# Real Exchange Rate Volatility on the Short- and Long-Run Trade Dynamics in Colombia

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**Abstract**

The short- and long-run implications of real exchange rate volatility on Colombian bilateral trade commodities and non-commodities with its major trade partners are analyzed from the perspectives of the Marshall-Lerner condition, a cointegration relation with other aggregate variables and the J-curve hypothesis. Long-run equilibrium on the Colombian bilateral balance of trade with a country is more common when the trade volume is denominated in terms of one of the world's main currencies; as is the case of commodity trade and trade with a country which its national currency is one of these currencies. No evidence of the J-curve was found.

**JEL Classification**: C22, F14, F31, N76

**Keywords**: bilateral balance of trade; real exchange rate fluctuations; Colombia

## 1 Introduction

Recent experiences of prolonged and successive appreciations of the Colombian peso have raised credible concerns on the stability of the emerging country's competitiveness and the current surplus in the balance of trade. Concerns on the permanence of the country's competitiveness strengths vis-à-vis improvements in its terms of trade are readily apparent since any international competitiveness gain in a Colombian industrial sector, due to enhancements in unit labor requirements and/or wage differentials, can be offset by an overvalued national currency. The validation of the concerns regarding an appreciated Colombian peso and its effect on the stability of the current trade surplus are a greater challenge to assess. This is due to the heterogeneous categories of goods in the Colombian balance of trade and their individual and possibly distinct short- and long-term reactions to changes in the terms of trade.

The 2003-2011 nine years period was one of vertiginous appreciation of the Colombian currency; e.g. a 40.1% total real appreciation or a 6.3% yearly rate. This appreciation of the peso was accompanied

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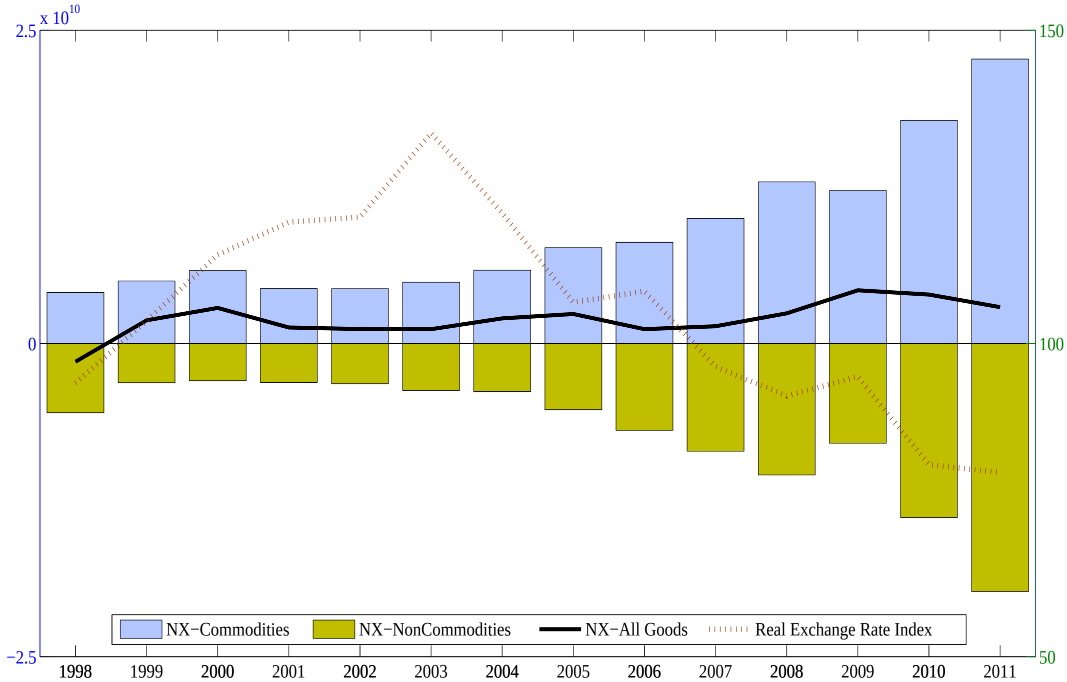


Figure 1: Colombian real exchange rate index (right axis), and net exports of all goods, commodities and non-commodities (left axis) with its main trade partners for the 1998-2011 period. Source: Central Bank of Colombia.

by a positive trade balance. Figure (1) illustrates the volume of Colombian total net exports with its main trade partners[1] and the corresponding value of its real exchange rate index for the 1998-2011 period.[2] The diagram in Figure (1) also contains the series of net exports decomposed in commodity and non-commodity goods. Figure (1) shows that since the year 1999 Colombia has been a net exporter of commodities and a net importer of non-commodities, and comparing the magnitudes of the net-export volumes of both types of goods, it is evident that the surplus in total trade results from the superior increases in the volume of the trade surplus of commodities relative to the trade deficit of non-commodities. The increases in net exports of Colombian commodities during this period is with certainty a response to the increases in world prices of commodities, which for this period increased as

[1] Colombia's main international trade partners are Germany, Belgium, Brazil, China, Ecuador, U.S.A., Netherlands, Italy, Japan, Mexico, Panama, Peru, U.K., Dominican Republic, Switzerland and Venezuela. Sources and descriptions of the data are provided in Section 3 of the paper.

[2] The Real Exchange Rate Index published by the Banco de la República of Colombia is used (1994=100). An increase in the Index indicates a real devaluation of the Colombian peso. A detailed explanation of the methodology used to construct the Index can be found in Huertas (2003).

an aggregate at a yearly rate of 11.3% (and of 17.3% if only oil is to be considered). [3]

A visual assessment on the behavior of the time series in Figure (1) suggests the existence of a degree of correlation between the exchange rate and net export dynamics, that is the most apparent for the trade of non-commodities. Not readily evident from Figure (1) is that the volume of the Colombian external sector with its main trading partners is dominated by the import of non-commodities, with an annual average value of $13,632 million U.S. dollars. Colombian annual exports of non-commodities to these commercial partners average $9,346 million USD, yielding the trade deficit of non-commodities observed in Figure (1). Annual Colombian commodity exports average to $7,498 million USD, with the vastest of these corresponding to oil exports to the United States. Colombian commodity imports average to an annual $400 million USD. As previously observed in Figure (1), the end result of adding the Colombian commodity trade surplus and the trade deficit non-commoditis is a positive balance of trade.

These characterizing traits of the country's external sector oblige an analysis on the Colombian balance of trade to incorporate a level of disaggregation in the trade volume that allows for individual analyses on commodity and non-commodity commerce. The composition of the volume of goods in the balance of trade of Colombia ultimately affects the impact that exchange rate volatility has on the country's trade balance, that is because non-commodity trade is likely to be denominated in the currency of the exporting country, while commodity trade is often priced in terms of the world's main currencies, mainly the U.S. dollar; see Boughton & Branson (1988) and Roberts & Schlenker (2010). The currency in which an international trade transaction is denominated, argues Wilson (2001), can limit the capacity to transfer prices among agents resulting from exchange rate variations.

The main question raised in this paper is whether an improvement in the Colombian terms of trade will ultimately detriment the country's bilateral trade balances of commodity and non-commodity goods. Addressing this question, a dynamic adjustment mechanism is used to analyze the short-run and long-run responses of Colombian international trade to real exchange rate volatility. The research is performed from the perspectives of the Marshall-Lerner condition, a cointegration analysis among

[3] Note: The data sources from which the growth rates were calculated are the All Commodity Price Index and Crude Oil Price Index, available at the data appendix of the IMF Commodity Market Review.

trade variables and the J-curve hypothesis.

The next section of this paper reviews the existing literature on the effects of real exchange volatility on short- and long-run trade balance dynamics. Section 3 provides a characterization of the bilateral trade of commodities and non-commodities of Colombia with its main trading partners and details the sources of the data used for the study. Section 4 presents the model used for analysis. Section 5 presents the empirical findings and Section 6 concludes summarizing the results of study and some policy considerations.

## 2 Literature Review

The scientific literature offers no conclusive answer on whether exchange rate manipulations are efficient public policy instruments for the correction of current account deficits. Significant works argue on the possible existence of distinct response behaviors for the balance of trade to exchange rate variations over the short-run and the long-run horizons. Trade data analysis over a long-run horizon is generally focused on the Marshall-Lerner condition (or M-L condition) and the search for a cointegration relation on the time series of balances of trade and exchange rates.

The M-L condition states, see Goldstein & Khan (1985) and Argy (1994), that exchange rate volatility yields changes in a country´s trade flows ultimately affecting its current account balance, and the price elasticities of imports and exports are what determine the magnitude of the changes in the current account. The M-L condition is said to hold when the sum of the absolute values of these elasticities is greater than unity (Bahmani-Oskooee, 1998).

Cointegrated time series are those that move together in a path towards long-run equilibrium. Researchers, see for instance: Bahmani-Oskooee & Goswami (2003), Halicioglu (2008), Bahmani-Oskooee & Hajile (2009) and Shahbaz et al. (2012), test for cointegration among trade balance and exchange rate time series assuming a dynamic adjustment mechanism on the trade balance. The models of choice for these enviroments are Pesaran et al. (2001) Autoregressive Distributed Lag (ARDL) cointegration model and adaptations of the Engle & Granger (1987) Error Correction (EC) model. These cointegration models tests on whether the short-term dynamics in the systems are in effect influenced by the deviation from equilibrium and if there is a tendency to correct any short-term error.

The J-curve hypothesis has recently become the work-horse for academics and practitioners alike for analyzing the short-run dynamics of the balance trade and exchange rate relation. The J-curve hypothesis, initially introduced in Junz & Rhomberg (1973) and Magee (1973), references the theorized behavior that follows a country's balance of trade following a real devaluation, initially registering a deficit followed by a surplus, resembling a "J". The value of trade contracts negotiated prior and after the devaluation is to be affected by the new terms of trade. The assumed initial deficit in the balance of trade after a devaluation is responding to the higher prices of imports faced by the home country. This immediate response in the balance of trade is known the "price effect", see Gupta-Kapoor & Ramakrishnan (1999). Once trade contracts are negotiated under the new terms of trade, the volume of home exports are expected to increase (e.g. the "volume effect").

Bahmani-Oskooee & Hegerty (2010) provides an excellent and very complete review on the findings of the existing empirical scientific literature on the J-curve. The authors' survey suggests that studies using aggregate trade data may result in ambiguous or conflicting results, because aggregate data conceals significant movements of variables within its subsets. Bahmani-Oskooee & Hegerty (2010) recognizes that studies employing bilateral and disaggregated data at industry or sector-specific level have a higher capacity to identify the presence of a J-curve. Of the surveyed works included in Bahmani-Oskooee & Hegerty (2010), only two addressed the presence of the J-curve in the balance of trade in Latin American countries. These are Gomes & Paz (2005) and Bahmani-Oskooee & Hegerty (2011) which, respectively, searched for evidences of J-curves in the trade balances of Brazil and Mexico. Gomes & Paz (2005) found evidence of the J-curve on Brazilian trade balance using aggregate data. Bahmani-Oskooee & Hegerty (2011) analyzed industry level bilateral trade data between the U.S. and Mexico, and found no J-curve. The authors argue that because of the level of economic integration and the prevalence of inter-industry trade between these countries trade flows are found to be relatively insensitive to the fluctuations of the Mexican peso. These studies are of particular interest to this paper because all use comparable cointegration methods on a dynamic adjustment mechanism to test for the existence of the J-curve, and when three important similarities between Mexico, Brazil and

Colombia are considered. First, the three countries are members of the LAC-7 group, meaning that they belong to the seven largest Latin American economies.[4] Second, the three countries experienced in the previous decade a deep and persistent degree of openness in their economies.[5] Third, the three countries have an external sector where commodity exports are of great importance. International commerce of commodities can have a buffer effect on the balance of trade to exchange rate volatility. As previously discussed, the degree to which prices are transferred and net exports affected from exchange rate variations during the international commercial trade of goods depends on the price elasticity of the imports and exports. Commodities are characteristically of low price elasticity, which decreases the possibility of price transfers; see Dwyer, Kent & Pease (1994). Section 3 discusses in detail the external sector of Colombia and the bilateral trade data used in the analysis of this study.

# 3 Data

The countries selected for the study are Colombia's primary bilateral trade partners, based on the criteria that these consistently ranked among the ten countries that Colombia had the highest yearly trade volume (exports plus imports) for the 1998-2009 time period. These are Germany, Belgium, Brazil, China, Ecuador, the U.S., the Netherlands, Italy, Japan, Mexico, Panama, Peru, the U.K., the Dominican Republic, Switzerland and Venezuela. Total Colombian trade with these countries during the considered time period represents, on average, 80.1% of its total exports and 72.7% of its total imports. These sixteen Colombian trade partners include four LAC-7 member countries and six countries which their national currency is one of the world's main currencies, e.g. the U.S. dollar, the Euro, the British pound and the Japanese Yen.

The data of interest for the study are the time series (i) of Colombian bilateral trade volume, disaggregated according to their respective Harmonized System (HS) Code Classifications, (ii) of Colombian bilateral real exchange rate with each of the considered trade partners, and (iii) of the national income of Colombia and each trade partner. All data is ultimately expressed in quarterly frequency.

[4] LAC-7 members are Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

[5] According to the Openness Index, the yearly openness growth rate of Colombia for the 1998-2009 time period was 2.1%, for Brazil 3.3% and for Mexico 3.8%. Source: Heston, et. al. (2012), Penn World Table Version 7.1.

Table 1: Volume of Colombian Exports and Imports (yearly million USD, nominal 1998-2009)

| | | **Comm** | **Flowers** | **Coffee** | **Corn** | **Sugar** | **Coal** | **Oil** | **Gold** | **FNickel** | **NonCom** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **GER** | X | **214.03** | 7.78 | 198.24 | - | 0.37 | - | 0.80 | 0.01 | 6.83 | **212.80** |
| | M | **0.42** | 5E-4 | - | - | 0.01 | - | 0.40 | - | 0.01 | **786.96** |
| **BEL** | X | **101.49** | 0.05 | 71.51 | - | 0.91 | 1.54 | 1.10 | - | 26.38 | **213.56** |
| | M | **0.43** | - | - | - | 0.08 | - | 0.35 | - | - | **94.90** |
| **BRA** | X | **74.22** | 1.45 | 1E-3 | - | - | 14.13 | 53.26 | - | 5.38 | **183.19** |
| | M | **22.61** | - | 0.62 | 1.25 | 10.92 | - | 9.82 | - | - | **1,106.94** |
| **CHIN** | X | **169.74** | 0.01 | 0.81 | - | 0.21 | 3E-3 | 41.23 | - | 127.48 | **95.86** |
| | M | **0.02** | 2E-4 | 2E-3 | - | 0.01 | - | 0.01 | - | - | **1,448.12** |
| **ECU** | X | **33.58** | 0.06 | 0.19 | 0.10 | 10.37 | 0.21 | 22.65 | - | 1E-4 | **905.02** |
| | M | - | - | - | - | - | - | - | - | - | **470.54** |
| **U.S.** | X | **5,688.5** | 631.49 | 463.6 | 7E-4 | 23.46 | 14.13 | 4,277.4 | 238.4 | 40.06 | **2,161.26** |
| | M | **248.92** | 0.01 | 0.05 | 0.71 | 0.20 | 0.02 | 247.93 | - | 6E-4 | **5,428.98** |
| **ITA** | X | **144.61** | 0.69 | 40.19 | - | 0.23 | 1.09 | - | 1.23 | 101.18 | **189.95** |
| | M | **1.04** | - | 0.06 | - | 0.00 | - | 0.98 | 1E-4 | - | **359.41** |
| **JAP** | X | **223.34** | 10.49 | 181.3 | - | 3E-3 | 0.04 | - | - | 31.51 | **53.98** |
| | M | **1.05** | - | - | - | - | 0.02 | 1.03 | - | - | **728.02** |
| **MEX** | X | **55.45** | 0.18 | 1.31 | 0.20 | 5.22 | 15.27 | 33.27 | - | - | **348.88** |
| | M | **5.71** | - | - | 0.68 | 0.40 | - | 4.63 | 6E-4 | - | **1,365.74** |
| **NET** | X | **74.01** | 11.80 | 32.07 | - | 0.08 | 1.78 | 0.44 | 3E-3 | 27.84 | **374.63** |
| | M | **2.03** | 0.01 | 1E-4 | - | - | - | 2.02 | - | - | **156.55** |
| **PAN** | X | **34.62** | 0.98 | 0.06 | 0.07 | 0.72 | 0.10 | 32.22 | 0.47 | - | **190.30** |
| | M | **1.19** | - | - | - | - | - | 1.19 | - | - | **67.14** |
| **PER** | X | **111.77** | 4E-3 | 0.08 | 0.32 | 29.00 | 21.27 | 61.09 | - | 0.01 | **430.94** |
| | M | **11.04** | 0.01 | 6.71 | | 0.07 | | 4.25 | - | - | **307.92** |
| **U.K.** | X | **101.43** | 33.57 | 39.64 | - | 0.03 | 2.90 | 23.29 | 2.00 | - | **244.22** |
| | M | **8.68** | 1E-4 | 0.01 | - | - | - | 8.67 | - | - | **204.46** |
| **DOM** | X | **209.37** | 4E-3 | - | 5E-3 | 2.29 | 0.07 | 207.0 | - | - | **151.12** |
| | M | **0.00** | - | | - | - | - | 3E-3 | - | - | **3.73** |
| **SWI** | X | **206.67** | 0.95 | - | - | 0.02 | 1.36 | 77.30 | 123.7 | - | **136.80** |
| | M | **0.20** | - | - | - | - | - | 0.20 | - | - | **220.22** |
| **VEN** | X | **55.47** | 4.15 | 0.64 | 0.81 | 38.77 | 4.85 | 6.25 | - | - | **2,331.7** |
| | M | **97.05** | - | 6E-4 | 0.12 | 0.01 | 1E-3 | 96.42 | 0.50 | - | **882.83** |

The source of Colombian bilateral trade data is the Statistical System of International Commerce at the Bureau of National Taxes and Tariffs of Colombia (SIEX at the DIAN, for their respective Spanish abbreviations), and is expressed in "Free on Board" (or FOB) and in monthly nominal U.S. dollars. The monthly data on the volume of bilateral trade is converted to quarterly frequency in order to make it comparable with the other data utilized in the analysis. The year 1998 is chosen as the start of the analyzed period because it is from this date that the SIEX at the DIAN stores and makes publicly available disaggregated bilateral trade data for Colombia. The analyzed time period extends until the end of calendar year 2009 because then Colombia and Venezuela abruptly halted their international trade due to diplomatic conflicts, ref: The Economist (September 10, 2009). Diplomatic relations were restored on August 2010, ref: Bloomberg (August 11, 2010).

The disaggregated bilateral trade data is classified as commodities or non-commodities. Commodity goods are identified as those traded goods which their prices are determined in international commodity exchange markets or are fixed seasonally upon supply and demand dynamics. These goods are flowers and flower bulbs, toasted and untoasted caffeinated and decaffeinated coffee, corn, unrefined cane sugar, coal, crude oil and bituminous minerals, raw gold and ferronickel.[6] Non-commodity goods are identified as those that remain in the bilateral trade time series after commodity goods are identified and removed from the series. Table (1) contains the annual average values, in millions of nominal USD, of Colombian bilateral exports and imports of commodities and non-commodities with its main trade partners for the 1998-2009 time period. Data on the volume of the bilateral trade of commodities is further dissaggregated in Table (1) using the previously described categories of traded goods.[7]

Colombia's primary commercial partner is the U.S.; this country is the destination of 41.1% of its exports and the source of 28.7% of its imports. Colombia's second most important trade partner is Venezuela, with whom shares a 2,219 km frontier, receiving 11.1% of Colombian exports and supplying 4.88% of imports. China is the third principal Colombian trade partner, despite being the destination of only one percent of Colombian exports and this country supplies 8.1% of imports. The main categories of exported goods, in descending order by volume, are crude oil, vegetable products, and mineral products to the U.S., and textile products to Venezuela and the U.S.. Main imports, also in descending order, are machinery and electrical equipment, chemical products, and transportation equipment from the U.S., machinery and electrical equipment from China, and machinery and electrical equipment from Mexico.

The bilateral real exchange rate between Colombia and country $j$ at time period $t$ (or $RER_t^j$) is calculated according to $RER_t^j = (P_t^{col} \cdot NER_t^j)/P_t^j$; where $P_t^{col}$ and $P_t^j$ are the consumer price indexes of Colombia and country $j$ at time $t$, and $NER_t^j$ is the nominal exchange rate between Colombia and country $j$ at time $t$. National income of country $j$ at time $t$, $Y_t^j$, is measured using the quarterly real

[6]Appendix A provides a detailed description of those goods considered in the study as commodities with their respective HS Code Classifications.

[7]Data on the bilateral trade of noncommodities, by major types of goods and services, is presented in Appendix B.

gross domestic product. Bloomberg is the source of quarterly data on bilateral exchange rate, and national price indexes and income statistics.

# 4 Modeling Environment

Equations (1), (2) and (3) contain the modeling environment for Colombian commodity and non-commodity bilateral trade with partner $j$. The setting folows the dynamic adjustment mechanisms in the Autoregressive Distributed Lag (ARDL) cointegration model of Pesaran et al. (2001) and the Engle & Granger (1987) Error Correction (EC) model, as advanced by Halicioglu (2008) and Bahmani-Oskooee & Hajile (2009) for bilateral trade scenarios. Equation (1) is the reduced form of the bilateral trade balance model. $tb^j_{i,t}$ is the natural logarithm of Colombian export to import ratio of commodities and non-commodities, i.e. $i = \{com, noncom\}$, with country $j$ at time $t$. $rer^j_t$ is the natural log of the real exchange rate between the Colombian and country $j$'s currencyat at time $t$. An increase in $rer^j_t$ represents a real devaluation of the Colombian peso and, with it, a detriment of Colombia's terms of trade. $y^j_t$ and $y^{col}_t$ are the natural logs of country $j$'s and Colombia's national income at time $t$, respectively, measured using each country's real gross domestic product. The model is set in quarterly frequency.

$$tb^j_{i,t} = \alpha^j_i + \lambda^j_i \cdot rer^j_t + \beta^j_i \cdot y^j_t + \beta^{col,j}_i \cdot y^{col}_t + \varepsilon^j_{i,t} \tag{1}$$

$\lambda^j_i$ is the real exchange rate elasticity of the Colombian trade balance of types of goods $i$ with country $j$ and is considered being the long-run response of $tb^j_{i,t}$ to bilateral real currency devaluations. If a real devaluation of the Colombian currency is believed to increase the country's exports and decrease imports, then $\lambda^j_i$ is expected to be positive. The Marshall-Lerner condition holds when the elasticity coefficient $\lambda^j_i$ is greater than one with statistical significance. $\beta^{col,j}_i$ and $\beta^j_i$ respectively denote the average percentage change in $tb^j_{i,t}$ as a response to a percentage increase in Colombian and country $j$'s real income. Either, a positive or negative sign for $\beta^{col,j}_i$ and $\beta^j_i$ is sustained by the literature. $\beta^{col,j}_i$ could be positive if an increase in Colombian real income leads also to an increase in imports of type $i$ goods. Yet, if the increase in real income is due to increases in national production of good $i$ import substitutes then $\beta^{col,j}_i$ is expected to have a negative sign; see Halicioglu (2008). Similar arguments apply for the expected sign of $\beta_i^j$.

Equation (2) contains the ARDL representation of Equation (1). Equation (2) considers a dynamic adjustment mechanism on the Colombian bilateral trade balance, where the differences in $tb_{i,t}^j$ are regressed against the lagged values of $tb_{i,t}^j$, $rer_t^j$, $y_t^j$ and $y_t^{col}$, and their $n0$, $n1$, $n2$ and $n3$ order lagged differences. Optimal lag lengths $n0$, $n1$, $n2$ and $n3$ are chosen based on the Akaike Information Criterion. The hypothesis of a J-curve pattern on the Colombian bilateral trade balance with country $j$ is supported when $\lambda_{i,k}^j$ assumes negative values at lower lags and positive values at higher. A cointegration relation between $tb_{i,t}^j$, $rer_t^j$, $y_t^j$ and $y_t^{col}$, i.e. moving in a path together towards long-run equilibrium, can be tested under the null hypothesis of no cointegration, e.g. $Ho: \delta_0^j = \delta_1^j = \delta_2^j = \delta_3^j = 0$. Considering that the F-test for testing the null has a non-standard distribution, Pesaran et. al. (2001) computes lower and upper bounds of critical values, assuming all variables are I(0) or I(1). If the F-statistic is higher [lower] than the upper [lower] bound, then reject [do not reject] the null. If the F-statistic is between the bounds, then the test is inconclusive.

$$\Delta tb_{i,t}^j = \theta_i^j + \sum_{k=1}^{n0}\varphi_{i,k}^j \Delta tb_{i,t-k}^j + \sum_{k=0}^{n1}\lambda_{i,k}^j \Delta rer_{t-k}^j + \sum_{k=0}^{n2}\beta_{i,k}^j \Delta y_{t-k}^j + \sum_{k=0}^{n3}\beta_{i,k}^{col,j} \Delta y_{t-k}^{col}$$
$$... + \delta_{i,0}^j \cdot tb_{i,t-1}^j + \delta_{i,1}^j \cdot rer_{t-1}^j + \delta_{i,2}^j \cdot y_{t-1}^j + \delta_{i,3}^j \cdot y_{t-1}^{col} + u_{i,t}^j \quad (2)$$

On Equation (3), the ARDL model in Equation (2) is reformulated into a general Error Correction model. $EC_{t-1}^j$ is the error-correction term and is constructed using the lagged residual of the reduced form model in Equation (1); i.e. $EC_{i,t-1}^j = tb_{i,t-1}^j - \left[\alpha_i^j + \lambda_i^j \cdot rer_{t-1}^j + \beta_i^j \cdot y_{t-1}^j + \beta_i^{col,j} \cdot y_{t-1}^{col}\right]$. A statistically significant negative value of coefficient $\phi_i^j$ can also be used to test the null hypothesis of no cointegration among the variables. Kremers et. al. (1992), Bahmani-Oskooee & Goswami (2003) and Halicioglu (2008) are examples in the literature where the statistical significance of $\phi_i^j$ is used to directly test for cointegration or to conclusively test variable cointegration for those cases where the calculated F-statistic of the ARDL model yield an inconclusive result. The Akaike Information Criterion is used to choose the optimal lag lengths $n0$, $n1$, $n2$ and $n3$ for Equation (3).

$$\Delta tb_{i,t}^j = \theta_i^j + \sum_{k=1}^{n0}\varphi_{i,k}^j \Delta tb_{i,t-k}^j + \sum_{k=0}^{n1}\lambda_{i,k}^j \Delta rer_{t-k}^j + \sum_{k=0}^{n2}\beta_{i,k}^j \Delta y_{t-k}^j + \sum_{k=0}^{n3}\beta_{i,k}^{col,j} \Delta y_{t-k}^{col}$$
$$... + \phi_i^j \cdot EC_{i,t-1}^j + u_{i,t}^j \quad (3)$$

The model estimation is evaluated based on its overall fit, stability of coefficients, sequential correlation of the residuals and misspecification. Overall fit is measured using the adjusted R-squared of the estimation. The CUSUM and CUSUMSQ tests, originally developed in Brown et. al. (1975) and based on the recursive regression residuals using their cumulative sum and their cumulative sum of squares, are used to assess the estimated coefficients stability. Stability is not implied by cointegration, as stated in Bahmani-Oskooee and Brooks (1999). If the graphical representations of these statistics are within the critical bounds of 5% significance, then the coefficients of the regression are stable. Serial correlation is tested under the null of no serial correlation using a Lagrangian Multiplier statistic, which has $\chi^2$ distribution with one degree of freedom. The model misspecification is tested using Ramsey's RESET test under the null of a not misspecified model, and also is distributed according to $\chi^2$ with one degree of freedom.

## 5 Empirical Findings

Tables (2) and (3) contain the coefficient estimates of the real exchange rate regressors $\lambda_i^j$ for the long-run reduced form model in Equation (1), and for the lagged differences of the real exchange rate regressors $\left\{\lambda_{i,k}^j\right\}_{k=0}^4$ and the lagged error-correction term $EC_{i,t-1}^j$ of the short-run dynamic adjustment error-correction model in Equation (3). Tables (2) and (3) also contain the diagnostic statistics that test the appropriateness of the model described in Equations (1)-(3) for analyzing Colombian bilateral trade data. These are the CUSUM and CUSUMSQ test statistics on the stability of the residuals of the optimal models, the $\chi^2$ statistic from the Lagrangian Multiplier on a test for serial correlation on the residuals of the model estimation, the $\chi^2$ statistic from the Ramsey's RESET test for model misspecification, and the adjusted R square indicating the overall fit of the estimation.

The J-curve hypothesis, tested by inspecting the presence of statistically significant negative coefficients for $\left\{\lambda_{i,k}^j\right\}_{k=0}^4$ at early lags and positive at later lags, is not sustained for any of the analyzed bilateral trade scenarios. Although no instances were found confirming the J-curve hypothesis, individual scenarios arouse where either Colombian bilateral net exports initially decrease following a real devaluation of the Colombian currency (e.g. the price effect of a devaluation), or where Colombian net exports increased in the longer run trailing a devaluation (e.g. the volume effect). As expected,

Table 2: Exchange Rate Coefficient for Colombian Commodity Trade

| $i =$ $comm$ | $\lambda^j_{i,0}$ | $\lambda^j_{i,1}$ | $\lambda^j_{i,2}$ | $\lambda^j_{i,3}$ | $\lambda^j_{i,4}$ | $\lambda^j_i$ | $EC^j_{i,t-1}$ | $LM$ $reset$ | $csum$ $csum2$ | $R^2_{adj}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| **GER** | **-1.95** | | | | | **-0.68** | **-0.74** | 0.1 | S | 0.57 |
| | (1.3) | | | | | (1.6) | (3.7)*** | 0.2 | S | |
| **BEL** | **-0.68** | | | | | **-3.5** | **-0.94** | 1.1 | S | 0.40 |
| | (0.2) | | | | | (3.2)*** | (4.5)*** | 0.9 | S | |
| **BRA** | **-0.66** | | | | | **5.46** | **-0.57** | 2.5 | S | 0.50 |
| | (0.2) | | | | | (2.2)** | (2.9)*** | 0.3 | S | |
| **CHIN** | **-6.4** | | | | | **5.03** | **-0.68** | 1.8 | U | 0.48 |
| | (0.2) | | | | | (0.6) | (3.2)*** | 0.1 | U | |
| **ECU** | **-0.52** | | | | | **2.22** | **-0.76** | 1.9 | S | 0.36 |
| | (0.3) | | | | | (2.9)*** | (3.4)*** | 0.0 | S | |
| **U.S.** | **0.72** | **-2.03** | | | | **0.12** | **-2.11** | 2.2 | S | 0.70 |
| | (0.5) | (1.6) | | | | (0.2) | (5.9)*** | 0.0 | S | |
| **ITA** | **1.29** | **5.4** | **1.51** | **-3.74** | **2.36** | **0.56** | **-1.86** | 0.4 | S | 0.51 |
| | (0.2) | (0.8) | (0.2) | (0.6) | (0.4) | (0.4) | (3.0)*** | 0.0 | S | |
| **JAP** | **1.94** | **2.43** | **0.42** | **-3.14** | **4.41** | **-0.37** | **-1.15** | 3.4* | S | 0.54 |
| | (0.5) | (0.6) | (0.1) | (0.8) | (1.2) | (0.5) | (2.5)** | 2.5 | S | |
| **MEX** | **-2.95** | **11.98** | **-15.2** | **-12.64** | **-4.76** | **-2.74** | **-0.57** | 1.3 | S | 0.49 |
| | (0.4) | (1.8)* | (2.0)* | (1.7)* | (0.7) | (1.1) | (2.5)** | 1.1 | S | |
| **NET** | **-18.07** | | | | | **-18.8** | **-0.67** | 0.7 | U | 0.50 |
| | (1.4) | | | | | (4.4)*** | (2.0)** | 0.0 | U | |
| **PAN** | **50.28** | **20.96** | **0.45** | **13.34** | **-47.95** | **22.27** | **-1.49** | 1.3 | U | 0.51 |
| | (1.0) | (0.4) | (0.0) | (0.2) | (1.0) | (2.1)** | (2.7)*** | 5.2** | S | |
| **PER** | **-5.28** | **-2.33** | **-8.45** | **6.6** | **1.46** | **-1.55** | **-0.68** | 1.2 | S | 0.35 |
| | (1.1) | (0.5) | (1.7) | (1.0) | (0.2) | (1.4) | (1.8)* | 0.2 | S | |
| **U.K.** | **7.61** | **4.96** | **-8.5** | **5.09** | **-2.94** | **3.68** | **-0.73** | 7.2*** | S | 0.55 |
| | (1.7)* | (1.0) | (2.0)* | (1.0) | (0.6) | (1.6) | (2.9)*** | 1.0 | U | |
| **DOM** | **0.78** | **-3.67** | **14.13** | **-5.3** | **-17.97** | **-1.98** | **-1.31** | 0.2 | U | 0.41 |
| | (0.1) | (0.3) | (1.1) | (0.4) | (1.3) | (0.6) | (1.8)* | 1.2 | U | |
| **SWI** | **9.23** | | | | | **-1.05** | **-0.76** | 2.7* | S | 0.47 |
| | (1.5) | | | | | (1.0) | (2.2)** | 0.0 | U | |
| **VEN** | **0.36** | **1.55** | **-7.02** | **3.43** | **1.36** | **1.93** | **-1.06** | 12.4*** | S | 0.27 |
| | (0.1) | (0.4) | (1.7) | (0.9) | (0.4) | (1.7)* | (2.2)** | 0.7 | S | |

Colombian non-commodity trade proves being more short-run responsive to exchange rate volatility than commodity trade. Following a home-currency devaluation, significant short term declines are present for Colombian bilateral non-commodity trades with Germany, Belgium, China, the U.K. and Switzerland. Combined, these five partners are the destination of 14% of Colombian non-commodity exports and the source of 20% of its imports. This short-run effect never occurred for the cases analyzed of bilateral trade of commodities.

Colombian bilateral trade of commodities with Brazil, Ecuador, Panama and Venezuela showed significant long-run improvements after the real devaluation of the Colombian currency. Three percent (3%) of Colombian commodity exports are destined to these countries and 30% of its commodity imports are sourced from them. The Marshall-Lerner condition holds for the cases of Colombian bilateral commodity trade with Brazil and Panama, that is one percent (1%) of total commodity exports and six percent (6%) of imports. A devaluation of the Colombian peso is found to be associated with long-run increases in the country's bilateral trade balance of non-commodities with Brazil, Ecuador, the U.S., Italy, Japan, Mexico, the Netherlands, Panama, Peru and Venezuela. These countries are the destination of 77% of Colombian non-commodity exports and the source of 80% of imports. The Marshall-Lerner condition holds for the non-commodity trade with Brazil, the Netherlands and Venezuela. These countries correspond to 31% of total Colombian non-commodity exports and 16% of imports.

Trade scenarios are observed where a real devaluation of the Colombian peso causes short-run improvements in the country's trade balance or long-run detriments. A devaluation of the Colombian currency, on average, causes short-run increases in the bilateral commodity trades with Mexico and the U.K.. Commodity trade with these countries during the 1998-2009 period averages to merely 2% of Colombian exports and 4% imports. Nevertheless, these instantaneous increases are immediately followed by even greater decreases in the trade balance, resulting in a negative net outcome for the bilateral trade balance in a longer horizon short-run. The long-run impact of a devaluation of the Colombian peso in the bilateral commodity trades with Belgium and the Netherlands is negative. Colombian commodity trade with these countries represents 2% of exports and 1% of exports. Colombian bilateral non-commodity trades with Brazil, the U.S., the Netherlands, Panama and Venezuela respond positively in the short-run to a real devaluation of the Colombian peso. These countries represent 56% of Colombian non-commodity exports and of its imports. Bilateral non-commodity trade with Germany (2% of Colombian non-commodity exports and 6% imports) responds negatively in the long-run to a real devaluation of the Colombian currency.

Cointegration, defined as the occurrence of a long-run relationship among the variables in the model, is considered to exist provided the presence of a statistically significant negative value for the error correction coefficient in Equation (3). The values reported in Table (2) indicate that there is presence

Table 3: Exchange Rate Coefficient for Colombian Non-Commodity Trade

| $i = no$ $comm$ | $\lambda^j_{i,0}$ | $\lambda^j_{i,1}$ | $\lambda^j_{i,2}$ | $\lambda^j_{i,3}$ | $\lambda^j_{i,4}$ | $\lambda^j_i$ | $EC^j_{i,t-1}$ | $LM$ $reset$ | $csum$ $csum2$ | $R^2_{adj}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| **GER** | **-0.16** | **-0.57** | **-1.19** | **0.98** | | **-0.74** | **-0.81** | 1.3 | S | 0.45 |
| | (0.2) | (0.9) | (1.7)* | (1.5) | | (3.7)*** | (3.9)*** | 0.0 | S | |
| **BEL** | **-0.42** | **0.5** | **0.29** | **-0.49** | **-1.79** | **-0.1** | **-0.88** | 5.0** | S | 0.51 |
| | (0.6) | (0.7) | (0.5) | (0.8) | (2.8)*** | (0.5) | (4.0)*** | 1.1 | S | |
| **BRA** | **2.98** | **0.38** | **0.22** | **0.14** | **1.82** | **2.26** | **0.08** | 0.4 | S | 0.32 |
| | (3.8)*** | (0.6) | (0.4) | (0.2) | (2.8)*** | (4.6)*** | (0.3) | 0.7 | S | |
| **CHIN** | **-1.82** | | | | | **0.29** | **-0.63** | 6.5** | S | 0.50 |
| | (3.0)*** | | | | | (0.9) | (4.8)*** | 0.1 | S | |
| **ECU** | **0.31** | **0.47** | | | | **0.35** | **-0.76** | 2.7 | S | 0.39 |
| | (0.9) | (1.5) | | | | (2.2)** | (4.2)*** | 0.2 | S | |
| **U.S.** | **1.00** | **0.41** | **-0.05** | **0.88** | **-0.84** | **0.44** | **-0.35** | 7.5*** | S | 0.60 |
| | (2.4)** | (0.9) | (0.1) | (2.2)** | (2.2)** | (2.4)** | (2.0)* | 0 | S | |
| **ITA** | **1.07** | **1.04** | **-1.43** | **0.8** | **-0.35** | **0.77** | **-1.06** | 1.2 | S | 0.52 |
| | (0.9) | (1.0) | (1.4) | (0.8) | (0.3) | (3.0)*** | (2.0)* | 5.5** | S | |
| **JAP** | **-0.42** | **-0.5** | **0.15** | **-0.15** | | **0.21** | **-0.8** | 2.1 | S | 0.34 |
| | (0.7) | (0.8) | (0.2) | (0.2) | | (1.8)* | (2.6)** | 1.6 | S | |
| **MEX** | **0.06** | **0.32** | **0.7** | **0.02** | **0.4** | **0.99** | **-0.28** | 6.8*** | S | 0.08 |
| | (0.1) | (0.5) | (0.9) | (0.0) | (0.6) | (3.7)*** | (1.3) | 1.1 | S | |
| **NET** | **-0.13** | **3.35** | **-1.81** | | | **1.53** | **-1.81** | 4.7** | S | 0.70 |
| | (0.2) | (3.9)*** | (1.9)* | | | (5.2)*** | (6.1)*** | 0.2 | S | |
| **PAN** | **1.43** | **-2.43** | **3.93** | **-5.66** | **2.69** | **0.89** | **-0.56** | 3.4* | S | 0.50 |
| | (0.7)* | (1.1) | (1.6) | (2.3)** | (1.3) | (1.8)* | (1.6) | 0.6 | S | |
| **PER** | **0.01** | **-0.12** | **0.07** | **-0.06** | **-0.22** | **0.32** | **-0.52** | 2.4 | S | 0.08 |
| | (0.0) | (0.2) | (0.1) | (0.1) | (0.4) | (3.3)*** | (1.8)* | 0.8 | S | |
| **U.K.** | **-2.34** | **-1.74** | **0.23** | **0.86** | **-0.12** | **-0.64** | **-0.83** | 0.5 | S | 0.48 |
| | (1.8)* | (1.5) | (0.2) | (0.7) | (0.1) | (1.2) | (2.5)** | 1.8 | S | |
| **DOM** | **0.16** | **-0.45** | **1.01** | **-0.4** | **-0.35** | **-0.42** | **-1.06** | 2.5 | S | 0.40 |
| | (0.2) | (0.5) | (1.2) | (0.4) | (0.4) | (1.2) | (2.4)** | 0.3 | S | |
| **SWI** | **-0.29** | **-2.58** | | | | **-0.44** | **-0.36** | 0.2 | S | 0.11 |
| | (0.2) | (1.7)* | | | | (0.9) | (2.2) | 4.1** | S | |
| **VEN** | **1.21** | **1.36** | **-1.75** | **-0.51** | **-0.19** | **2.11** | **-0.71** | 2.9* | S | 0.48 |
| | (2.0)** | (2.1)* | (2.0)** | (0.6) | (0.3) | (6.4)*** | (2.8)*** | 4.8** | U | |

of cointegration in Colombian commodity bilateral trade with all analyzed trading partners. Cointegration is less common in Colombian non-commodity trade, as is observed in Table (3) . Cointegration is not present on Colombian non-commodity trade with Brazil, Mexico, Panama and Switzerland.

The results of the diagnostic tests on the model estimation results, e.g. overall fit, stability of coefficients, sequential correlation of the residuals and model misspecification, suggest that the model described in Equations (1)-(3) is appropriate for analyzing Colombian bilateral trade data. The overall fit of each of the estimated models is measured using the adjusted R-square statistic. With the exception of the regression equations modeling Colombian non-commodity trade with the Netherlands, Peru and Switzerland, all estimated equations are able to explain over a third of the observed variability (adjusted for degrees of freedom) in $\Delta tb^{j}_{i,t}$. The combined result of the CUSUM and CUSUMSQ tests (both considering bounds corresponding to $\alpha = 5\%$) coincide on the instability of the estimated parameters that describe Colombian commodity trade with China, the Netherlands and the Dominican Republic. On other cases the combined results of both tests are not conclusive: the CUSUM stability test considers unstable Colombian commodity trade with Panama, and the CUSUMSQ considers unstable that with the U.K. and Switzerland. Colombian bilateral trade of non-commodities with the considered partners appears to be more stable. Both stability tests did not concurrently considered unstable the coefficients of any model describing this type of Colombian trade. Only the CUSUMSQ test considers unstable such trade with Venezuela. Most model estimations did not give evidence of serial correlation in the residuals or misspecification. According to the Lagrange Multiplier test statistic, considering the critical value of $\chi^2$ at a significance level of 5% and one degree of freedom, e.g. $\chi^2_{\alpha=5\%}(1) = 3.84$, the residuals of the regression estimations for Colombian bilateral commodity trade with the U.K. and Venezuela and for Colombian bilateral non-commodity trade with Belgium, China, the U.S., Mexico and the Netherlands show first order serial correlation. The Ramsey test statistic for model functional misspecification, also considering $\chi^2_{\alpha=5\%}(1) = 3.84$, indicate that the estimation equations for Colombian commodity trade with Panama, and non-commodity trade with Italy, Switzerland and Venezuela are misspecified.

## 6 Conclusion

A dynamic adjustment mechanism is used to analyze the short-run and long-run responses of Colombian international trade to real exchange rate volatility. This is done under the scope of the Marshall-Lerner condition, a cointegration analysis and the J-curve hypothesis where an Error-Correction model is used to estimate Colombian bilateral commodity and non-commodity trade with its main exchange partners for the 1998-2010 period. The main international trade partners of Colombia in term of total volume of trade are Germany, Belgium, Brazil, China, Ecuador, the U.S., the Netherlands, Italy, Japan, Mexico, Panama, Peru, the U.K., the Dominican Republic, Switzerland and

Venezuela. International trade with these countries represents 80.1% of Colombia's total exports and 72.7% of total imports.

Colombian bilateral trade of commodities with each of its main trade partners is cointegrated. That is, the commodity bilateral balances of trade for Colombia with all of these countries are in long-run equilibria with their real exchange rates and their income levels. Cointegration is also always found in the Colombian bilateral trade of non-commodities with those countries that their national currency is one of the world's main currencies, e.g. the U.S. dollar, the Euro, the British pound and the Japanese Yen. Such a precise result is not found on the Colombian bilateral trade of non-commodities with countries that their national currency is distinct from those that are the world's main currencies. Considering these results, it may be argued that the distinctions in the presence of long-run equilibria in international trade may be due to the currency denomination of the trade volume and not specifically the trade partner; i.e. non-commodity trade is likely to be denominated in the currency of the exporting country, while commodity trade is often priced in terms of the world's main currencies.

Although no evidence sustaining the J-curve hypothesis was found analyzing Colombian bilateral trade of commodities or of non-commodities, individual scenarios arouse where either Colombian bilateral net exports initially decrease following a real devaluation of the Colombian currency, or where Colombian net exports increased in the longer run trailing a devaluation. These are cases where either the "price effect" or the "volume effect" following a devaluation is present, but not both. The "price effect" or the short-run decrease in the trade balance after the devaluation is never observed in the Colombian bilateral trade of commodities, nor in the Colombian bilateral trade of non-commodities with each of its main Latin-American partners. The "price effect" in some occasions is observed in the non-commodity trade of Colombia with countries that their national currency is one of world's four main currencies. The opposite effect, or a short-run increase in the trade balance following a devaluation, is significantly a more predominant behavior of the Colombian bilateral balance of trade of non-commodities than is a short-run decrease. Colombian bilateral trade, with most of its trade partners and particularly in the trade of non-commodities, experienced long-run increases in its net-export after a devaluation.

Summarizing, the results presented in this paper indicate that the detriment of the Colombian terms of trade will have no significant short-run impact on the bilateral trade of commodities with any of its main partners and will have a positive long-run impact on the bilateral trade of these goods exclusively with the country's main Latin-American trade partners. The satisfaction of the ML-condition in only a few of these trade scenarios suggests that it is trivial the volume of the balance of payments of commodity trade that is affected by real exchange rate volatility. The detriment of the Colombian terms of trade will have a negative short-run impact on the bilateral trade of non-commodities with a considerable number of its main trade partners as the J-curve hypothesis would predict, but most of the volume of Colombian bilateral trade of non-commodities exhibits short- and long-run improvements after a real devaluation of the currency. In great contrast with what observed in the Colombian trade of commodities, the ML-condition suggests that real exchange rate volatility affects a significant volume of the balance of payments from the bilateral trade of non-commodities.

Considering that the most recent economic history of Colombia involves stark real appreciations of its currency it is important to analyze the trade balance from the perspective of improvements in the terms of trade of the country and its possible impact on the permanence of the current surplus. The results of this paper suggest that: (1) improving the terms of trade of Colombia will not significantly affect the short-run surplus of Colombian commodity trade, (2) improving the terms of trade of Colombia will negatively affect, in a trivial amount, the long-run surplus of Colombian commodity trade, mostly by increasing these import categories from its Latin-American partners, and (3) improving the terms of trade of Colombia will negatively affect the Colombian short- and long-run balance of trade of non-commodities, increasing the current deficit. These results support the conjecture that, ceteris paribus, if continuous improvements in the terms of trade of Colombia are not accompanied by enhancements in the country's productivity (e.g. international differentials in wages and/or unit labor requirements), especially in the manufacture of non-commodities, then the permanence of the current Colombian trade balance surplus is not sustainable over a longer horizon.

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Table 4: Appendix A - HS Classification Codes and Description of Colombian Commodities

| **Head & Subhead** | **Description of commodity good** |
|---|---|
| 0603 | Cut flowers and flower buds of a kind suitable for bouquets or for ornamental purposes, fresh, dried, dyed, bleached, ,impregnated or otherwise prepared. |
| 090111 | Coffee, not roasted, Not decaffeinated |
| 090112 | Coffee, not roasted, decaffeinated |
| 090121 | Coffee roasted, Not decaffeinated |
| 090122 | Coffee roasted, decaffeinated |
| 100510 | Cornseed |
| 170111 | Raw sugar not containing added flavouring or colouring matter. Cane sugar |
| 170199 | Raw sugar not containing added flavouring or colouring matter. Other |
| 2704 | Coal |
| 2709 | Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes |
| 2710 | Petroleum oils and oils obtained from bituminous minerals, other than crude |
| 710812 | Gold (including gold plated with platinum) |
| 720260 | Ferro-nickel |

Table 5: Appendix B - Colombian Non-Commodity Exports and Imports (million USD, 1998-2009)

| | | GERM | BEL | BRA | CHIN | ECUA | U.S. | ITA | JAP | MEX | NET | PAN | PER | REIN | U.K. | SWI | VEN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Animal | X | 1.8 | 0.8 | 0.3 | 0.3 | 6.0 | 35.6 | 1.0 | 5.4 | 0.6 | 0.3 | 1.4 | 0.6 | 0.1 | 0.2 | 0.1 | 287.8 |
| Products | M | 0.7 | 0.3 | 3.1 | 1.4 | 13.0 | 19.6 | 0.1 | 0.0 | 0.6 | 1.4 | 2.4 | 3.5 | 0.7 | 0.0 | 0.2 | 3.9 |
| Vegetable | X | 90.6 | 176.7 | 6.6 | 2.3 | 13.0 | 203.8 | 35.6 | 4.4 | 14.8 | 16.5 | 4.5 | 6.2 | 50.9 | 5.0 | 1.0 | 57.5 |
| Products | M | 3.9 | 1.2 | 32.4 | 10.4 | 76.5 | 506.4 | 1.7 | 0.3 | 9.6 | 9.0 | 0.0 | 8.3 | 1.0 | 0.0 | 0.2 | 18.7 |
| Food | X | 16.1 | 6.1 | 3.7 | 0.2 | 64.0 | 112.7 | 24.2 | 16.6 | 11.9 | 7.6 | 8.8 | 30.3 | 13.8 | 15.0 | 1.4 | 138.3 |
| Products | M | 2.7 | 1.8 | 58.2 | 6.5 | 85.8 | 136.1 | 6.7 | 0.2 | 29.2 | 7.5 | 1.7 | 33.7 | 16.7 | 0.3 | 1.3 | 48.8 |
| Mineral | X | 75.0 | 16.9 | 29.7 | 1.8 | 54.7 | 634.9 | 82.5 | 6.2 | 12.7 | 330.2 | 16.1 | 32.8 | 152.3 | 28.3 | 13.7 | 61.4 |
| Products | M | 2.6 | 0.1 | 9.5 | 9.2 | 6.7 | 18.0 | 2.0 | 1.1 | 2.8 | 0.3 | 0.1 | 2.8 | 1.6 | 0.6 | 1.2 | 6.3 |
| Chemical | X | 2.4 | 3.6 | 28.1 | 4.2 | 186.1 | 131.2 | 2.4 | 1.2 | 62.8 | 1.1 | 54.0 | 97.8 | 3.6 | 19.7 | 37.8 | 252.8 |
| Products | M | 237.6 | 41.9 | 132.5 | 137.0 | 22.1 | 1,113.8 | 64.0 | 53.7 | 253.5 | 45.6 | 9.1 | 27.2 | 65.9 | 0.2 | 113.2 | 208.9 |
| Plastics / | X | 1.5 | 1.5 | 69.0 | 3.8 | 104.3 | 82.3 | 4.2 | 0.0 | 48.5 | 2.7 | 13.4 | 89.3 | 2.8 | 27.5 | 0.3 | 148.5 |
| Rubber | M | 43.7 | 13.5 | 80.5 | 68.7 | 27.6 | 348.8 | 19.3 | 54.0 | 79.9 | 5.8 | 1.8 | 31.9 | 12.3 | 0.0 | 3.4 | 95.7 |
| Leathers | X | 1.7 | 2.1 | 0.5 | 8.9 | 3.4 | 39.7 | 28.3 | 0.9 | 8.6 | 1.0 | 2.1 | 1.2 | 1.0 | 1.5 | 0.0 | 53.6 |
| | M | 0.4 | 0.1 | 1.9 | 24.3 | 0.7 | 3.5 | 1.6 | 0.1 | 0.5 | 0.0 | 0.5 | 0.6 | 0.1 | 0.0 | 0.1 | 0.3 |
| Wood | X | 0.3 | 1.1 | 4.1 | 1.6 | 89.9 | 38.7 | 0.2 | 1.7 | 37.1 | 0.3 | 18.5 | 46.9 | 3.0 | 16.7 | 0.0 | 158.6 |
| Products | M | 25.7 | 3.9 | 37.3 | 16.1 | 25.4 | 164.2 | 8.6 | 1.9 | 19.9 | 4.1 | 0.7 | 16.4 | 6.2 | 0.6 | 2.4 | 15.4 |
| Textiles | X | 13.4 | 0.2 | 9.5 | 0.7 | 84.5 | 360.3 | 5.8 | 0.2 | 80.3 | 0.8 | 13.9 | 27.6 | 8.8 | 5.9 | 0.3 | 388.8 |
| | M | 9.9 | 4.1 | 55.3 | 127.4 | 32.7 | 188.2 | 20.5 | 2.8 | 48.8 | 2.8 | 4.9 | 29.8 | 3.4 | 0.1 | 1.9 | 18.2 |
| Footwear / | X | 1.9 | 0.5 | 0.1 | 0.0 | 7.9 | 5.1 | 0.0 | 0.0 | 2.7 | 0.3 | 2.4 | 1.0 | 0.2 | 0.6 | 0.0 | 44.1 |
| Headgear | M | 0.2 | 0.0 | 9.3 | 66.5 | 16.0 | 4.4 | 2.4 | 0.1 | 0.7 | 0.2 | 10.7 | 1.8 | 0.1 | 0.0 | 0.0 | 0.9 |
| Stone | X | 3.1 | 2.0 | 3.9 | 0.1 | 31.5 | 216.3 | 2.5 | 15.0 | 10.4 | 0.4 | 9.4 | 14.4 | 4.4 | 5.6 | 81.5 | 69.5 |
| & Glass | M | 6.8 | 1.2 | 25.2 | 36.2 | 6.5 | 28.9 | 8.1 | 1.6 | 19.8 | 0.4 | 0.8 | 10.4 | 1.1 | 0.0 | 0.4 | 11.3 |
| Metals | X | 1.0 | 1.5 | 13.8 | 70.1 | 54.9 | 130.9 | 1.2 | 1.5 | 20.5 | 11.1 | 17.2 | 34.9 | 0.8 | 9.9 | 0.1 | 108.7 |
| | M | 42.9 | 5.3 | 210.5 | 109.2 | 31.7 | 210.6 | 18.3 | 99.2 | 108.4 | 3.5 | 3.2 | 131.1 | 15.5 | 0.3 | 4.0 | 332.8 |
| Machinery / | X | 1.9 | 0.1 | 5.2 | 1.8 | 66.1 | 81.2 | 1.2 | 0.2 | 27.5 | 1.6 | 14.1 | 36.8 | 1.3 | 8.8 | 0.3 | 204.8 |
| Electrical | M | 290.6 | 18.1 | 261.4 | 614.2 | 16.1 | 1,571.3 | 168.0 | 219.3 | 581.3 | 41.5 | 17.2 | 6.0 | 55.7 | 0.3 | 62.7 | 26.6 |
| Transports | X | 0.1 | 0.0 | 1.7 | 0.0 | 119.4 | 40.2 | 0.2 | 0.0 | 1.9 | 0.3 | 4.1 | 1.8 | 0.2 | 1.3 | 0.0 | 296.2 |
| | M | 62.9 | 1.9 | 150.6 | 56.3 | 107.9 | 786.0 | 10.9 | 233.8 | 192.1 | 20.3 | 8.7 | 0.2 | 10.2 | 0.5 | 0.5 | 90.7 |
| Miscel. | X | 1.9 | 0.4 | 7.0 | 0.1 | 19.4 | 47.4 | 0.6 | 0.6 | 8.3 | 0.4 | 10.2 | 9.3 | 1.0 | 5.2 | 0.3 | 61.1 |
| | M | 56.1 | 1.7 | 31.5 | 139.2 | 1.9 | 325.7 | 19.9 | 45.7 | 18.5 | 14.0 | 5.0 | 4.1 | 13.8 | 0.7 | 25.8 | 4.2 |
| Services | X | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.9 | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 |
| | M | 0.1 | 0.0 | 7.9 | 25.6 | 0.1 | 3.4 | 7.3 | 14.3 | 0.3 | 0.0 | 0.1 | 0.1 | 0.1 | 0.0 | 3.1 | 0.2 |