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Abstract

This paper documents the adjustment of international trade for the Colombian manufacturing sector following the 2014-2105 depreciation of the peso. We combine detailed information on trade with firm-level balance sheet and credit data, and we analyze the response of exports and imports at the macro-, firm-, and product-level to the exchange rate shock. The evidence indicates that export and import prices are sticky in dollars, and therefore the depreciation triggered a relatively rapid contractionary response from imports, whereas the response from exports was slower and weaker. Our micro-level analyses of the combined data suggest that the muted response of exports is associated with exporting firms' reliance on imported imports, and with their preexisting higher debt, as predicted by the literature on balance sheet effects.

JEL Codes: F1; F4; L1; L6

Key Words: Exchange Rate; Exports; Imports; Manufacturing Sector

La depreciación del peso colombiano en 2014-2015 y el ajuste del comercio exterior en el sector manufacturero

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Resumen

En este documento describimos el ajuste del comercio internacional del sector manufacturero colombiano a la depreciación del peso de 2014-2015. Combinamos información detallada de comercio exterior con datos de balances y créditos comerciales a nivel de firma, y analizamos la respuesta de las exportaciones y las importaciones al choque cambiario a niveles macro, de firma y de producto. Encontramos que los precios de las exportaciones y las importaciones son rígidos en dólares, y por lo tanto la depreciación generó una contracción rápida de las importaciones mientras que la respuesta de las exportaciones fue menor y más lenta. El análisis de los microdatos sugiere que la respuesta débil de las exportaciones está asociada con el uso de insumos importados por parte de las firmas exportadoras, y con la existencia previa de mayores niveles de endeudamiento.

Códigos JEL: F1; F4; L1; L6

Palabras clave: Tasa de cambio; Exportaciones; Importaciones; Sector manufacturero

1. Introduction

In the year 2014 the Colombian peso, as many other world currencies, suffered a large depreciation that took its price from less than COP $2000 per US dollar in 2013 to more than $3000 per US dollar in 2015. Similar depreciations against the US dollar occurred across the world and were related to the sudden drop in the US dollar prices of commodities. In the Colombian case, the depreciation was tied to the fall in the price of oil, which constitutes a large portion of Colombian exports and generates a large portion of fiscal revenues.

In this paper we document the adjustment of export and import prices and flows that took place after this depreciation. We focus on the manufacturing sector and analyze both trade and production data. Therefore, we are not addressing broader issues, like the recomposition of demand between tradable and non-tradable sectors. We perform product- and firm-level analysis, informed by the literature on expenditure switching (as described in, for example, Engel, 2002).

A careful analysis of trade prices at the 10-digit product level suggests that the response of export and import prices of manufactured goods to the peso depreciation was small and slow when measured in dollars, while prices in pesos adjusted with the exchange rate. This evidence is consistent with results in Casas (2020), who shows that most exports are invoiced in US dollars across manufacturing sectors. Moreover, it suggests that imports are also predominantly invoiced (and priced) in dollars. This result contributes to shed light on an important data gap since customs declarations only record the currency of invoicing for exports.

Regarding trade flows, our main observation is that the depreciation of 2014-2015 triggered a relatively rapid response from imports, whereas the response from exports was relatively slower and weaker. These results stand in contrast with cross-country evidence that exports adjust rather immediately after a large depreciation (as reported by Leigh et al., 2017). The evidence is instead consistent with a model in which trade prices are set in a foreign dominant currency and adjust slowly, as suggested by Gopinath et al. (2020). We also evaluate the relative relevance of the adjustment channels in trade and production patterns that have been pointed out by the literature.

The paper is organized as follows. In the second section, we present a brief review of the literature to fix the ideas that guide our empirical analysis. In the third section, we describe our data and show the results of some descriptive analyses. In the fourth section we perform an econometric analysis. The fifth section concludes.

2. Related literature

The current debate in the literature about the effects of exchange rate changes on trade and production dates back to the 1970s when the system of exchange rate pegs across advanced economies broke down (see, for example, Magee, 1973, and Junz and Rhomberg, 1973) causing changes in the exchange rates across all developed economies. If prices are set in the producer's currency, then the standard notion is that a currency depreciation lowers the price of exports relative to the price of imports and improves the relative competitiveness of exports. Hence, it should increase exports and decrease imports. Nevertheless, it has been noted that the adjustment process is hindered and slowed down by frictions and other market features (see Engel, 2002 for a full review of the issues and the literature).

The connection between exchange rate fluctuations and real production and trade has two components: on the one hand, there is the transmission of exchange rate fluctuations to the prices faced by firms and consumers. On the other hand, there is the link between price changes and real variables. The debate has important policy implications regarding the optimal type of exchange rate regime and its regulation.

A common empirical fact, which we will analyze in the context of our Colombian data set, is that the pass-through of exchange rate fluctuations to trade prices (in the currency in which prices are denominated) is often slow and incomplete. The fact that the prices of traded goods do not adjust flexibly to changes in the exchange rate may mean that prices are sticky in dollars, at least in the short run. Therefore, production and exports adjust slowly to the shock, even if there are no additional frictions, whereas imports adjust swiftly.

One reason why trade prices are sticky and adjust slowly is that trade contracts cover relatively long periods of time and are usually set in a given currency for their duration (see Gopinath and Rigobon, 2008). The literature has highlighted the fact that the effects of an exchange rate change depend on the currency on which trade prices are set. For instance, Gopinath et al. (2010) show that the average effect of exchange rate changes on export and import prices differs significantly when products are priced in the producer's currency or in buyer's currency.

We will show evidence that, in our Colombian data, export and import prices of manufactured goods are sticky after the depreciation when measured in US dollars. Price setting in a few dominant currencies (particularly in dollars) regardless of the origin or destination of trade is common around the world (see Gopinath, 2015). This "dominant currency" pricing implies that the prices in domestic currency of imports and exports change rapidly. Consequently, demand for imports changes rapidly, but demand for exports adjusts more slowly, depending on the *dollar* fluctuations of the exchange rates across all trading countries. As shown in Boz et al. (2017), a U.S. dollar appreciation relative to all other currencies is associated with a reduction in aggregate rest-of world trade volumes, since the response of prices to changes in the dollar exchange rate dominates the response to changes in bilateral exchange rates.

We will also highlight other factors that hinder the adjustment of prices and production to changes in the exchange rate. In particular, we will show evidence of the effects of the exchange rate depreciation on firms' costs. First, we will show that, in the Colombian case, the response of Colombian firms to the 2014 depreciation was affected by the exposure of firms to imported inputs. As pointed out in Carranza et al. (2018), Gopinath et al. (2020) and Casas (2020), imported inputs have a substantial offsetting effect on production and exports after exchange rate changes. Carranza et al. (2018) show that in the Colombian case, the increase in costs due to the increased price of imported inputs after the 2014 depreciation nearly wiped out all of its effect on measures of the real exchange rate.[1] Recent literature (e.g. Leigh et al., 2017) has also highlighted the potential effects of the growth of global value chains on the relationship between prices and trade, but has not found any supporting evidence.

Similarly, a depreciation has an immediate effect on the debt denominated in foreign currency held by firms (for an analysis of this type of "balance sheet effects" see Aguiar, 2005, and Casas et al., 2020 for an analysis of the Colombian case). More generally, firms will have trouble expanding exports and/or imports if they have financing constraints (Berman and Berthou, 2009; Berman and Héricourt, 2010; Muûls, 2015), or if the depreciation coincides with an economy-wide shortage of financing (Amiti and Weinstein, 2011). In a model with both financial constraints and balance-sheet effects, Kohn et al. (2020) show that financially constrained firms respond to a depreciation, reallocating their exports across destinations. The empirical analysis of these effects is usually limited by the lack of data linking bank financing and firm' production and trade information. In our case, we will be able to estimate the correlation of trade and production with bank lending and interest rates after the 2014 depreciation. We will also be able to show whether there is any recomposition of export destinations after the depreciation.

[1] In Carranza et al. (2018), the effects of the devaluation on the real exchange rate are computed assuming that firms don't substitute imported inputs. This type of assumption is usual in the computation of real exchange rates. In general, though, firms adjust the sourcing of its inputs after any substantial exchange rate fluctuation.

Other factors that affect the adjustment of trade and production to depreciations fall outside the reach of our data. For example, as shown in Caggese and Cuñat (2013), permanent financial constraints and other persistent market frictions can have anticipated effects on firms' investment and export decisions. If these frictions don't vary across firms but are an overall feature of the economy, their effects cannot be identified in a single-country data set. In addition to financial constraints, physical capacity constraints are also important determinants of this adjustment (Ahn and McQuoid, 2017).

In the following section we describe our data and the main facts that motivate our econometric analysis.

3. Data and descriptive analysis

Our data is based on three main sources. First, we use the detailed Colombian international trade data collected by DIAN, the Colombian customs authority. It contains monthly volume and value of trade information at the level of individual firms, with information about the product and the country of origin/destination. Second, we use the SIREM database, that contains annual balance sheet data reported by individual firms to the Superintendencia de Sociedades, the regulator of corporations, including sales and input purchases. This firm-level data corresponds to a subset of relatively large firms, which is unfortunately available only until the year 2014. Third, we use quarterly firm- and bank-level loan data reported by banks to the Superintendencia Financiera, the regulator of the financial system, that include details about the size, timing and interest rate of every commercial loan to individual firms.

In this document we focus on the exchange rate shock suffered by the Colombian economy following the sharp fall in the price of oil and other commodities in 2014. Since the Colombian economy is relatively dependent on commodities exports, the price shock induced an immediate correction in the exchange rate markets. In Figure 1a we show the evolution of the nominal exchange rate (COP per USD) index and the consumer price index between 2007 and 2017. As shown, following the 2008 financial crisis, the nominal exchange rate appreciated gradually until the year 2014. In 2014 the exchange rate depreciated by more than 40% within a span of around three months. Meanwhile, annual inflation was always below 10%.

In our data we observe the unit value (dollars per net kilogram) at the product-firm-trading partner level, and we use them to construct export and import price indices. To calculate aggregate indices, average price changes are computed at the 10-digit product level and then they are weighted by each product's average exports or imports shares across the complete time span of the sample. We exclude from these indices goods closely related to commodities such as refined oil, gold and ferronickel, which constitute a significant part of Colombian international trade.

In Figure 1b we show the indices for export and import prices in USD and COP of manufactured imports and exports since 2007[2]. As shown, prices in dollars of both imports and exports are fairly constant throughout the whole period. On the other hand, prices in pesos are more or less constant until 2014 when they increase reflecting the evolution of the nominal exchange rate. In other words, the data show stickiness of prices denominated in dollars, but relative flexibility of prices in pesos. This type of price stickiness in a dominant currency has been studied recently by Casas et al. (2017), in the context of dynamic macro models of international trade and using the same trade data as ours. Notice that after 2014 USD-denominated prices fall gradually, which is consistent with the notion that sticky prices should adjust downwards over time, as exporting firms adjust their production to take advantage of the real depreciation.

Figure 1b also shows the relative price of exports to imports (Px/Pm) at the 10-digit product level, averaged across products. To obtain this average, product-level relative prices are weighted by the product's share in total trade (exports plus imports) across the whole time span of the sample. Notice that, even though the average prices of exports and imports behaved similarly, the product-level relative price of exports to imports fell over time after 2014. In other words, at the product level exports became gradually relatively less expensive than imports. This is consistent with the notion that, given their higher profit margins in local currency after the depreciation, exporters can eventually decrease their prices in foreign currency, therefore increasing their production to take advantage of the increased demand that they face.

Altogether, Figure 1 suggests that, after the depreciation, COP prices of both imports and exports increased proportionally to the peso-dollar exchange rate. Afterwards, the dollar-denominated prices of imports and exports decreased slowly, and therefore exports could only increase slowly even if other demand shifters were constant. Over time, as firms increase their production and renegotiate their trade contracts, the relative prices of exports also adjusted downwards gradually.

[2] In this graph COP prices are just USD prices multiplied by the exchange rate.

Figure 1a: COP-USD nominal exchange rate and consumer price index, 2007-2017

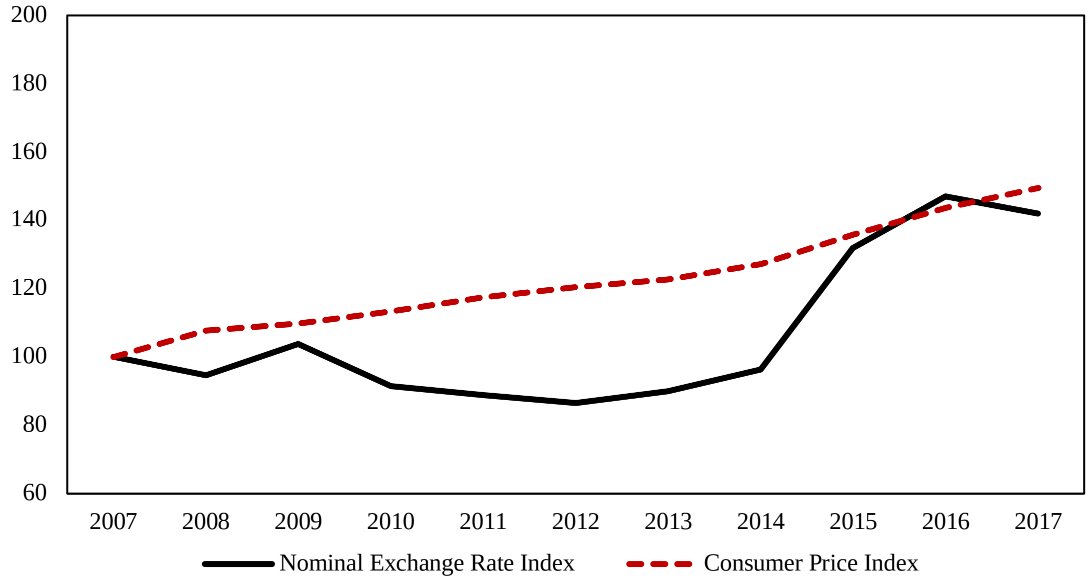
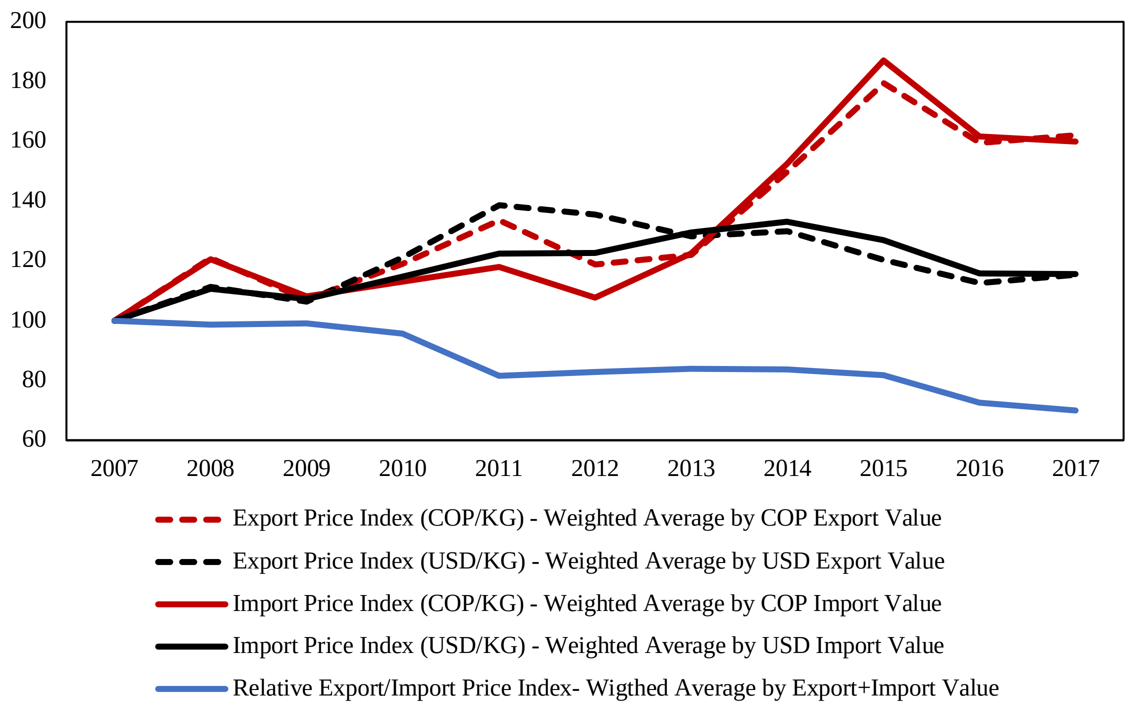


Figure 1b: Export, import price indices, and relative export/import price index, 2007-2017



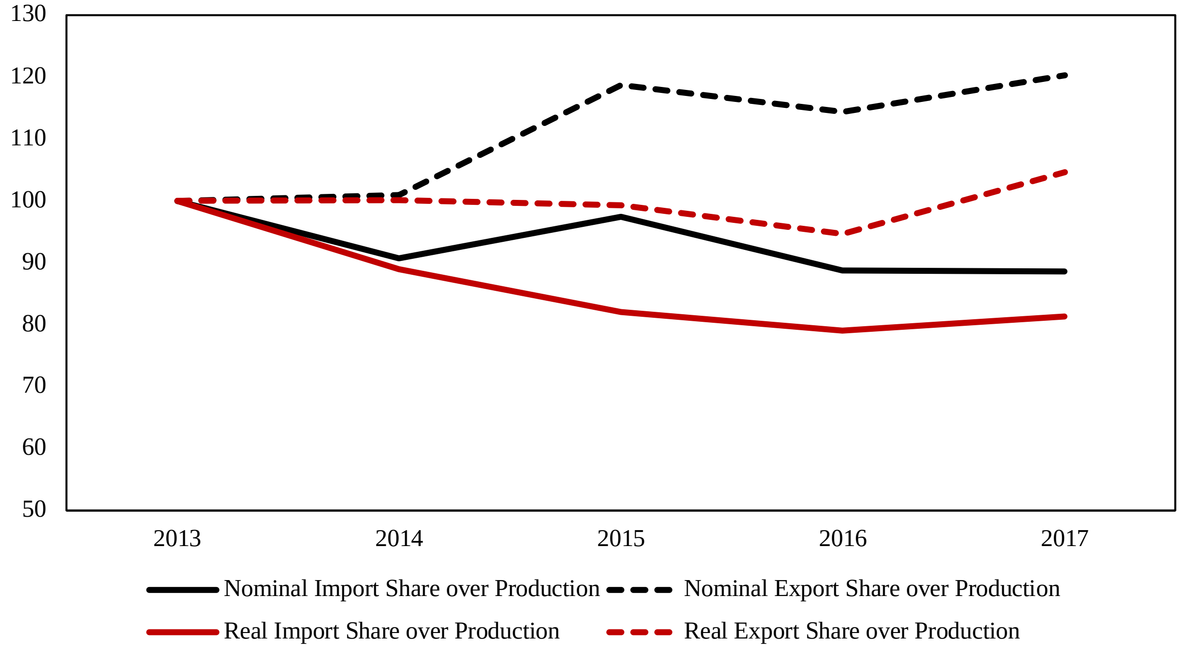
Source: DANE, DIAN, and Banco de la República.
Figure 1a: The consumer Price index is the reported index at the end of the year. The nominal exchange rate index is based on the annual average exchange rate.
Figure 1b: Export and Import values are originally in USD. We use the Free on Board (FOB) values in both cases. The COP values are computed using the monthly average exchange rate.

To illustrate the adjustment of production to this shock, in Figure 2 we show indices of the average shares of imports and exports over total production (X/Y) and (M/Y), which effectively reflect expenditure switching (conditional on total production). In order to obtain these indices, we compute the shares at the 4-digit industry-level at which production data is available. We show the nominal value shares and measures of the real production shares. The real production shares are obtained by dividing trade quantity indices by production indices at the product level. The export and import quantity indices are computed using the observed variation in weight at the 10-digit product-level, which is then averaged across products using fixed average production shares, as explained above. The total production indices are computed from the value of production at the 4-digit product-level deflated with the producer price indices reported by DANE, and then averaged across products using the same weights as above. Since production data is only available since 2013, we show results for the period 2013-2017.

The figure shows that, right when the depreciation took place in 2014, the average share of the value of imports over the value of production fell, as well as the share of real imports over real production. The share of real imports over real production kept on falling on 2015 and 2016 and then stabilized in 2017, whereas the share of the value of imports over the value of production stayed more or less constant after 2014. In other words, real product-level imports decreased immediately after the depreciation relative to real production and kept on falling until 2016, while nominal imports by product decreased immediately relative to nominal production but then stabilized. Between 2013 and 2017, the nominal share of imports fell around 10%, while the real share of imports fell around 20%.

On the other hand, the product-level share of the value of exports over total production, as well as the product-level share of real exports over real production, stayed constant in 2014. In other words, there was no immediate relative response of exports vis-à-vis production to the depreciation after mid 2014. In 2015 the share of the value of exports over the value of production increased sharply and stayed constant afterwards. The share of real exports over real production decreased slightly between 2014 and 2016 and then increased in 2017. In contrast to the overall decrease in the import shares, between 2013 and 2017 the nominal share of exports increased around 20%, while the real share of exports increased around 5%.

Figure 2: Nominal and real export and import shares over production, 2013-2017



Source: DANE, DIAN
Export and Import values are originally in USD and we use the average monthly exchange rate for getting the COP values. Export/ Import real value is fixed in 2013, every next year we assume export/import value grows at the growth rate of its corresponding volume. We use the gross production from the EAM and the real production is the result of the gross production deflated using the producer price index.

So far, we have shown evidence that the peso depreciation of 2014 had a weak immediate effect on export and import dollar prices, but over time it generated a change in the product-level relative prices of manufacturing exports to imports. There is evidence that imports reacted swiftly to the depreciation, but exports less so. We should point out that the depreciation coincided with a substantial slowdown of the economy. Therefore, the increase in the export shares and the decrease in the import shares do not mean that the production increased, since overall demand weakened across the board. In the following section we show how product- and firm-level variables adjusted to the shock.

4. Product- and firm-level analysis

We now analyze the adjustment of trade at a micro level after the 2014 depreciation using econometric methods. We perform the analysis at the product- and the firm-level. At the product-level we use the international trade and production information from 2013 to 2017. At the firm-level we use the yearly international trade data and control for the 2014 characteristics of firms which, as indicated above, are not available for more recent years.

We are interested corroborating whether the general patterns described in the previous sections hold at the product level, and in evaluating the mechanisms identified by the literature and discussed in section 2. First, we estimate the annual ratio of exports and imports to production between 2013 and 2017 at a finer level of detail than in the figures above. We use trade data at the Nandina (tariff code) 10-digit product level, and production data at the ISIC 4-digit level, which is the most disaggregated available level. [3] Specifically, we estimate the following product-level panel regression via least squares:

$$E(X_{kt}/Y_{Kt}) = \beta_{xt} + \beta_{xk} + \beta_{xE}E_{xkt},$$

$$E(M_{kt}/Y_{Kt}) = \beta_{mt} + \beta_{mk} + \beta_{mE}E_{mkt},$$

where X_{kt} and M_{kt} are the value of exports at the 10-digit product level, M_{kt} is the value of imports at the 10-digit product level, and Y_{Kt} is the value of production at the 4-digit level. The variable E_{mkt} and E_{xkt} are the real exchange rate of product k imports and exports at time t, respectively, which are computed as the average of the bilateral real exchange rates of trade based on the origin/destination weights in 2013.

Since we add fixed product-level effects $\beta_{xk}$and β_{mk}, all estimates are based on differences over time. Therefore, the time-changing β_{xt} and β_{xt} are the mean differences of the ratio at each year t with respect to its constant. Since production is measured in pesos in the data, exports and imports are converted from dollars using the annual average exchange rate and all ratios are then computed in pesos. Notice that the effect of the nominal depreciation is going to be absorbed by the aggregate time effects, whereas the real exchange rates will absorb the variation across exported products of the changes in the real exchange rates of their destination countries.

The results of the regression are shown in tables 1 and 2 for imports and exports, respectively. In each table we show results for the nominal shares and the real shares, with different sets of controls. Columns (1) and (4) in table 1 show the mean changes in the yearly ratios of imports over production. As shown, the mean changes in the ratio of COP-denominated nominal imports over production were positive throughout the time span of the sample, due to the COP depreciation and despite the fall in the overall ratio. The mean changes in the real ratio, though, were negative in 2015 but were otherwise insignificant.

[3] Although the level of aggregation is different across classification systems, each 10-digit product on the Nandina classification is associated with a unique 4-digit ISIC code.

Table 1: Imports to product at the 10-digit product level

	Imports					
	Nominal			Real		
	(1)	(2)	(3)	(4)	(5)	(6)
β_2014	0.00846*		0.0192**	0.00183		0.0105*
	(0.004800)		(0.007720)	(0.003860)		(0.006230)
β_2015	0.0111**		0.0341**	-0.00923**		0.00872
	(0.004800)		(0.013500)	(0.003860)		(0.010900)
β_2016	0.0202***		0.0382***	-0.00499		0.00838
	(0.004800)		(0.010600)	(0.003870)		(0.008550)
β_2017	0.0236***		0.0387***	0.00186		0.0146*
	(0.004800)		(0.009850)	(0.003870)		(0.007950)
Real Exhange Rate		0.000261***	-0.000458*		-0.000226***	-0.000395*
		(0.000097)	(0.000261)		(0.000078)	(0.000211)
Constant	0.0675***	0.0546***	0.120***	0.0660***	0.0990***	0.112***
	(0.003360)	(0.012400)	(0.026400)	(0.002710)	(0.010000)	(0.021300)
Observations	28,023	25,432	25,432	28,023	25,432	25,432
Number of id	5,833	5,306	5,306	5,833	5,306	5,306

In column (2) we show that the correlation of the change of the ratio of nominal imports to production with the change in the real exchange rate of each product is positive, which is counterintuitive. Once we focus on the real ratio in column (5), we find that the correlation is negative and significant. In other words, relative real imports adjusted towards origins with lower real exchange rates.

In columns (3) and (6) we show that the correlation of the changes in the product-level ratios with the changes in the real exchange rate disappears once we condition for the time effects, which absorb the common component of the variation of the exchange rates. Interestingly, the mean changes in the nominal ratios in column (3) are higher once we control for the exchange rate, which means that the differences across products in their real exchange rate had a negative effect on the mean nominal ratios. Similarly, the changes in the real exchange rate also dampens the decrease in the real ratio when we compare (6) and (3).

Table 2 shows the results of the same regressions for the case of the export shares. In columns (1) and (4), we show that the mean ratios do not change significantly between 2013 and 2015. The nominal ratio increases in 2016 and 2017, whereas the real ratio increases only in 2017. This result is important because is contrary to international evidence that shows very rapid effects of depreciations on exports, based on less detailed data than ours.

Table 2: Exports to product ratios at the 10-digit product level.

	Exports					
	Nominal			Real		
	(1)	(2)	(3)	(4)	(5)	(6)
β_2014	0.00009		-0.00080	-0.00101		-0.00258
	(0.001140)		(0.002140)	(0.002280)		(0.004160)
β_2015	0.00140		-0.00061	-0.00187		-0.00532
	(0.001140)		(0.003880)	(0.002280)		(0.007560)
β_2016	0.00275**		0.00139	-0.00123		-0.00427
	(0.001140)		(0.003030)	(0.002290)		(0.005890)
β_2017	0.00273**		0.00161	0.00380*		0.00182
	(0.001140)		(0.002790)	(0.002290)		(0.005440)
Real Exhange Rate		6.23e-05**	0.00005		-0.00002	0.00006
		(0.000028)	(0.000078)		(0.000054)	(0.000151)
Constant	0.00535***	0.00052	0.00116	0.00517***	0.00860	0.00002
	(0.000799)	(0.003490)	(0.007840)	(0.001600)	(0.006790)	(0.015300)
Observations	23,621	18,507	18,507	23,621	18,507	18,507
Number of id	4,927	3,875	3,875	4,927	3,875	3,875

The correlation of the changes in the nominal export ratios with the changes in the real exchange rate in column (2) has the expected positive sign. The same correlation for the real export ratios in column (5) is insignificant, which is consistent with the notion that real exports did not really respond to the depreciation, whereas nominal exports did. Moreover, when comparing columns (6) and (3), we see that the mean changes in the export ratios measured by the time effects are similar, which means that any effect of the depreciation on the ratio was due to the common component of the exchange rates and not to the differences across products.

The results in tables 1 and 2 show somewhat weak effects of the depreciation on both the import and export ratios, when examined at the product level. The real import ratio fell in 2015, whereas the export ratio had a delayed increase in 2017. In order to see the behavior of total trade at the product level, we run similar regressions as equations 1 but for total exports and imports to see how the total quantities adjusted to the depreciation:

$$E(X_{kt}) = \beta_{xt} + \beta_{xk} + \beta_{xE} E_{xkt},$$

$$E(M_{kt}) = \beta_{mt} + \beta_{mk} + \beta_{mE} E_{mkt},$$

where the variables are defined similarly as above. We show the results of these regressions in table 3. We show the results corresponding to the real data with the same controls as in tables 1 and 2.

Table 3: Total imports and exports at the 10-digit product level.

	Real Exports			Real Imports		
	(1)	(2)	(3)	(4)	(5)	(6)
β_2014	-3.97E+08		-8.257e+08*	4.29E+08		-3.510e+09***
	(4.1E+08)		(5.0E+08)	(7.4E+08)		(11.9E+08)
β_2015	-5.89E+08		-1.48E+09	-1.908e+09***		-1.082e+10***
	(4.1E+08)		(9.0E+08)	(7.4E+08)		(21.3E+08)
β_2016	-6.07E+08		-1.378e+09*	-3.908e+09***		-1.059e+10***
	(4.1E+08)		(7.1E+08)	(7.4E+08)		(16.4E+08)
β_2017	-2.08E+08		-1.369e+09**	-3.573e+09***		-9.657e+09***
	(4.1E+08)		(6.5E+08)	(7.4E+08)		(15.3E+08)
Real Exhange Rate-X		-1.430e+07**	1.56E+07			
		(637.0E+04)	(1,805.0E+04)			
Real Exhange Rate-M					-4.220e+07***	1.856e+08***
					(1,479.0E+04)	(4,176.0E+04)
Constant	4.025e+09***	6.368e+09***	3.598e+09**	1.531e+10***	1.983e+10***	-2.17E+09
	(2.9E+08)	(8.1E+08)	(18.2E+08)	(5.2E+08)	(18.9E+08)	(42.1E+08)
Observations	26,125	20,330	20,330	26,125	24,380	24,380
Number of id	5,225	4,066	4,066	5,225	4,876	4,876

As shown in columns (1) and (3) of table 3, the mean change in exports across products is slightly negative, but mostly insignificant. Its correlation with the changes in the real exchange rate in column (2) and (3) is negative and, surprisingly, significant. This finding corroborates an important result of our analysis which is that real exports did not increase after the depreciation.

On the other hand, and as shown in column (4), the mean change in real imports across products was negative and significant on 2015 and 2016 and was still significantly below its initial level in 2017. This rapid and significant decrease in imports stands in contrast with the overall stagnant real exports. As shown in column (5), the changes in real imports across products was negative and significantly correlated with the changes in the exchange rate. Nevertheless, this negative correlation disappears once we control for the aggregate time effects which absorb the common component of the real depreciation. Interestingly, column (6) shows that, conditional on the exchange rate faced by each product, the mean fall in imports was even bigger, which suggests that the changes in the real exchange rate across products due to its variation across countries, mitigated to some extent the effect of the depreciation.

We have shown so far that the depreciation of 2014 was followed by large decreases in imports which are consistent with the usual notion of expenditure switching. On the other hand, exports did not show any significant increase and only increased relative to production in 2017. To further examine the effects of the depreciation on the origin/destination patterns of trade, we run a regression of country-product shares of exports and imports on each country's exchange rate, adding time- and product-fixed effects. In this regression, an observation of the dependent variable is the product-level share of exports and imports by country over product-level exports and imports. In other words, we condition on total exports and imports and examine whether origin/destination patterns changed according to the bilateral exchange rate, keeping total trade constant. The exchange rate varies across countries and is defined as the COP price of each country's local currency.

The results of this estimation are shown in table 4. We show results of regressions with time-fixed effects, and with both time- and product-fixed effects. The upper panel corresponds to value shares, whereas the lower panel corresponds to volume shares which are measured in kg at the 10-digit product-level. Columns (1) and (2) show results for the shares of exports, while columns (3) and (4) show results for the share of imports. All estimates include product-level fixed effects. Notice that the volume results do not depend on any price index and strictly reflect real effects.

Table 4: Export shares by county and exchange rates.

	Share of Exports		Share of Imports	
	(1)	(2)	(3)	(4)
Panel A: Values				
Bilateral Exchange Rate	9.87e-06***	1.10e-05***	-1.32e-05***	-1.38e-05***
	(0.000001)	(0.000001)	(0.000000)	(0.000000)
Observations	122,779	122,779	303,530	303,530
R-squared	0.433	0.434	0.29	0.29
Panel B: Volumen				
Bilateral Exchange Rate	8.50e-06***	9.58e-06***	-2.43e-05***	-2.52e-05***
	(0.000001)	(0.000001)	(0.000000)	(0.000000)
Observations	122,774	122,774	303,540	303,540
R-squared	0.419	0.42	0.27	0.271
FE: Year		X		X

The results are very robust and show that, conditional on total imports, the shares of imports increased from countries with higher appreciations vis-à-vis the Colombian peso. On the other hand, conditional on total exports, the shares of exports adjust toward countries with lower depreciations vis-a-vis the Colombian peso.

These results show that, even though total exports do not change substantially, they do adjust across destinations according to the relative changes in the exchange rates. This finding is consistent with a model with firms that cannot adjust flexibly their production or sales and therefore reallocate it across markets (including the domestic market) after an exchange rate shock, as in Kohn et al. (2020). It is also consistent with a model with sticky USD-denominated prices, so that demand adjusts differentially depending on each country's USD exchange rate as in Gopinath et al. (2020). More generally, the results show that even if prices are sticky, trade adjusts across countries depending on their relative exchange rates.

We now turn to firm-level data to analyze the factors that may have inhibited the expansion of exports after 2014. We base our analysis in the literature, as described in section 2. Since we only have detailed data on the characteristics of individual firms for the year 2014, we focus on the adjustment of firm-level exports between 2014 and 2017, conditional on several firm characteristics in 2014. We infer the correlation of the firm-level change in exports with their initial total sales, financial information and input imports. Specifically, we estimate the following equation:

$$E(\Delta X_j) = \gamma + \gamma_y Y_{0j} + \gamma_M \Delta Z_j,$$

where ΔX_j is the change in exports for firm j between 2014 and 2017. We regress this change on a set of 2014 firm-level variables Y_{0j} and a set of exogenous time-changing variables ΔZ_j. The included initial variables Y_{0j} are the sales, the total exports, the value of imported inputs, the interest rate paid by the firm, the total outstanding loans of the firms and the loans denominated in foreign currency. The values of all these variables correspond to the year 2014.

The included exogenous time changing variables ΔZ_j are the change in foreign demand and the change in the real exchange rate. The change in foreign demand is the average change in GDP across destination countries weighted by the initial country shares. Similarly, the change in the real exchange rate is the average of the bilateral real exchange rates weighted by the initial country shares. These shares are computed at the level of the individual firms or the 4-digit industry depending on the sample. We use two samples: a sample with all the firms for which information is available, and a smaller sample of firms that export both in 2014 and 2017. In the broader sample, in which most firms don't export in 2014, the weights are at the industry level. In the smaller sample, the weights are at the firm-level.

To isolate currency-related price changes, we run the regressions for exports in USD and COP. Notice that the dependent variable is the change in the value of exports between 2017 and 2014. Therefore, the results from the USD regression are not necessarily proportional to the results from the COP regression. We show the results of these four regressions in table 5. Columns (1) and (2) show the results for the broad sample of more than 3000 manufacturing firms, while columns (3) and (4) show the results for the small sample of around 1200 firms.

It should be noted that the smaller sample contains firms that export in both 2014 and 2017, so they are relatively large.

Table 5: Firm level export changes 2013-2017

	Broader Sample		Smaller Sample	
	D.Export Value (USD)	D.Export Value (COP)	D.Export Value (USD)	D.Export Value (COP)
	(1)	(2)	(3)	(4)
L.Export Value	-0.0957***	0.333***	-0.0937***	0.337***
	(0.006580)	(0.009790)	(0.011100)	(0.016500)
L.Sales	1.85e-05***	22.70***	2.02e-05***	24.78***
	(0.000002)	(2.314000)	(0.000003)	(4.062000)
L.Input Imports	-3.15e-09***	-0.00395***	-3.48e-09***	-0.00438***
	(0.000000)	(0.000691)	(0.000000)	(0.001140)
L.Average interest rate	0.00723	20.54000	0.01490	41.37000
	(0.010700)	(31.980000)	(0.028100)	(83.650000)
L.Total Loans	-0.0222**	-0.0280**	-0.02260	-0.02830
	(0.009670)	(0.012000)	(0.017300)	(0.021600)
L.Loans Denominated in Foreign Currency	-0.0890***	-0.117***	-0.114***	-0.152***
	(0.022700)	(0.028300)	(0.044200)	(0.055000)
Average Real Exchange Rate	-7.01400	-2.21E+04	-7.39100	-2.28E+04
	(8.744000)	(2.6E+04)	(9.402000)	(2.8E+04)
External Demand (%)	-0.01520	-45.69000	0.00151	2.20E-01
	(0.018600)	(55.250000)	(0.021900)	(65.3E+00)
Constant	0.39500	1.29E+03	9.99E-02	4.13E+02
	(0.675000)	(2,011.0E+00)	(8,280.0E-04)	(2,464.0E+00)
Observations	3,199	3,199	1,200	1,200

The variables of most interest are the exposure of the firms to input imports and the financial variables, which have been pointed out by the literature as being potential factors that hinder the adjustment of trade. The controls for initial exports and sales have no particular interpretation, but serve as scale variables to condition the effect of inputs and the financial variables.

As shown in table 5, the estimates show a robust and negative effect of the imported inputs measured in 2014 on the growth of exports between 2014 and 2017 measured both in COP and USD. This result is consistent with the notion that the insertion of firms in global value chains dampens the effects of any depreciation on exports. The result is also consistent with results in Carranza et al. (2018) showing that the Colombian manufacturing sector depends on input imports as much as on exports.

The results in columns (1) and (2) also show that in the broad sample firms with higher loans in 2014 increased their exports less between 2014 and 2017. In other words, indebtedness hindered the growth of exports after the depreciation. For the case of the smaller set of bigger firms that exported both in 2014 and 2017, total loans did not have a significant effect on the growth of exports, but the loans denominated in foreign currency did. In other words, for these firms the foreign debt affected negatively their capacity to export, which is consistent with a balance sheet effect which is analogous to the effects of the exposure to imported inputs discussed above.

The results show no significant effect of the real exchange rate or the real depreciation. Since the regression is on the differences in the variables, this means that the external demand and real exchange rates did not have an effect beyond an aggregate shock that is absorbed by the estimated constant.

To summarize, beyond the fact that firms may have had difficulties to increase their exports due to price stickiness and other aggregate frictions, we have found that liquidity constraints, balance sheet effects and imported inputs may have had a dampening effect on exports after the depreciation of 2014.

5. Conclusion

We have documented the adjustment in the relative values of Colombian manufacturing exports and imports that occurred after the depreciation that took place in 2014. Right after the depreciation, the COP-denominated prices of exports and imports increased, while the USD-denominated prices stayed relatively constant. Consequently, imports fell rapidly after the depreciation, while export stayed mostly constant.

Our results stand in contrast with cross-country evidence that shows rapid growth of exports after large depreciations. Our results, though, are based on detailed trade quantity data that are not usual in the literature, and do not rely on price indices. They are also in line with predictions of the recent literature on dominant currency pricing.

We also find that the difficulties of firms to increase exports after the devaluation are associated with their ex-ante debt in both local and foreign currency. These findings corroborate the predictions of the literature on balance sheet effects and liquidity constraints. We also find strong effects of the exposure to imported inputs on the growth of exports, which is consistent with a recent and growing literature on the effects of global value chains on trade adjustment, which merits further research.

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