchange rate volatility are also included in this study. Most previous studies use a country's GDP. Since fruits and vegetables are staple commodities, we include countries' per capita GDP to represent export capacity for the exporting country and purchasing power in the importing country. Pagoulatos and Sorensen (1975), Bergstrand (1989), Baier and Bergstrand 2009); and Markusen (2010) showed that there is more trade among countries with high per capita incomes.

The distance between countries (D_{ij}) is used a proxy for transportation costs and was included under the hypothesis that countries close to each other are more likely to have similar cultures or cultural heritages, similar patterns of production and consumption. Relative short distances between countries result in lower transportation costs and the countries have high incentives for trade with each other. The common border dummy variable was retained in the empirical model because, in addition to characteristics identified for countries with close proximity, we assumed that there is more trade between countries with common borders than countries that are geographically separated (see Bergstrand, Larch, and Yotov;2015 for more information).The agricultural production per capita is used to represent the production capacity in the exporting country and self-sufficiency in consumption for the importing country. Increases in the population of trading countries will likely increase the volume of trade.

2.2.1 Role of Major Regional Free Trade Agreements

Major regional free trade agreements included in the analysis are listed in Table 1.

1. NORTH AMERICAN FREE TRADE AGREEMENT,NAFTA			
United States	Canada	Mexico	
2. EUROPEAN UNION MEMBER,EU			
Austria	Czech Republic	Denmark	Greece
Cyprus	France	Germany	Latvia
Finland	Ireland	Italy	Netherlands
Hungary	Luxembourg	Malta	Slovakia
Lithuania	Portugal	Romania	
Poland	Spain	Sweden	
Slovenia	France	Great Britain	
Belgium	Bulgaria	Estonia	
3. ASSOCIATION OF SOUTH EAST ASIAN NATIONS: ASEAN			
Brunei Burma	Cambodia	Indonesia	Laos

Malaysia	Myanmar	Philippines	
Singapore	Thailand	Vietnam	
4. COMMON MARKET OF THE SOUTH AMERICA, MERCOSUR			
Argentina	Brazil	Paraguay	Uruguay

The above table 1 shows, by world regions and membership, the RFTAs included in the study. When countries enter into free trade agreements, two effects occur: trade creation and trade diversion effects. A trade creation occurs when a beneficiary country's imports displace higher cost domestic production. A member country 'exports diverted from non-beneficiary countries to beneficiary countries are a trade diversion. In the following variables, a subscript m identifies trade among member countries of a trading bloc, a trade creation; while subscript n indicates trade between member countries and non-member countries, a trade diversion. For example, in equation 3, the dummy variable $NAFTA_m$, represents a trade flow between two NAFTA countries, and was included to identify and estimate NAFTA's trade creation effects. Another dummy variable, $NAFTA_{n,}$ represents a trade flow between NAFTA member countries and non-NAFTA countries included in the study period. The variable, $NAFTA_{n,}$ is used to identify the extent of trade diversion. Likewise, a dummy variable representing membership in the European Union, EU_m was included to identify the extent to which membership in the EU led to trade creation among EU members. Another dummy variable, EU_n, representing trade flows between EU and non-EU members was used to address the extent of trade diversion. The following additional dummy variables were included in the models to represent trade creation block members ($ASEAN_m$ and $MERCOSUR_m$) and trade diversion ($ASEAN_n$ and $MERCOSUR_{n)}$ between block members and non-members. It is hypothesized that free trade agreements enhance trade flows through trade creation and trade diversion effects.

2.2.2 The Impacts of Exchange Rate Uncertainty

The exchange rate is one of the macroeconomic factors affecting international trade flows and one of the most researched. Most previous empirical studies use aggregate commodity trade flows and, as such, they assume that the effect of exchange rate volatility is the same across commodities. However, the effects of exchange rate volatility on a single product may be different than the effects on another product. When those products are aggregated, the effects may interfere or offset one another. Therefore, the effects of the exchange rate volatility on trade flows remain inconclusive.

Some findings suggested that exchange rate uncertainty affects the levels of trade flows while others implied that the exchange rate uncertainty has no effect on trade flows. For example, DeGrauwe and Skudelny (2000) and Bacchetta and van Wincoop (2000) suggest that exchange rate uncertainty may lead to increased trade. However, Risk-averse traders would reduce trade flows under increased level of uncertainty, thereby resulting in a negative impact of exchange rate uncertainty on trade flows. Pick (1990) addressed the impacts of exchange rate on agricultural exports and argued that changes of exchange rates do not significantly affect agricultural trade flows for developed markets, while they negatively affect United States (U.S.) agricultural exports to developing markets. Langley (2000) showed that exchange rate variability positively affects poultry exports to Thailand. Davis et al (2014) show evidence of negative impacts of exchange rate volatility in global poultry trade. Cho et al (2002), in a sectorial analysis, suggested that exchange rate uncertainty negatively affects trade flows across all sectors. Sheldon et al. (2013) found that the exchange rate uncertainty has negative and significant effects on U.S. bilateral trade flows of fresh fruits. However, their study also found positive but insignificant effects of the exchange rate volatility on vegetable trade under alternative measures of exchange rate uncertainty. The use of groups of fruits and vegetables retains some degree of aggregation and implicitly assumes that the effects are uniform within commodity groups. The aggregation effects may cover up individual crop effects. Our study provides further insights on the impacts of exchange rate uncertainty on specific fruits and vegetable trade flows.

2.2.3 Two Measures of Exchange Rate Volatility

This study offers two measures of exchange rate uncertainty[1]. The short-term and long-term exchange rates measures used in this study are explained in foreign exchange rate literature. Below, we offer a brief summary. The first measure of volatility was computed following Koray and Lastrapes (1989) and Chowdhury (1993) as a moving standard deviation shown in equation (1). Thus, the short-run exchange rate volatility is measured as:

$$V_t = \left[(1/m) \sum_{i=1}^{m} \left(\log X_{t+i-1} - \log X_{t+i-2} \right)^2 \right]^{1/2} \quad (1)$$

where X_t is the currency real exchange rate at time t, and m is the order of the moving average.

The second measure of exchange rate uncertainty is provided by Peree and Steinherr (1989). This measure was used by Cho et al. (2002), Karemera et al. (2009, 2011), and Davis et al. (2014) and others. According Peree and Steinherr (1989), the long-term volatility of exchange rate between any two trading countries 'currency is computed as:

$$X_t = \frac{\max X_{t-k}^{t} - \min X_{t-k}^{t}}{\min X_{t-k}^{t}} + \left[1 + \frac{\left| X_t - X_t^{p} \right|}{X_t^{p}} \right] \quad (2)$$

where max and min X, respectively, represent the maximum and minimum values of the exchange rate within a time interval t and k and X^p is the equilibrium exchange rate. Peree and Steinherr (1989) explained that the first term in the equation (2) reflects learned experience of the previous period while the second term represents a correction factor based on current exchange rate deviations from expected equilibrium levels. The study by Cho et al. (2002) noted that since there is no formal way of computing equilibrium exchange rate, the mean of the exchange rates over the previous periods can be used as equilibrium exchange, ^{Xp}. Thus, following Cho et al. (2002), Karemera et al. (2009), Sheldon (2013, and Davis et al. (2014), the equilibrium exchange rate was set to the average exchange rate over the moving window within the sampled period of study. The value of k in the equation (1) has been set to 4. Alternative values of k set to 5 and 6 yielded comparable results.

2.3 A Generalized Commodity-Specific Gravity Model

Following Bergstrand (1985, 1989), Anderson and van Wincoop (2003), and Karemera et al. (2009, 2011), an empirical model was developed on the basis of a reduced form specification. Thus, the empirical commodity specific generalized gravity model of vegetable trade was specified as follows:

$$X_{ij} = BY_i^{\beta 1}\, Y_j^{\beta 2}\, D_{ij}^{\beta 3} N_i^{\beta 4}\, N_j^{\beta 5}\, Pr_i^{\beta 6}\, Pr_j^{\beta 7}\, v_{ij}^{\beta 8} \times exp[\beta_9 A_{ij} + \beta_{10} NAFTA_m + \beta_{11} NAFTA_n + \beta_{12} EU_m + \beta_{13} EU_n + \beta_{14}\, ASEAN_m + \beta_{15}\, ASEAN_n + \beta_{16}\, MERCOSUR_m + \beta_{17} MERCOSUR_n\,]\epsilon_{ij}, i = 1, \ldots, N_1 \text{ and } j = 1, \ldots N_2 \quad (3)$$

where

X_{ij}= the quantity of country i's commodity exported to country j;

$Y_i(Y_j)$= per capita gross domestic product of country i (country j):

D_{ij} = the shortest distance between country i's export port and country j's import port;

N_i (N_j)= the population of exporting country i (importing country j);

Pr_i(Prj)= the quantity produced per person in country i (country j);

A_{ij} = the adjacency dummy = 1 if countries i and j share a common border, 0 otherwise;

V_{ij} = the exchange rate volatility;

$NAFTA_m$, the dummy variable=1.0 for a trade flows between two NAFTA countries; 0 otherwise;

$NAFTA_n$, the dummy variable =1.0 for a trade flows between a NAFTA country and a non NAFTA member; 0 otherwise;

EU_m, the dummy variable=1.0 for a trade flows between two EU countries; 0 otherwise;

$EU_{n,}$ the dummy variable =1.0 for a trade flows between a EU country and a non EU member; 0 otherwise;

$ASEAN_m$, the dummy variable =1.0 for a trade flows between two ASEAN countries; 0 otherwise

$ASEAN_{n,}$ the dummy variable =1.0 for a trade flows between an ASEAN country and a non ASEAN member; 0 otherwise

$MERCOSUR_m$, the dummy variable =1.0 for a trade flows between two MERCOSUR countries; 0 otherwise

$MERCOSUR_n$, the dummy variable =1.0 for a trade flows between a MERCOSUR country and a non-MERCOSUR member; 0 otherwise.

$\varepsilon_{ij} =$ An error term.

Gravity models typically use GDP to represent income (Linneman 1966; Bergstrand 1985, 1989; Summary 1989; Koo and Karemera 1993, Anderson, J.E., & van Wincoop, E. 2003, Hilbun, B.M. 2006, and Ghazalian (2016). Since fruits and vegetables are staple commodities, we use per capita GDP to represent production and export capacity in exporting countries and absorption capacity and disposable income in importing countries. A rise in the countries' per capita incomes lead to trade increased flows and positive signs are expected (Baier and Bergstrand, 2009; and Markusen, 2010).

Per capita production variable was included in model specification to reflect the unique characteristics associated with the commodity traded in exporting and importing countries. An exporting country's per capita production was included to reflect the country's production and export capacity. A rise in the exporting country's per capita production leads to increased exports, and a positive coefficient sign is hypothesized. A rise in the production per capita in the importing country would be associated with reduced imports and a negative coefficient sign is expected. A rise in the exporting and importing country's population will increase production and consumptions needs and lead to increased trade volume. The variable is expected to be positively signed.

The regional free trade variables $NAFTA_m$, EU_m, $ASEAN_m$, and $MERCOSUR_m$ identify trade creation effects among the block members. The variables are hypothesized to have positive coefficient signs. The variables, $NAFTA_n$, EU_n, $ASEAN_n$, and $MERCOSUR_n$ should have negative signs reflecting trade diversion from non-member to beneficiary members. The distance variable, d_{ij}, was used as a proxy for transportation costs and represented resistance to trade. The shortest distance between commercial centers of trading countries was used for countries with multiple export and imports ports. A negative coefficient sign was expected. The border dummy variable was retained in the empirical model under an assumption that there is more trade between countries with common borders than countries that are geographically farther apart. A positive coefficient sign is hypothesized.

Finally, the variable representing the exchange rate volatility was added to the empirical specification. Equations (1) and (2) propose two measures of the exchange rate volatility. The first equation is used to identify the short run impact of exchange rate volatility while the second equation is used to identify the long run impacts of the exchange rate uncertainty on fruits and vegetable trade flows. In a sectorial study, Cho et al. (2002) argued that exchange rate uncertainty impairs agricultural product trade flows. Sheldon et al. (2013) used several volatility measures and focused on fresh fruits and vegetable flows. They found negative and significant effects of exchange rate uncertainty on fruits. However, they concluded that the exchange rate uncertainty is not significantly affecting vegetables trade flows. Therefore, the impact of exchange rate uncertainty is still inconclusive. This study provides additional insights on the impacts of exchange rate volatility on specific fruits and vegetables.

3. Econometric Issues and Data Sources

3.1 Econometric Issues

In the empirical implementation of the model presented in equation (3), we pooled data over 48 countries for the time period from 1999 to 2008. This technique combines time series and cross-section observations on trade flows and allows for increase in the degrees of freedom. Judge, Griffiths, Hill, Lutkepohl, and Lee (1985) offered techniques for model estimation. However, since the time series is so short relative to the number of estimable model parameters, the time effects inherent to pooling techniques cannot be estimated (Karemera et al. 2009 and Davis et al. 2014). Hausman (1978), Judge et al (1985), and Hsiao (1986) also discussed technical problems associated with the estimation of a model with panel data. To address the heteroskedacity problems associated with the cross-section series, the model was estimated with the Eicher-White Heteroskedacity consistent estimator provided in Estima (2010). Readers can see Bergstrand (1985, 1989) for more applications of the estimation procedure.

3.2 Data Sources

The list of vegetables and fruits used in the analysis are shown in table below:

Table 2. Commodity Level Trade by Global Trade Atlas, Inc.

Commodity	070110	Potatoes, Seeds, Fresh or Chilled
Commodity	070200	Tomatoes, Fresh or Chilled
Commodity	070810	Peas, Fresh or Chilled
Commodity	070820	Beans, Fresh or Chilled
Commodity	120100	Soybeans, whether or not broken
Commodity	200110	Cucumbers including Gherkins prepared or preserved

Source: Global Trade Atlas, Inc. (2010) under its alternative Harmonized System Codes (HS Code) from 1999 to 2008. The commodities represent the largest trade volume between country pairs that were consistently engaged in trade during the period of study.

Commodity data including exports, imports, and price data were obtained from the *Global Trade Atlas, Inc.* (2010) under its alternative Harmonized System Codes (HS Code) from 1999 to 2008.The initial sample included ten fruits and vegetables with the largest international trade volumes covering the study period. However, due to data limitations from developing countries, the number of commodities studied was reduced to six in order to retain data consistent overtime and cross countries for the period of study. Gross Domestic Product, population and inflation were collected from the World Bank's Development Indicators. Exchange rates were obtained from the *International Financial Statistics of International Monetary Fund* in various issues. Distances were obtained from *Fitzpatrick and Modlin* (1986).

4. Empirical Results

The parameters of the model were estimated by use of the RATS Programs provided by Estima (2010). The Eicher-White Heteroskedacity consistent estimator was applied to estimate the model. Table 3 presents the estimated parameters of logarithmic transformation of the gravity Equation 3. Most of the estimated parameters have the expected signs and are statistically significant. These results are similar to those of previous studies that used gravity models to analyze aggregate trade flows. The use of single commodity data offers more insights on the trade behavior of individual commodities in the framework of global trade. The estimates and impact of specific determinants of international commodity-specific trade flows are discussed below.

4.1 The Effects of Income, Production and Population

The estimated coefficients of income, population and production have the expected signs and are significant at the 1% level. With respect to estimated coefficients of income, the results suggest that an increase in per capita income of the exporting and the importing countries leads to increased trade flows of vegetables and fruits. The coefficients are significant and positive in most models. The magnitude of the exporter coefficients on Beans, Soybeans, and Tomatoes are greater than 1.0, suggesting that these commodities are more sensitive to change in per capita incomes in exporting countries. The estimated per capita income elasticities in importing countries are all less than 1.0, suggesting that imports of fruits and vegetables are less sensitive to changes in income or purchasing power in importing countries. The extent of insensitivity is greater in importing countries than exporting countries and seems to vary by commodity. Beans are a notable exception.

A closer look at beans data shows that several emerging countries included in sample had disposable incomes that were steadily rising while imports of beans declined. For example, from 1998 to 2008, disposable income rose to an average of 4% per year in Singapore, Thailand, Malaysia, Argentina and Brazil while bean import decreased at an average of 2% per year. Therefore, the negative and significant income elasticities may suggest that beans are seen as goods inferior in consumption in the importing countries.

The results show that the population of trading countries is a significant factor enhancing trade flows. A rise in the importing country's population lead to increased consumption needs while increases in exporting country's population lead to increases production. The estimated elasticities were positive and significant at the 1% level almost uniformly. This result is consistent with Hilbun (2006). The magnitudes of the elasticities are less than 1.0 suggesting that quantities of commodities traded are not sensitive to changes in trading country populations.

Per capita production variables in exporting and importing countries have the expected signs and are significant at the 1% level, in most cases. The estimated elasticities are less than 1.0 in all cases, suggesting that trade flows are not sensitive to changes in the production capacity. The insensitivity to domestic production changes in the exporting country may be due to its excess production capacity and domestic export promotion policies and programs. The insensitivity to domestic production changes by importing countries may be due to the fact that vegetable commodities are essentially staple products.

Table 3a The Eicker-White Heteroscedasticity-Consistent Estimates of A Gravity Model by Commodity and Exchange Rate Volatility Measures

	Beans		Cucumbers		Peas	
Variables	Short Term Volatility	Long Term Volatility	Short Term Volatility	Long Term Volatility	Short Term Volatility	Long Term Volatility
Constant	-11.155*** (-3.32)	-11.369*** (-3.43)	-3.722 (-1.36)	-2.967 (-1.13)	-10.197*** (-3.66)	-10.859*** (-3.88)
Exporter's per capita GDP	1.753*** (9.84)	1.802*** (10.28)	0.315*** (3.1)	0.288*** (2.95)	0.798*** (5.28)	0.864*** (5.72)
Importer's per capita GDP	-0.917*** (-6.89)	-0.899*** (-6.76)	-0.012 (-0.11)	-0.032 (-0.3)	0.009 (0.07)	0.062 (0.52)
Distance	-0.75*** (-6.62)	-0.78*** (-6.85)	-0.321*** (-4.27)	-0.341*** (-4.55)	-0.403*** (-6.38)	-0.425*** (-6.6)
Exporter's Population	0.646*** (10.31)	0.644*** (10.34)	0.735*** (13.59)	0.735*** (13.79)	0.53*** (11.85)	0.523*** (11.64)
Importer's Population	0.475*** (8.1)	0.484*** (8.36)	0.127*** (2.6)	0.124** (2.56)	0.488*** (11.31)	0.486*** (11.24)
Exporter's per capita Production	0.104*** (2.67)	0.119*** (3.02)	0.172*** (4.1)	0.171*** (4.25)	0.051 (1.03)	0.05 (0.99)
Importer's per capita Production	0.185*** (3.69)	0.194*** (3.84)	-0.143*** (-2.67)	-0.146*** (-2.72)	-0.01 (-0.21)	-0.01 (-0.19)
Both Countries NAFTA	2.809*** (4.97)	2.721*** (4.78)	1.011** (2.42)	0.99** (2.38)	1.046*** (3.64)	1.122*** (3.91)
One Countries NAFTA	0.126 (0.34)	0.146 (0.146)	-0.666*** (-4.2)	-0.641*** (-4.06)	1.19*** (3.34)	1.436*** (3.94)
Both Country EU	3.234*** (6.65)	3.376*** (7.04)			-0.343 (-1.25)	-0.107 (-0.39)
ONE Country EU	2.618*** (8.03)	2.628*** (8.03)	-0.348** (-2.48)	-0.33** (-2.36)	-0.704*** (-2.73)	-0.617** (-2.34)
Both Countries ASSEAN			-4.959*** (-6.35)	-5.167*** (-6.64)		
One country ASSEAN	0.684** (2.01)	0.685** (2.00)	-1.425*** (-6.42)	-1.484*** (-6.7)		
Share a Common Land Border	1.901*** (8.7)	1.925*** (8.72)	0.674** (2.33)	0.694** (2.41)	0.379*** (3.21)	0.432*** (3.65)
Exchange Rate Volatility	-4.623 (-6.00)	- 0.372*** (-5.46)	-1.288*** (-2.77)	-0.139*** (-4.95)	-7.572*** (-7.24)	-0.618*** (-6.75)
Statistics						
N	1094	1094	1587	1587	1465	1465
SES	2.168	2.169	2.251	2.239	1.896	1.905
Log Likelihood value	-2391.095	- 2392.055	- 3532.105	-3523.696	-3009.285	-3015.542
R^2	0.517	0.516	0.245	0.253	0.349	0.343

Notes: T-ratios in parenthesis for above and below tables: ***: *** denotes significance at 1% level, ** at 5% level, and * at 10% level

Table 3b The Eicker-White Heteroscedasticity-Consistent Estimates of A Gravity Model by Commodity and Exchange Rate Volatility Measures

	Potatoes		Soybeans		Tomatoes	
Variables	Short Term Volatility	Long Term Volatility	Short Term Volatility	Long Term Volatility	Short Term Volatility	Long Term Volatility
Constant	1.717 (1.01)	1.584 (0.93)	-31.622*** (-10.63)	-25.49*** (-8.45)	-21.709*** (-11.13)	-21.823*** (-11.13)
Exporter's per capita GDP	0.192* (1.88)	0.237** (2.35)	1.133*** (8.24)	1.012*** (7.56)	1.239*** (11.81)	1.273*** (12.31)
Importer's per capita GDP	-0.093 (-1.23)	-0.075 (-1.00)	0.623*** (5.56)	0.375*** (3.32)	0.871*** (12.86)	0.902*** (13.21)
Distance	0.19*** (3.54)	0.189*** (3.53)	-0.139 (-1.19)	-0.121 (-1.04)	-0.431*** (-7.65)	-0.437*** (-7.71)
Exporter's Population	0.4*** (10.58)	0.39*** (10.32)	0.485*** (8.02)	0.388*** (6.27)	0.6*** (15.88)	0.589*** (15.59)
Importer's Population	0.284*** (8.6)	0.277*** (8.33)	0.485*** (8.02)	0.388*** (6.27)	0.6*** (15.88)	0.589*** (15.59)
Exporter's per capita Production	0.479*** (7.49)	0.467*** (7.37)	0.075*** (2.92	0.066*** (2.6)	0.286*** (10.28)	0.292*** (10.5)
Importer's per capita Production	0.396*** (7.11)	0.394*** (7.11)	0.113*** (4.46)	0.104*** (4.15)	0.302*** (10.91)	0.307*** (11.03)
Both Countries NAFTA	1.735*** (3.5)	1.755*** (3.57)	2.821*** (6.68)	2.406*** (5.79)	1.507*** (6.03)	1.497*** (5.98)
One Countries NAFTA	0.015 (0.04)	-0.078 (-0.19)	1.494*** (5.79)	1.773*** (7.00)	-1.752*** (-7.97)	-1.771*** (-8.05)
Both Country EU	0.237 (0.5)	0.335 (0.72)	0.244 (1.00)	1.295*** (4.72)	0.586*** (3.84)	0.622*** (4.07)
ONE Country EU	-0.001 (-0.00)	0.014 (0.03)	0.479*** (2.81)	1.279*** (6.47)	-0.295** (-2.33)	-0.304** (-2.39)
Both Countries ASSEAN			0.268 (0.72)	-0.92** (-2.28)	0.02 (0.07)	-0.027 (-0.1)
One country ASSEAN	0.837*** (3.21)	0.673** (2.57)	1.338*** (6.44)	0.671*** (3.04)	-2.097*** (-9.61)	-2.131*** (-9.85)
Both Countries MERCOSUR	-1.487*** (-2.88)	-1.976*** (-3.89)	2.814*** (4.16)	3.502*** (5.22)	-0.817 (-1.59	-1.055** (-2.07)
One Country MERCOSUR	-1.119*** (-3.96)	-1.269*** (-4.48)	3.775*** (10.15)	4.507*** (12.38)	-2.243*** (-4.89)	-2.441*** (-5.31)
Share a Common Land Border	-0.016 (-0.13)	-0.002 (-0.02)	1.532*** (6.45)	1.565*** (6.2)	0.511*** (4.69)	0.538*** (4.93)
Exchange Rate Volatility	-4.606*** (-7.31)	-0.388*** (-5.48)	0.74 (1.03)	0.155* (1.84)	-2.911*** (-6.45)	-0.235*** (-6.35)
Statistics						
N	2294	2294	1750	1750	3020	3020
SES	1.747	1.75	2.694	2.647	2.203	2.204
Log Likelihood value	- 4525.685	- 4530.907	-4208.592	-4177.389	-6661.512	-6662.459
R^2	0.197	0.194	0.428	0.448	0.427	0.426

Notes: T-ratios in parenthesis for above and below tables: ***: *** denotes significance at 1% level, ** at 5% level, and * at 10% level

4.2 Trade Creation and Trade Diversion Effects of Regional Free Trade Agreements

Table 3 presents the estimated results. The gravity models include variables representing factors aiding or resisting trade flows. To identify trade creation effects, dummy variables representing trade activities between the two member countries of each trading blocs ($NAFTA_m$, EU_m, $ASEAN_m$ and $MERCOSUR_m$) are included in the model as shown in equation 3.

The results show the formation of the EU and NAFTA clearly increased vegetable and fruit trade among members through trade creation and trade diversion. The NAFTA coefficients are positive and significant at 1% for most commodities included in the study. The EU coefficients are mostly significant at 1% level for beans, soybeans and tomatoes. However, the findings show no evidence of significant trade creation for ASSEAN countries. The MERCOSUR association generated significant trade creation for only soybeans.

The extent of trade diversion was also analyzed. The dummy variables $NAFTA_n$, EU_n, ASEANn, and MERCOSURn identify trade flows between members of each trading bloc and non-members. Negative coefficients represent trade diversion of the economic integrations which occurs when trade flows are diverted from a non-beneficiary country to member countries. The results clearly demonstrate that trade diversion effects vary over commodities and trading blocs. NAFTA lead to trade diversion effects except in cucumbers and tomatoes trade. The U.S. increased cucumber imports from Mexico since 1994 when NAFTA became effective and reduced its imports from other countries such Caribbean and Central American countries (Sheldon, et al. 2013). The EU generated significant trade diversion for cucumbers, peas, and tomatoes. The associations of the ASEAN led to significant trade diversion in cucumber and tomato trade with non-member countries. The MERCOSUR association generated significant trade diversion of potatoes and tomato trade flows. In general, the formation of the free trade blocs resulted in significant trade creation and limited trade diversion in vegetables and fruits trade. The findings are consistent with previous studies (Sun and Reed, 2010; Jean and Bureau, 2016; Dal Bianco, el al., 2017.)

4.3 The Effects of Distance and Border

The theory of spatial equilibrium suggests that the quantity of commodity trade varies inversely with distance. The estimated coefficients of distance are negative and significant at 1% level in most. However, the degree of significance varies by commodity. The findings suggest that distance is one of the major factors affecting commodity trade patterns. Potato trade flows ate the only except. The results suggested that potato trade flows are not determined by distances among partners. This finding suggests that distance may not be any longer a trade impairment factor it used to be due to modern means of communication and transportation (see Karemera et al., 1999 and more recently Bergstrand, Larch, Yotov. 2015 for more details). Finally, as expected, countries that share a common border trade more intensively than countries that are more geographically separated. The border coefficients were significant across all commodities and countries included in the sampled period.

4.4 The Impacts of Exchange Rate Volatility on Fruits and Vegetables

The impact of the exchange rate volatility was estimated following Chowdhury (1993), Cho et al (2002), and Karemera et al. (2009 and 2011). Two different measures of exchange rate volatility were used. Table 3 also presents the results for both short and long term volatility measures. Unlike studies by Sheldon et al. (2013) who analyzed impacts of exchange rate volatility on fruits/ vegetables as groups, our research focused on the impacts of exchange rate uncertainty on specific fruits and vegetables. Our findings reveal that the impacts of exchange rate uncertainty on beans, cucumbers, peas, potatoes and tomatoes is negative and significant at 1% level for both short and long term volatility measures. However, the results clearly showed that the impacts of exchange rate uncertainty on soybeans is positive and significant at 1% level.

This finding was partly consistent with Cho et al (2002), who suggested that both short- and long-term exchange rate volatilities impair trade flows in sectorial trade studies. However, our results reveal that the negative impact is not uniform. Our results further extend findings in Sheldo, et al. (2013) with a focus on individual commodities and show that the effects are not uniform across individual crops. This evidence supports the arguments of DeGrauwe and Skudelny (2000), and Bacchetta and van Wincoop (2000) which stipulated that exchange rate uncertainty may vary across sectors, but it also may vary by commodity and the volatility type. Klein (2000) also found positive effect of exchange rate volatility on sectorial trade flows. Our findings confirm that the impacts of both short and long term uncertainty are commodity-specific, and may vary by sector, and uncertainty measures.

5. Conclusions

A commodity-specific gravity model was developed to evaluate factors affecting trade flows of specific vegetables and fruits. In general, it was found that gravity models for aggregate trade flows can reparameterized and applied to single commodity trade flows with minor modifications. The factors such per capita income, population, and production were seen as significant determinants of vegetable and fruit trade flows.

The findings reveal that the EU and NAFTA have enhanced fruits and vegetable trade flows through trade creation and limited trade diversion. The ASEAN and MERCOSUR showed limited trade creation and trade diversion.

Consistent with most previous studies, our findings suggested that the exchange rate volatility significantly impaired fruits and vegetable trade flows. This study showed that both short-term and long-term volatilities have negative effects and reduced trade flows of specific commodities. However, there is some evidence that the effect is crop-specific and may not be uniform across crops. A positive effect was found on soybean trade flows. This finding is contrary to the findings of Cho et al. (2002) who suggested that exchange rate volatility has uniform negative effects on all trade flows. This study supports the research of DeGrauwe and Skudelny (2000) and Bacchetta and van Wincoop (2000) which suggested that exchange rate volatility may vary by sectors, but it also may vary by commodity and method of analysis. Thus, the evidence suggests that future commodity level studies be considered when addressing impacts of exchange rate volatility on trade flows.

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Foot notes

1. Several measures of exchange rate uncertainty exist in literature. However, there is no formula for the selection of a specific measure. Therefore, our choice of the exchange rate uncertainty measures reflects data availability, time period of study, and similarity with previous studies. The results are robust to the choice of the parameters m and k in the moving process of the volatility measures (See also Cho et al 2002