

Harms, Philipp; Beck, Günter; Hussain, Muzammil; Ruszel, Mark

Conference Paper

Retail prices during the 2014-2015 US dollar rally: a microscopic perspective using scanner data

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2023: Growth and the "sociale Frage"

Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

Suggested Citation: Harms, Philipp; Beck, Günter; Hussain, Muzammil; Ruszel, Mark (2023) : Retail prices during the 2014-2015 US dollar rally: a microscopic perspective using scanner data, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2023: Growth and the "sociale Frage", ZBW - Leibniz Information Centre for Economics, Kiel, Hamburg

This Version is available at:

<https://hdl.handle.net/10419/277626>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Retail prices during the 2014-2015 US dollar rally: a microscopic perspective using scanner data

Guenter W. Beck* Philipp Harms† Muzammil Hussain‡
Mark Ruszel§

This version: February 26, 2023.

Abstract

In the second half of 2014, the US dollar appreciated substantially and persistently against most other currencies in the world. The appreciation reflected market expectations of a tighter monetary policy and accelerating growth in the US, and was not related to specific events in individual countries. We focus on this episode to analyze the effects of exchange rate movements on domestic prices, i.e. the extent of exchange rate pass-through. Using scanner data on retail prices of fast-moving consumer goods in Brazil, Chile, Colombia, Mexico and Peru, we document the following findings: during the dollar rally, retail prices of imported goods (“imported products”) increased, but the increase was delayed and muted. More importantly, retail prices of domestically produced goods (“domestic products”) moved in parallel to the prices of imported products of the same product category, such that relative prices of imported products vis-à-vis their domestic substitutes barely changed. Our results suggest that the role of the retail sector goes beyond a mere “buffer”, which dampens the effect of exchange rate fluctuations on relative prices. As a consequence, we conjecture and show that – after a depreciation of the domestic currency – expenditure switching from imported to domestic products is much weaker than generally believed.

Keywords: Exchange Rate Pass-through · Scanner Data · Dominant Currency Paradigm

JEL codes: E31 · F31 · F41 · L81

*University of Siegen. Contact: guenter.beck@uni-siegen.de.

†Johannes Gutenberg University Mainz. Contact: philipp.harms@uni-mainz.de.

‡University of Siegen. Contact: muzammil.hussain@uni-siegen.de.

§Johannes Gutenberg University Mainz. Contact: mark.ruszel@uni-mainz.de.

1 Introduction

In times of high inflation rates, it is important to identify the forces behind rising consumer prices. One prominent candidate are exchange rate fluctuations, with a depreciation of the domestic currency potentially raising domestic prices of imported products if foreign producers fix their prices in their own currency. The rising price of imported products possibly induces consumers to shift their spending to domestically produced substitutes, whose prices are not directly affected by the exchange rate. However, the extent of expenditure switching may be limited by low elasticities of substitution, or by the lack of domestic products that serve the same purpose as imports. Hence, despite its effect on relative prices, a depreciation is likely to raise the overall price level.

Of course, this narrative about the effect of exchange rate fluctuations on domestic prices – i.e. the extent of exchange rate pass-through (ERPT) – is based on a whole range of assumptions, which may be violated in practice: first, foreign exporters may fix their prices in the currency of the importing country (“local currency pricing”), such that, at least in the short run, domestic prices are immune to exchange rate fluctuations. Second, the prices of domestically produced products (“domestic products”) may also increase, due to the higher costs of imported raw materials and intermediate inputs. Finally, price reactions at the retail level may differ from price reactions at the border, with the “retail wedge” substantially dampening the effect of exchange rate fluctuations. Given the resulting ambiguities in the exchange rate-inflation nexus, it is not surprising that a large literature explores the extent and dynamics of ERPT.

Our paper contributes to this literature in the following way: We focus on the “US dollar (USD) rally” that started in mid-2014, and that resulted in a substantial nominal appreciation of the US dollar against most other currencies in the world. This appreciation was driven by markets’ expectations of a tighter monetary policy and accelerating growth in the US, and thus exogenous to the countries whose currencies were affected. To explore the effects of the US dollar rally on prices, we use a detailed household scanner data set on “fast-moving consumer goods” (FMCG) – i.e., food and non-alcoholic beverages, as well as personal care and household products. The focus on individual products (rather than highly aggregated price indices) comes with several advantages: first, we are able to separate price movements from changes in spending patterns. Second, we can distinguish between imported products and domestically produced goods (“domestic products”) of the same product category, i.e. close substitutes whose prices should not be directly affected by developments on foreign exchange markets. While we believe that our analysis is of general relevance,

we focus on Colombia and four other Latin American countries (Brazil, Chile, Mexico and Peru) since the overwhelming share of these countries' imports are priced in US dollars – i.e. prices of imported products should have been affected particularly strongly by the US dollar rally.

We started our analysis with the expectation that the massive appreciation of the US dollar against the Colombian peso (COP) should have left its trace in Colombian retail prices, and that – at least in the short run – the prices of imported products should have moved more strongly than the prices of domestic products of the same product category. Interestingly, this is not what we found: the price reaction to the US dollar rally was delayed and muted. More specifically, it took about six months until price indices of imported products started to increase, and the mild increase in prices of a few percent pales against the depreciation of the Colombian peso against the US dollar by 40 percent. Moreover, and even more surprisingly, we found that prices of imported products and of domestic products of the same product category – i.e. domestically produced close substitutes – moved in parallel, such that the ratio of imported product prices over domestic product prices barely changed. The parallel evolution of similar imported and domestic products suggests a role of the retail sector that is much more active than generally believed. Moreover, due to the absence of relative price changes we should not expect a considerable shift of consumers' spending from imported to domestic products. Our analysis of (aggregate) expenditure switching and (disaggregate) quantity reactions supports this conjecture.

The rest of this paper is structured as follows: in Section 2, we outline the basic argument and relate our work to the existing literature on exchange rate pass-through. In Section 3, we discuss the global US dollar rally and the macroeconomic environment in Colombia. The initial focus on this country is justified by two considerations: first, the depreciation of the Colombian peso against the US dollar was particularly strong in the second half of 2014 and first quarter of 2015. Second, the macroeconomic situation in Colombia was free of turbulences, justifying the “event-study approach” that we adopt. Section 4 presents our data set. Section 5 describes our empirical approach and presents our results for Colombia. Section 6 focuses on the robustness of the Colombian-specific findings and extends the analysis to Brazil, Chile, Mexico and Peru. Section 7 offers a summary and some conclusions.

2 Conceptual foundations and relevant literature

Most analyses of ERPT start from the simple hypothesis that, with foreign (F) exporters fixing the price of good i in their own currency ($P_{i,t}^F$), the domestic (H) currency-price of this good ($P_{i,t}^H$) should be given by

$$P_{i,t}^H = E_t \times P_{i,t}^F \quad (1)$$

where E_t is the domestic currency-price of the foreign currency. That is, the *law of one price* (LOP) should prevail, and a change in the nominal exchange rate should be reflected by a change in the domestic price of the same percentage, i.e. $\Delta p_{i,t}^H = \Delta e_t$, with lower-case letters denoting the natural logarithm of variables. If foreign producers do not adhere to *producer currency pricing* (PCP), but fix their prices in a “vehicle currency”, e.g. the US dollar, the same logic applies. In this case, however, the relevant exchange rate is not the relative price of the exporter’s currency in terms of the importer’s currency, but the exchange rate of the importer with respect to the vehicle currency. Recent research highlights the pervasive role of the US dollar and of *dominant currency pricing* (DCP).¹

There are numerous reasons why “full ERPT” may not be observed in reality: first, producers may fix prices in the importers’ currency. In this case of *local currency pricing* (LCP), domestic prices are immune to exchange rate fluctuations – at least in the short run. Moreover, while prices “at the dock” – so-called *border prices* – may react very strongly to exchange rate fluctuations, *retail prices* combine border prices and the price of (non-traded) distribution services, which reflect the costs of moving goods from the border to the store shelf, the market structure in the domestic retail industry etc. One should therefore expect retail prices to be much less responsive to exchange rate fluctuations than border prices. For the same reason, the consumer price index (CPI), which represents a weighted average of individual goods’ prices at the retail level, should be less affected by the exchange rate than an import price index. This is, in fact, what the literature finds. As reported in the survey by Burstein and Gopinath (2014), “ERPT into consumer prices is lower than into border prices” (page 401).

Many studies that explore ERPT into price aggregates (see, e.g., Campa and Goldberg, 2005) or individual goods prices (see, e.g., Frankel, Parsley, and Wei, 2011) regress changes of domestic prices on exchange rate changes at various lags, possibly applying a (vector) error correction specification. While this allows tracing the extent

¹See Boz, Gopinath, and Plagborg-Møller, 2017; Gopinath et al., 2020; Gopinath and Itskhoki, 2021; Boz et al., 2022.

of ERPT over time, it comes with the problem that exchange rates may as much be driven by domestic price movements as prices by exchange rates – i.e. it is hard to identify causal relationships. To address this shortcoming, several contributions adopt an “event study” design, which observes the evolution of domestic prices shortly before and after an exogenous – and often sizable – move of the exchange rate. In this vein, Burstein, Eichenbaum, and Rebelo (2005) analyze the reaction of domestic prices during currency crises episodes. Bonadio, Fischer, and Sauré (2019) as well as Auer, Burstein, and Lein (2021) consider the behavior of prices in Switzerland in the wake of the massive appreciation of the Swiss franc in early 2015. Finally, Breinlich et al. (2021) focus on prices in the United Kingdom after the Brexit-induced depreciation of the British pound.

Our paper contributes to this literature in the following way: we consider the effects of the “US dollar rally” of 2014-2015, which originated in changing expectations about future US monetary policy. While this change in expectations resulted in a strong (and exogenous!) appreciation of the US dollar vis-à-vis most currencies in the world, it did not come with the usual financial and economic turbulences that characterize most currency crises. Using an event-study design, we analyze prices of (and expenditures on) a large number of goods at the retail level. The granular nature of our data set allows juxtaposing the prices of imported and domestic products. This makes it possible to analyze whether the prices of imported products reacted more strongly to the depreciation of the domestic currency – in our case: the Brazilian real (BRL), Chilean peso (CLP), Colombian peso (COP), Mexican peso (MXN) and Peruvian sol (PEN) – than the prices of domestic products.

3 The global US dollar rally and the macroeconomic environment in Colombia

3.1 The global US dollar rally

An important challenge faced by analysts of ERPT is that both prices and exchange rates are endogenous. To solve this issue, several contributions focus on “clean exchange rate shocks” (Bonadio, Fischer, and Sauré, 2019, p. 507), i.e. changes in the nominal exchange rate that are driven by developments on financial markets, political decisions, or changes in investor sentiment, but are arguably not reflecting endogenous reactions to the evolution of domestic prices. Such an event could be observed in many countries around the globe (including Colombia) between mid-2014 and early 2015, when the US dollar appreciated against most currencies in the world. Figure 1a depicts the evolution of the dollar’s nominal effective exchange rate, which

increased by 13.48 percent between July 2014 and March 2015 after more than one year of stability. We label this period the *global US dollar rally*. Of course, the time series in figure 1a is not informative about the appreciation vis-à-vis individual currencies, but it documents the global scale of the US dollar rally.

Importantly – and in contrast to the episodes analyzed, e.g., by Burstein, Eichenbaum, and Rebelo (2005) – the US dollar appreciation did not reflect a crisis in any of the countries involved. Instead, it predominantly mirrored markets’ re-assessment of the Fed’s future monetary policy and of the country’s growth prospects. Two US monetary policy-related factors were primarily held accountable for the global US dollar’s strength: First, the Federal Open Market Committee (FOMC) reduced the pace of its asset purchases several times in 2014.² And second, expectations spread that the Fed would start raising interest rates in 2015 from historic lows. This (expected) monetary policy tightening in the US clashed with a still extremely loose monetary policy stance in many other economies in the world. In addition to this ongoing monetary policy divergence, the (relative) strength of the US economy and low commodity prices contributed to a strong US dollar. As the Financial Times reported in a 2014 end-of-year review: “Investors have been reversing the trend of the past few years to put money outside the US in search of higher yields and stronger returns in emerging markets as interest rate expectations have shifted and the US economy has powered ahead.”³ In a similar spirit, the IMF in its 2015 *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER) relates the appreciation of the US dollar to “...shifts in markets’ expectation of the Federal Reserve’s interest rate liftoff” (p.2).

While the scanner data set we use covers a large number of countries, we initially focus on the evolution of prices in Colombia for the following reasons: First, as documented by figure 1b, the appreciation of the US dollar against the Colombian peso was particularly sharp, amounting to 40 percent between July 2014 and March 2015, and occurred after a long period of USD/COP stability.⁴ In fact, the rapid increase of the exchange rate satisfies the criteria of a “currency crash” established

²In the FOMC statement on December 18, 2013, the FOMC announced “to modestly reduce the pace of its asset purchases”. In each of the FOMC statements from January 2014 to September 2014, the FOMC announced “to make a further measured reduction in the pace of its asset purchases”, and in the FOMC statement on October, 29, 2014, the FOMC announced to “to conclude its asset purchase program this month”. See <https://www.federalreserve.gov/monetarypolicy/fomchistorical2014.htm>.

³From the Financial Times. December 31, 2014: “Dollar surges in 2014 on rate rise hopes”.

⁴Apparently, the US dollar kept appreciating against the Colombian peso after a short pause in spring 2015. However, our analysis will focus on the first nine months of the US dollar rally. This is because, as the time period considered grows larger, it becomes increasingly difficult to relate price movements (exclusively) to exchange rate fluctuations.

by Frankel and Rose (1996, p. 3), who define a currency crash as a “nominal depreciation of the currency of at least 25 percent [in a year] that is also at least a 10 percent increase in the rate of depreciation.” The currency crash in Colombia is, however, not being associated with the typical symptoms of a “currency crisis” (Kaminsky, Lizondo, and Reinhart, 1998), i.e. large-scale stress in the financial system, wide-spread bankruptcies, or a deterioration in gross international reserves.⁵

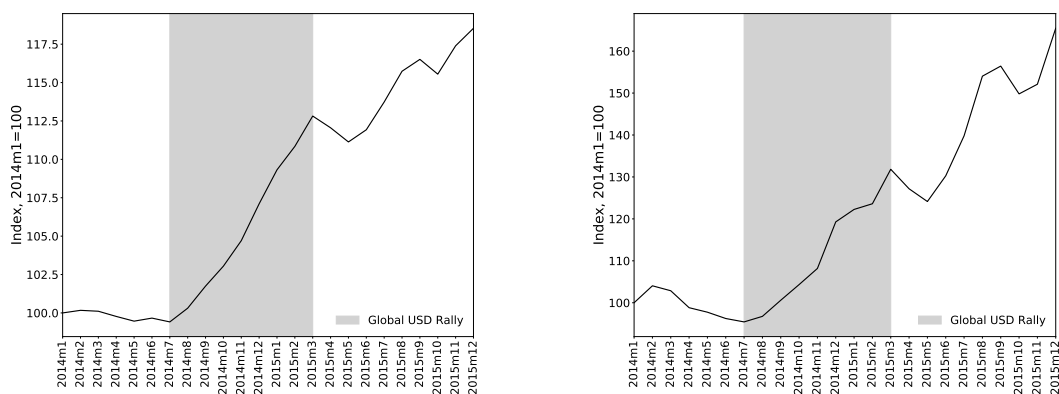
Second, the US dollar plays a dominant role as import invoicing currency in Colombia – i.e. import prices should have been affected particularly strongly by the US dollar rally. Table 1 reveals the high US dollar import share in Latin American countries provided by Boz et al. (2022). Surprisingly, Colombian imports are not documented in the data set, but we conjecture that the importance of the US dollar is comparable to the import share in the other Latin American countries. In addition, Gopinath et al. (2016) and Gopinath et al. (2020) document a high and instant pass-through of variations in the USD/COP exchange rate into prices charged by Colombian exporters and importers.

Year	Argentina	Brazil	Chile	Costa Rica	Ecuador	Paraguay	Peru	Uruguay
2012	87.13	86.31	88.12	98.64	NA	NA	93.27	NA
2013	87.84	NA	86.50	97.58	NA	NA	92.90	NA
2014	87.39	NA	87.23	97.52	NA	95.17	93.15	NA
2015	87.52	NA	86.06	96.60	94.78	94.95	93.88	75.50
2016	87.75	NA	83.18	97.57	93.46	94.62	92.86	70.40
2017	87.74	81.15	83.08	97.12	93.47	94.97	91.93	64.50
2018	88.13	83.36	83.11	97.12	93.72	94.99	91.60	67.70

Table 1: US dollar % import invoicing share in Latin American countries, 2012 to 2018, annual frequency. Source: Boz et al., 2022

We thus argue that, from the Colombian perspective, the US dollar rally was exogenous, which solves one of the key problems when it comes to identifying the causal effect of exchange rate movements on prices. Moreover, the USD/COP exchange rate change was particularly sharp, and most of the US dollar appreciation took place within a relatively short period of time, which suggests using an event study design to assess the extent and speed of exchange-rate pass-through. Finally, Colombian import prices should have been affected particularly strongly by the US dollar rally, as the US dollar plays a dominant role as invoicing currency for Colombian imports.

⁵According to the World Bank’s WDI, the share of non-performing loans relative to Colombian banks’ total loans increased from 2.77 percent in 2013 to 2.92 percent in 2014 and dropped back to 2.85 percent in 2015. According to Kaminsky, Lizondo, and Reinhart (1998), a “currency crisis” usually leads to a large decline in international reserves. In Colombia, however, gross international reserves increased from 37,871 million US dollars in January 2013 to 46,099 million US dollars in July 2014 and then remained fairly stable with an end-of-2015 balance of 46,740 million US dollars.



(a) Broad NEER, monthly frequency. Source: Federal Reserve Bank of St. Louis

(b) Nominal USD/COP exchange rate, monthly frequency. Source: IMF

Figure 1: US dollar exchange rates, 2014-2015

3.2 The Colombian macroeconomy before, during and after the global US dollar rally

The Colombian economy did not exhibit signs of macroeconomic volatility between July 2014 and March 2015. This is of crucial importance for the event study analysis, as a simultaneous occurrence of currency depreciation and macroeconomic turmoil would hamper the use of an event study framework.

Colombia entered 2014 with a very strong and robust economy. Colombia’s real GDP growth averaged 4 percent and annual inflation averaged 2.7 percent (close to its target of 3 percent) in the five years prior to 2014. The IMF projected in its 2014 Staff Country Report on Colombia (p.1) that real GDP growth will “converge to potential (about 4,5 percent) in 2014, with inflation remaining within the 2-4 percent target range”. Figure 2a plots year-to-year changes in real GDP and figure 2b plots year-to-year changes in the consumer price index in 2014 and 2015. Indeed, real GDP was growing steadily in 2014 and the first three quarters of 2015, and experienced a drop in the growth rate in the final quarter of 2015. Inflation exhibited an upward trend in 2014 and 2015 and escaped the 2-4 percent target range at the beginning of 2015. However, none of these evolutions was disruptive.

Colombia’s economy has important ties with the global economy. As a commodity exporter⁶, Colombia’s economy is sensitive to oil prices. As Colombia had a floating exchange rate regime, as classified and identified by the IMF throughout all years in

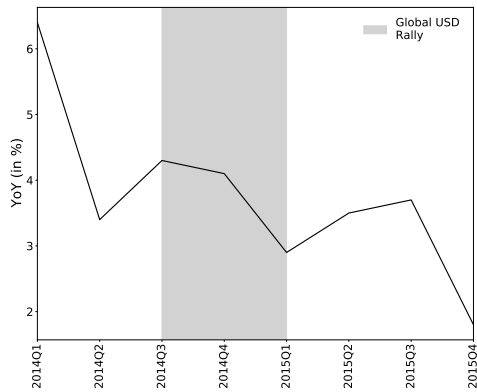
⁶Petroleum exports including derivatives accounted for more than 50 percent of total exports “free on board” in US dollars in 2013 and 2014, and to around 40 percent of total exports “free on board” in US dollars in 2015 according to oil export shares published by the *Departamento Administrativo Nacional de Estadística* (DANE).

the 2010s⁷, external shocks, like monetary policy shifts in the United States, have a strong impact on the external value of the Colombian peso. Just when the US dollar started to gain strength in the third quarter of 2014, oil prices plummeted. Figure 2c shows the World Spot Crude Index in 2014 and 2015. The index dropped sharply by over 44 percent between July 2014 and March 2015.

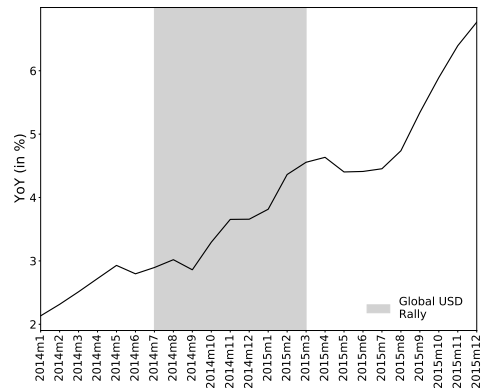
Colombia's real economy absorbed the severe drop in oil prices and the global US dollar rally remarkably well. Figure 2d plots year-to-year changes in real consumption. Real consumption was central to solid real GDP growth in 2014 and the first three quarters of 2015. In addition, historically low unemployment rates were observed in 2014 and 2015 (see figure 2e).

All in all, the exogenous and sharp Colombian peso depreciation vis-à-vis the US dollar, the high reliance of Colombian import prices on the US dollar and the strong and robust Colombian economy turns Colombia into our “flagship country” to analyze retail price movements during the global US dollar rally of July 2014 to March 2015 in an event study framework.

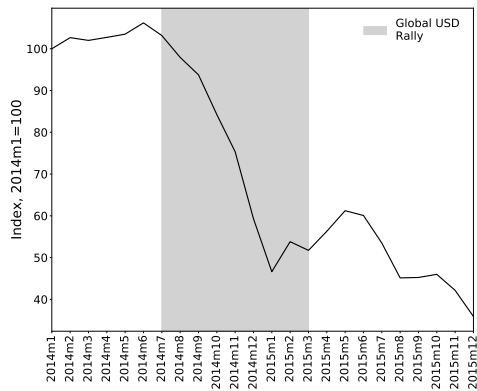
⁷See AREAER summary feature tables on www.elibrary-areaer.imf.org.



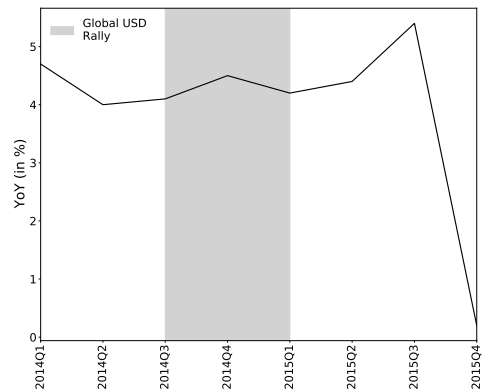
(a) Real GDP growth, quarterly frequency. Source: Departamento Administrativo Nacional de Estadística (DANE)



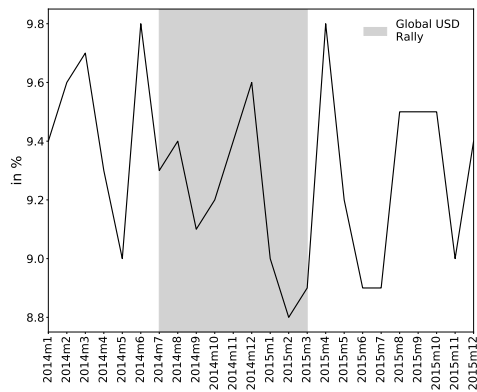
(b) CPI growth, monthly frequency. Source: Departamento Administrativo Nacional de Estadística (DANE)



(c) World Spot Crude Index, monthly frequency. Source: IMF



(d) Real consumption growth, quarterly frequency. Source: Departamento Administrativo Nacional de Estadística (DANE)



(e) Seasonally adjusted unemployment rate, monthly frequency. Source: Departamento Administrativo Nacional de Estadística (DANE)

Figure 2: Macroeconomic indicators in Colombia, 2014-2015

4 The scanner data set

In our empirical examination, we make use of a large micro scanner data set, covering purchases of “fast-moving consumer goods” (FMCG) in Colombia in 2014 and 2015. FMCG are consumed frequently by households, transacted at relatively low prices and generally fall into the product categories food and beverages, as well as personal and household care.

The scanner data set is provided by Kantar, a multinational market research firm that collects market research data globally, and can be classified as a household scanner data set, as households report their purchases digitally using scanner technology⁸. The scanner data set provides detailed transaction information at high frequency, tracking a nationally representative panel of consumers. We briefly highlight the main features of the scanner data set, explain important data cleaning steps and present some summary statistics.

In our scanner data set, we obtain information on total value transacted and total quantity transacted by time (day of transaction) and place of purchase (retailer and retailer type) at the barcode level. In addition to expense and quantity information, we obtain detailed features of each transacted product (=barcode) in a separate product dictionary file, including a precise product description (with up to 5 product characteristics), weight and size information, as well as brand and category affiliation. In total, 161 product groups (= “subcategories”) are covered, which are defined at a very granular level, usually below the 5-digit *Classification of Individual Consumption by Purpose* (COICOP). The scanner data set is also supplemented by a household dictionary file that shows socio-demographic information (household size, education, income, etc.) collected from households through survey questionnaires. A snapshot of the (merged) data set (=scanner data set + information from product dictionary file + information from household dictionary file) is shown in table 2. A corresponding summary of the complete data set (after having dropped transactions with missing or negative total value or total quantity information and after having applied an outlier filter to the data⁹) is presented in table 3.

⁸Household scanner data “collected by individuals or households using scanner technology that is typically provided by a third-party company” is often contrasted with store scanner data “collected at the point of sale by the in-store scanners used at check-outs” (Dubois, Griffith, and O’Connell, 2022, p. 1). Although both forms of scanner data share a number of key features, household scanner data offer the following attractive features: i) they usually cover transactions in a multitude of stores or retail chains; ii) they usually track households through time, which allows analyzing a household’s choice behavior and to relate it to a household’s socio-demographic information. See Dubois, Griffith, and O’Connell (2022) for more information on scanner data and its benefits for economic research.

⁹The rationale for an outlier filter is to exclude transactions with unusually high or low total value and total quantity information, as these transactions may be prone to coding errors or other

Date	Hh ID*	Ret. ID*	Ret. Type	Product ID	Expense in COP
17.06.2014	554556	31	Neighborhood Store	7702518021005	1000
07.11.2014	777284	44	Big Chain	7702025186440	3827.5
13.02.2015	665920	28	Convenience Store	7509546056098	3150
22.04.2015	445456	93	Other Chain	7709990556087	1231
Units	Volume	Measure	Category	Subcategory	
1	1	Pack	Toilet Paper	Toilet Paper - Regular	
2	864	Gram	Biscuit	Biscuit - Sweet	
1	75	Milliliter	Dental Product	Dental Product - Toothpaste	
2	1100	Gram	Industrialized Bread	Industrialized Bread - Regular	

Table 2: Snapshot of the data set

Note: This snapshot ignores information on socio-demographic features of the households and some product features provided in the product dictionary file. *The household and retailer identifiers are randomized, i.e. they do not correspond to the true data to comply with data nondisclosure agreements.

	Complete	Reduced
Nr. of Transactions	6,465,122	4,971,440
Nr. of Households	5,394	5,344
Nr. of Retailers	114	113
Nr. of Retailer Types	13	13
Nr. of Products	67,515	52,877
Nr. of Categories	65	65
Nr. of Subcategories	161	160
Sum of Expense in COP	20,023,691,299	14,931,666,601

Table 3: Summary of the data set

One key advantage of our data set is that it allows us to distinguish between imported and domestic products. Following Bems and Giovanni (2016), we identify the domestic/foreign origin of each transacted product via barcode characteristics. In particular, the first three digits of the Global Trade Identification Number (GTIN) identify the country in which the label was applied for. The product identifiers/barcodes that do not coincide with a GTIN are usually assigned by the data provider as globally standardized barcode information is missing, with the bulk falling into staple food product categories such as bread, liquid milk and rice, primarily transacted in the retailer types neighborhood stores and bakeries.¹⁰ A summary of the reduced data set – next to the summary of the complete data set – is presented in table 3. Since the products we consider can, in theory, be manufactured anywhere in

mistakes in the data set (Eurostat, 2022). We choose the following thresholds for identifying outlier transactions on a barcode-retailer level: A total-value-over-total-quantity ratio that is higher (lower) than three times (a third of) the median, and total units purchased higher than 25 times the median.

¹⁰We dropped all transacted products for which we could not identify their – domestic or foreign – origin.

the world, and not necessarily in the country where the label was applied for, we check whether the GTIN-based domestic/foreign labeling identification is a valid proxy for the domestic/foreign origin (=manufacturing location). We focus on web-scraped data from www.world.openfoodfacts.org (which provides GTIN and country of manufacturing information on thousands of products) and find that the method of identifying the domestic/foreign origin using the first 3 digits of the GTIN has 96 percent accuracy in the case of Colombia, i.e. in 96 percent of all the web-scraped GTINs that have a country of origin attached and match with GTINs in our data set, the web-scraped information on domestic/foreign origin (=manufacturing location) coincides with the GTIN-based domestic/foreign labeling identification.

In the analysis section, we crucially rely on price indices. Several price index formulas can be applied in order to obtain (elementary) price indices¹¹. Any formula takes prices and quantities as inputs. In scanner data with information on total value transacted and total quantity transacted, prices are unit values, i.e. total value transacted over total quantity transacted, and the elementary aggregate is the *homogeneous product* level. The specification of a homogeneous product, i.e. the unit for which unit values and quantities are observed over time, is central to any price index formula, as mis-specifications may lead to unit value bias (Diewert and Lippe, 2010). When specifying homogeneous products, we group together transacted products with identical features. As shown by Chessa (2016), grouping is a valid strategy in order to capture possible price increases after a “relaunch”, which is defined as a product of the same quality that is transacted with a new barcode.¹² Two such relaunches in the data set are shown in table 4.

The difference between the number of transacted products (52,877) and the number of homogeneous products (47,092) is -10.94 percent. Thus, a homogeneous

¹¹Elementary price indices are price indices at the lowest level of aggregation. Thus, the elementary aggregate is defined as the lowest level at which reliable expenditure weighting information is available (see the Intersecretariat (IMF, ILO, etc.) Working Group Consumer Price Index Manual: Concepts and Methods, 2020, p.177).

¹²Nakamura and Steinsson (2012) illustrate the importance of price adjustments that occur at the time of product replacements (observable in micro datasets) for exchange-rate pass-through estimates and for the construction of price indices. They argue that such price adjustments are “lost in transit” in a conventional price index, in which price changes of identical (transacted) products enter, and product replacements are only linked into the index. They propose a model of such a “product replacement bias” and conclude that “our adjustment is designed to address a situation where characteristics data are unavailable, and therefore it is not possible to calculate the quality-adjusted prices using hedonic methods. Ideally, future research using more detailed data will allow for more direct estimates of product replacement bias based on comparisons of the quality-adjusted prices of entering and exiting items.” (p. 3313). The richness of our scanner data set would allow us to provide direct estimates of a potential product replacement bias, which is, however, not a goal of this paper. More importantly, our results are not prone to this “product replacement bias” as we capture possible price increases after relaunches/product replacements by grouping together transacted products with identical features.

Product ID	Origin	Volume	Measure	Category	Subcategory	Manufacturer
7702047005330	Domestic	400	Grams	Tomato Sauce	Tomato Sauce - Regular	Unilever
7702047138519	Domestic	400	Grams	Tomato Sauce	Tomato Sauce - Regular	Unilever
7702001049998	Domestic	300	Milliliters	Industrialized Juice	Industrialized Juice - Without Gas	Alpina
7702001550178	Domestic	300	Milliliters	Industrialized Juice	Industrialized Juice - Without Gas	Alpina
Brand	Subbrand	Characteristic 1	Characteristic 2	Characteristic 3	Characteristic 4	
Fruco	NA	Normal	Valve Pack	NA	NA	
Fruco	NA	Normal	Valve Pack	NA	NA	
Soka	NA	Zero	Soft Drink	Light	Maracuja	
Soka	NA	Zero	Soft Drink	Light	Maracuja	

Table 4: Relaunch examples

Note: The transacted products in the first two rows (and the transacted products in the last two rows) have identical (i) total volumes; (ii) (sub)category affiliation; (iii) manufacturer affiliation; (iv) brand affiliation; (v) domestic/foreign origin; and (vi) characteristics (identified by up to the 4th criteria), but have a different barcode. For the purpose of this paper, such transacted products are treated as homogeneous.

product may refer to a single transacted product or to a group of transacted products that share exactly the same features. On average, each homogeneous product comprises 1.12 transacted products.

On the place-of-purchase dimension, we combine retailers of the same type. The different retailer types, including information on number of transactions and total value transacted, are shown in table 5. With this type of assortment, we keep the data highly disaggregated and capture quality differences between retailer types, while avoiding to blow up the product universe, i.e. the number of individual homogeneous products that may ultimately enter the price index compilation.

Retailer Type	Expense in COP	% Expense (Domestic)	% Expense (Imported)
Neighborhood Stores	3,366,971,608	22.55	1.23
Convenience Stores	3,106,573,456	20.80	2.77
Big Chains	2,601,083,600	17.42	3.24
Other Chains	2,226,228,180	14.91	3.14
Other Channels	412,344,798	2.76	0.87
Bakeries	322,331,425	2.16	0.13
Hyperstores	295,734,035	1.49	0.46
Specialty Stores	221,928,073	0.91	0.56
Drugstores	130,954,445	0.53	0.33
Catalogs	78,844,009	0.52	2.43
Marketplaces	70,469,571	0.37	0.09
Warehouses / Wholesalers	40,748,923	0.21	0.05
Virtual Shops	821,662	0.01	0.01

Table 5: Expense by retailer type

Note: The retailer-to-retailer-type affiliation is provided by Kantar.

Table 6 provides information on the transaction of homogeneous products across different types of retailers. The table shows that the majority of these products (16,667) are transacted by a single retailer type, while the remaining products are transacted by at least two different types of retailers. Specifically, 8,091 products are

transacted by two types of retailers, 5,683 by three types, and so on. The table also shows that the number of products transacted decreases as the number of retailer types increases, with only one product being transacted across 13 different types of retailers.

Count of Retailer Types	Count of Homogeneous Products
1	16,667
2	8,091
3	5,683
4	4,592
5	3,602
6	2,717
7	1,828
8	1,068
9	539
10	240
11	64
12	7
13	1

Table 6: Products by count of retailer types

Figure 3 plots the differences in median unit values of homogeneous products relative to neighborhood stores (the retailer type with the highest expense). In total, 15,766 homogeneous products are sold in neighborhood stores and at least one other retailer type. As figure 14 shows, median unit values of the same homogeneous product differ across retailer types. Thus, aggregation across retailer types is not acceptable as it may lead to unit value bias. The difference between the number of unique homogeneous product-retailer type combinations (131,970) and the number of homogeneous products (47,092) is -64.32 percent. This implies that one and the same homogeneous product is on average transacted in 2.8 different retailer types.

In order to observe a single unit value for each homogeneous product at the retailer type level, we sum total value transacted and total quantity transacted by retailer type and month, and then divide total value transacted by total quantity transacted. From now on, we define a homogeneous product at the retailer type level that may ultimately enter the price index computation simply as a “product”. The aggregated data set (on an annual level) is summarized in table 7.

A distinct feature of scanner data sets is that they are typically dynamic in the sense that some products are not continuously purchased throughout the years, new products start being transacted (usually because they enter the market) and obsolete products stop being transacted (usually because they are removed from the assortments). Figure 4 shows that 3.64 percent of total products are transacted in each month between January 2014 and December 2015, which amounts to 4,802 products and 48.37 percent of total value transacted. Figure 5 shows that the product

	Year	Sales Value in COP	% Sales Value Growth	Nr. of Homogeneous Products
All Products	2014	7,226,600,036	NA	94,501
All Products	2015	7,705,066,565	6.62	96,974
Domestic	2014	4,552,359,647	NA	72,082
Domestic	2015	4,821,714,372	5.92	74,723
Imported	2014	2,674,240,389	NA	22,419
Imported	2015	2,883,352,194	7.82	22,251

Table 7: Summary of the aggregated data set

universe in our scanner data set is steadily changing over time. The percentage of products that are transacted in two adjacent months (“flow”) lies above both the percentage of products that are not transacted in the next month (“outflow”) and the percentage of products that had not been transacted in the previous month (“inflow”)¹³, but inflows and outflows are substantial in each month¹⁴. This implies that price indices based on a *static product universe*, i.e. based on “continuously transacted products” throughout all months in 2014 and 2015, may differ from price indices based on a *dynamic product universe*, which allows for a changing basket, and thus product entry and exit.

¹³As Chessa, Verburg, and Willenborg (2017) highlight, “inflow” does not only contain new products, but also products that are temporarily unavailable, and “outflow” does not only capture products that disappear forever.

¹⁴Adjusted for expenditure, flows play a more dominant role.

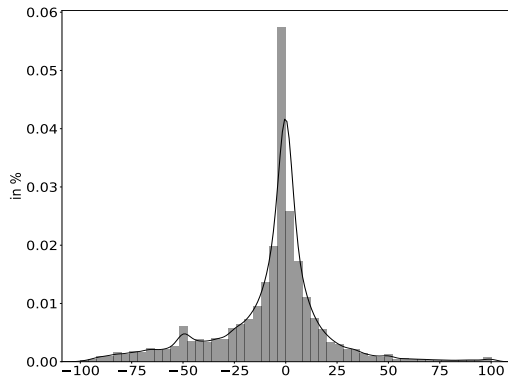


Figure 3: Median unit value dispersion

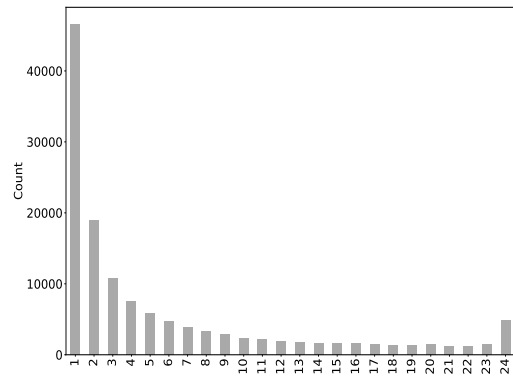


Figure 4: Number of products transacted by number of months

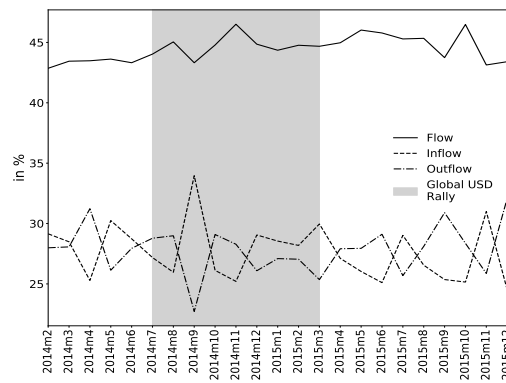


Figure 5: Flow, inflow and outflow of products in the data set

5 Colombian-specific analysis

5.1 Reconstructing the official FnB price index

Our first step is to determine whether our dataset can be used to track official price indices in Colombia. To do so, we must follow procedures similar to those used by the *Departamento Administrativo Nacional de Estadística* (DANE), which is responsible for compiling and publishing official economic statistics in Colombia. According to DANE’s methodological datasheets and technical bulletins, unweighted geometric averages of price relatives are computed below the COICOP subclass level. These index numbers are then aggregated using arithmetic averages and weights from the National Household Budget Survey (NHBS), which was conducted in 2016-2017 and before that in 2006-2007, to create higher-level indices such as the COICOP division level for Food and non-alcoholic Beverages (FnB).

DANE’s monitoring basket of goods and services, which is representative of household expenditures, consists of 443 items or representative products at the COICOP 7-digit level. Each month, DANE records prices for one or multiple varieties of each representative product. Although the selected varieties are not published, DANE states that they choose the most commonly sold varieties, which are expected to remain on the market for some time. If a variety is no longer available, it is replaced by a similar substitute.

To replicate DANE’s procedure with our dataset, we should thus select a sample of frequently transacted products, weight products according to their economic importance, keep consumption baskets fixed, and compute monthly price variations. By following these procedures, we can determine whether our dataset can be used to track official price indices in Colombia.

We decided to compute the Laspeyres index on the “static product universe”, meaning that we did not consider changes in the availability of products over time by relying on the products that were purchased at least once every month in 2014 and 2015. This approach is similar to the one used by Braun and Lein (2021), who utilized a “super common varieties sample” to replicate the official price index computed by the Swiss Federal Statistical Office with scanner data on prices and expenditures in the CPI subgroups of food, beverages, and tobacco. The “super common varieties sample” consists only of products that are purchased at least once every quarter. By focusing on continuously transacted products, we aim to approximate the frequently transacted goods sample and fixed consumption basket used by DANE in its price index calculation. Moreover, we limit our analysis to products that could be classified under the FnB division, which has the highest total value transacted in our data

set (58 percent), and for which we could obtain official price index numbers. This division accounted for 20.14 percent of the total consumption basket derived from the NHBS conducted in 2006-2007 and 17.93 percent of the total consumption basket derived from the NHBS conducted in 2016-2017. To compute the Laspeyres (1871) index numbers between two consecutive periods, we used the following formula:

$$P_{s,t} = \frac{\sum_{i \in \Omega_s} p_{it} q_{it-1}}{\sum_{i \in \Omega_s} p_{it-1} q_{it-1}} \quad (2)$$

where Ω_s refers to the set of continuously transacted products that belong to the FnB division. Finally, we chained the Laspeyres period-on-period index numbers to obtain the cumulative Laspeyres index.

Figure 6 displays the Laspeyres FnB index based on our reduced scanner data set and the official consumer price FnB index published by DANE. Three key observations are worth noting: First, the two lines move in parallel, indicating that the information incorporated in both indices is quite similar. Second, there were two waves of price hikes, one in the first quarter of 2015 and the other at the end of 2015, beginning in September. Finally, the rise in FnB prices of roughly five percentage points during the USD rally (July 2014 to March 2015) is rather low compared to the almost 40 percent increase in the US dollar over the same period (see figure 1b).

5.2 Relative price movements (imported over domestic products)

Of course, the moderate pass-through of the US dollar appreciation into the FnB retail price index as such is not puzzling. It is well known that the “retail wedge” isolates prices from exchange rate fluctuations – at least in the short run (see Burstein and Gopinath, 2014). This is because the distribution services that are necessary to take imported products from the border to the store shelf entail a large non-traded component, which is not directly affected by exchange rate fluctuations. The specific role of distribution services for ERPT depends on whether they enter the production of retail goods in a multiplicative or in an additive way. In the first case – as, e.g., in Breinlich et al. (2021) – prices at the wholesale level are independent of the retail industry. In the second case – as in Corsetti and Dedola (2005) or Harms, Hoffmann, and Ortseifer (2015) – the existence of distribution costs affects the markup charged by producers. Moreover, the “retail wedge” hinges on the market structure in the retail industry, with the assumption of perfect competition being a frequent, but not obvious choice. Finally, exchange rate fluctuations may affect the costs at which distribution services are produced (Breinlich et al., 2021). Despite the dampening effect of the “retail wedge”, we conjecture that – at least in the short run – a

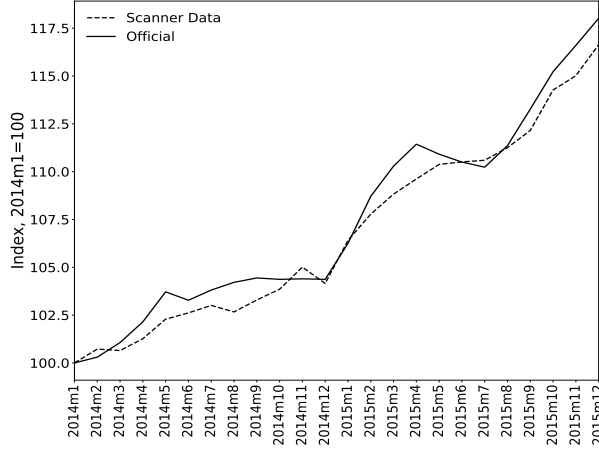


Figure 6: Official vs. Data Set based FnB Price Index, 2014-2015. Source: DANE
Note: The data set based FnB price index is a Laspeyres index based on the static product universe.

depreciation of the domestic currency raises the prices of imported products by more than the prices of their domestically produced substitutes. The plausibility of this conjecture is supported by Burstein and Gopinath (2014) who observe that prices of domestically produced goods are insensitive to nominal exchange rates (page 415). Moreover, in their analysis of “Brexit depreciation”, Breinlich et al. (2021) do not find evidence that, in the time frame considered, domestic firms raised the prices of products that are close substitutes to imported products. An obvious explanation for these observations is that price-stickiness impedes a swift reaction of domestic product prices. To verify our expectation that the appreciation of the US dollar increased the prices of imported products by more than the prices of close domestic substitutes, we consider the evolution of subcategory-specific *price ratios* that divide a price index for imported products by a price index for domestic products of the same subcategory. More specifically, we compute

$$\rho_{gt}^T = \frac{P_{gt}^{M,T}}{P_{gt}^{D,T}} \quad (3)$$

where $P_{gt}^{j,T}$ (with $j = M, D$) gives a period-on-period *Törnqvist price index number* (Törnqvist, 1936) for imported (M) and domestic (D) products assigned to subcategory g , i.e.

$$P_{gt}^{j,T} = \prod_{i \in \Omega_g^j} \left(\frac{p_{it}}{p_{it-1}} \right)^{(s_{it-1} + s_{it})/2} \quad (4)$$

where Ω_g^j is the set of imported/domestic products assigned to subcategory g ,

p_{it} is the price of product i at time t , p_{it-1} is the price of product i at the previous period, and s_{it} is the share of period t expenditure on product i defined as:

$$s_{it}^j = \frac{p_{it}q_{it}}{\sum_{i \in \Omega_g^j} p_{it}q_{it}} \quad (5)$$

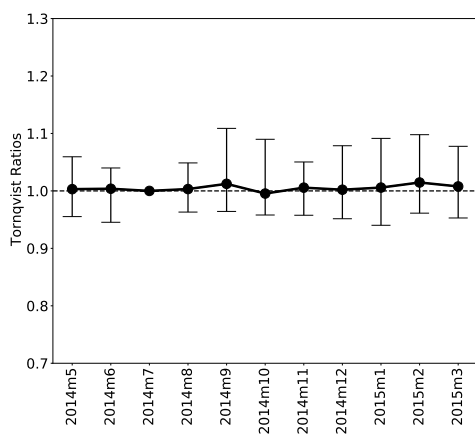
The denominator of the expression is the total expenditure on all imported/domestic products in period t . The period-on-period index numbers are then chained, i.e. the price index is calculated as the cumulative product of the period-on-period index numbers.

Figure 7a illustrates the distribution of ρ_{gt}^T across different product subcategories g for the *static product universe*, i.e. we restrict the sets Ω_g^M and Ω_g^D to those products that are purchased at least once every month in 2014 and 2015. Figure 7b illustrates the distribution of ρ_{gt}^T for the *dynamic product universe*, i.e. we resample the sets for each pair of adjacent periods being compared and thus let the sets Ω_g^M and Ω_g^D vary over time. Interestingly, figure 7a does not reveal the increase in the (empirical) distribution of ρ_{gt}^T that we would have expected. In fact, the price ratio remains surprisingly stable, with the median moving sideways and the 10th/90th percentiles of the data remaining below/above the 1.0-line. The fact that relative prices of imported products over their domestic substitutes remain constant comes as a surprise, and contradicts the wide-spread notion that exchange rate movements generate relative price movements. Figure 7b documents that the surprising stability of relative prices does not disappear, even if we allow for changes in the availability of products over time.

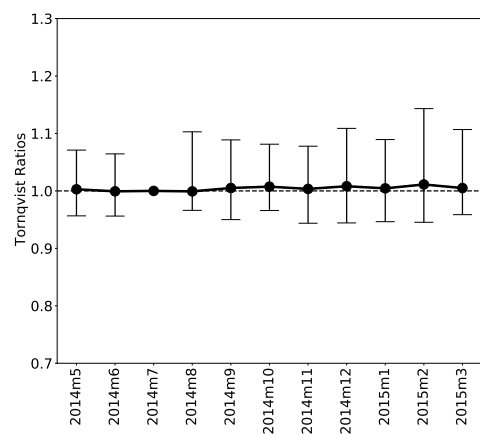
5.3 Separate price indices (imported and domestic products)

The surprising stability of relative prices documented in the preceding subsection allows for different interpretations: possibly, neither imported nor domestic product prices change despite the considerable depreciation of the Colombian peso. Or both change over time, but move in parallel. To explore which of the two interpretations is supported by the data, we compute separate price indices for imported and domestic products. We restrict the analysis to those products and subcategories that enter the price ratios in figure 7.

To calculate an origin-specific price index, we first compute period-on-period Tornqvist price index numbers at the subcategory level by assigning weights to all products within a subcategory. Then, we aggregate the individual index numbers using subcategory-origin specific weights and ultimately chain the aggregated index numbers to observe the price index. More specifically, we compute



(a) Tornqvist, static product universe



(b) Tornqvist, dynamic product universe

Figure 7: Distribution of price index ratios around the US dollar rally

Note: This figure illustrates the distribution of ρ_{gt}^T as defined by equations (4) to (5) across different product subcategories g . The medians are denoted by dots. The whiskers define the 90th and 10th percentile of the data, respectively. The left column is based on the static product universe and the right column is based on the dynamic product universe. We restrict the analysis to 51 subcategories (static product universe) and 60 subcategories (dynamic product universe) for which we observe at least 5 domestic and imported products.

$$P_t^{j,T} = \sum_g \prod_{i \in \Omega_g^j} \left(\frac{p_{it}}{p_{it-1}} \right)^{(s_{it-1} + s_{it})/2} W_{gt-1}^j \quad (6)$$

with

$$W_{gt-1}^j = \frac{\sum_{i \in \Omega_g^j} p_{it-1} q_{it-1}}{\sum_{i \in \Omega_g^j} p_{it-1} q_{it-1}} \quad (7)$$

Figure 8 illustrates the origin-specific price indices resulting from the static product universe and the dynamic product universe. It demonstrates the pick-up in inflation in the first quarter of 2015 that was already present in figure 6.¹⁵ Prices increased by approximately 3 percent in the first quarter of 2015, which amounts to an annualized inflation rate of approximately 12 percent. Interestingly, however, the upward movement appears in both the domestic and foreign price index. We thus conclude that both imported and domestic product prices change over time, but move in parallel.

5.4 Spending patterns

The fact that we observe constant ratios of imported over domestic product prices within a subcategory suggests that there was no significant impact on consumers' (relative) spending behavior. We therefore conjecture that consumers did not systematically switch from imported products to domestic products, or vice versa, in the wake of the US dollar rally.

In order to explore whether domestic products gained market share during the US dollar rally, we compute the aggregate import expenditure share from product-level data for each month in 2014 and 2015 via

$$s_t^M = \sum_g \sum_{i \in \Omega_{gt}^M} s_{igt} \quad (8)$$

Here s_{igt} refers to the expenditure share on product i in subcategory g in period t ,

¹⁵The inflation rates shown in figure 6 and figure 8a differ due to two factors. First, the product universe used to calculate each index differs: figure 6 only includes FnB products, whereas figure 8a includes FnB, personal care, and household products. Secondly, the formula used to calculate each index differs: the Laspeyres index used to compute the inflation rate in figure 6 relies on previous period expenditure shares, which may not accurately reflect changes in consumer behavior and preferences over time. On the other hand, the Tornqvist index used to calculate the inflation rate in figure 8a updates both the quantities of goods consumed and the expenditure shares each period, which can better capture changes in consumer behavior and preferences over time. Overall, the Tornqvist index in figure 8a is rated as the more accurate measure of inflation, while the Laspeyres index in figure 6 was used to replicate the official FnB price index, which follows a methodology closer to the Laspeyres index.

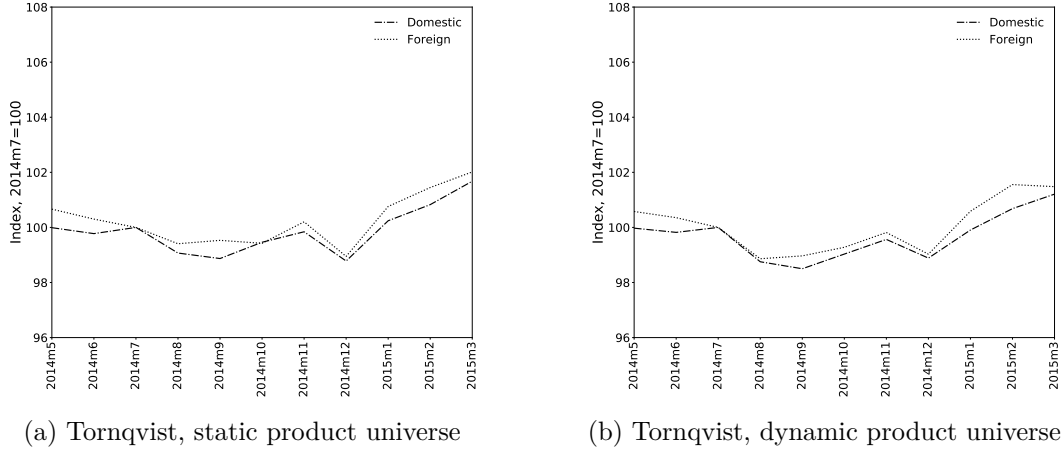


Figure 8: Price indices by product origin around the US dollar rally

Note: This figure presents Tornqvist price indices for imported and domestic products separately, which are calculated based on equations (6) to (7), using the static product universe (left column) and the dynamic product universe (right column). The analysis focuses on 51 subcategories (static product universe) and 60 subcategories (dynamic product universe) with at least 5 observed domestic and imported products, which corresponds to the product universe used in the price index ratio plots presented in figure 7.

Ω_{gt}^M is a subset of imported products in subcategory g in period t , and $\sum_g \sum_i s_{igt} = 1$, i.e. expenditure shares sum up to one over all products and subcategories in period t . Figure 9 shows that the aggregate import expenditure share was constant. In other words, consumers did not switch their spending from domestic products to imported products, or vice versa, during the period of analysis.

Although we observe that the aggregate import expenditure share remained constant, which indicates that the proportion of overall spending on imported products did not change over time, we cannot conclude that consumers did not switch from imported to domestic products *within a narrowly defined subcategory*. To understand whether such switching occurred, we need to examine whether import expenditure shares and relative quantities of imported and domestic products within a subcategory also remained constant. To start with the former, we define the share of imports within a subcategory as

$$\phi_{gt}^M = \frac{s_{gt}^M}{s_{gt}} \quad (9)$$

Figure 10 plots the distribution of import expenditure share year-on-year growth rates for the first four months in 2015. All four subfigures show a distribution

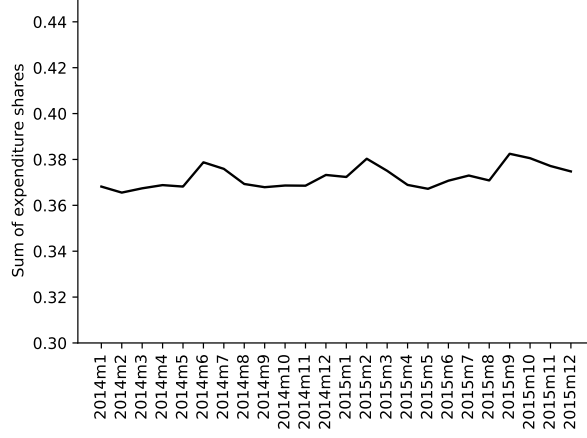


Figure 9: Aggregate import expenditure share, 2014-2015

Note: This figure plots the aggregate import expenditure share as defined by equation (8) based on all products in the (reduced) data set.

centered around zero with an import expenditure share growth rate of the median subcategory of zero or at most 1 percent.

Next, we compute quantity indices on a subcategory level to explore potential quantity effects. If these relative quantities changed, then consumers could have shifted their preferences from domestic to imported products, or vice versa, even if the aggregate import expenditure share remained constant. Formally, we compute

$$\sigma_{gt}^T = \frac{Q_{gt}^{M,T}}{Q_{gt}^{D,T}} \quad (10)$$

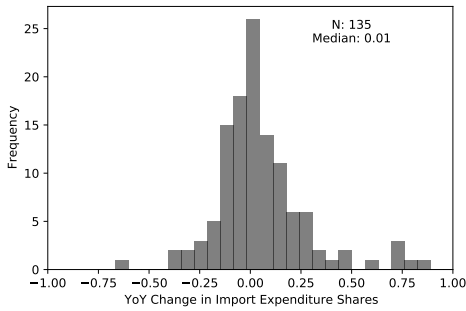
where $Q_{gt}^{j,T}$ (with $j = M, D$) gives a period-on-period *Tornqvist quantity index number* for imported (M) and domestic (D) products assigned to subcategory g , i.e.

$$Q_{gt}^{j,T} = \prod_{i \in \Omega_g^j} \left(\frac{q_{it}}{q_{it-1}} \right)^{(s_{it-1} + s_{it})/2} \quad (11)$$

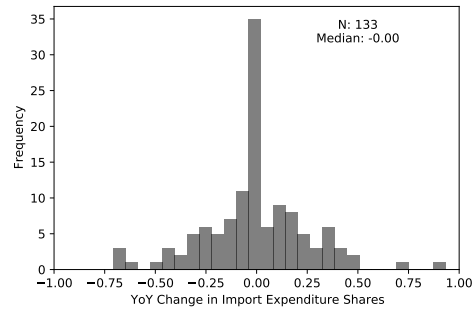
where Ω_g^j is the set of imported/domestic products assigned to subcategory g , q_{it} is the quantity of product i at time t , q_{it-1} is the quantity of product i at the previous period, and s_{it} is the share of period t expenditure on product i defined (as before) as:

$$s_{it}^j = \frac{p_{it}q_{it}}{\sum_{i \in \Omega_g^j} p_{it}q_{it}} \quad (12)$$

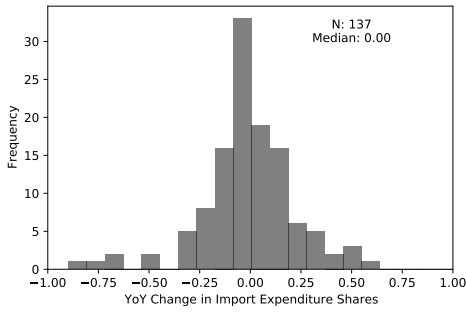
with the resulting quantity indices being computed as chained indices based on



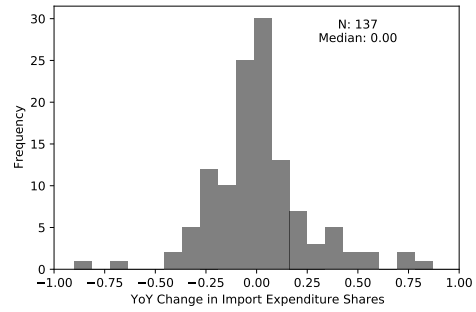
(a) YoY, 2015m1 vs. 2014m1



(b) YoY, 2015m2 vs. 2014m2



(c) YoY, 2015m3 vs. 2014m3



(d) YoY, 2015m4 vs. 2014m4

Figure 10: Distribution of import expenditure share growth rates

Note: This figure shows the distribution of import expenditure share year-on-year growth rates for the first four months in 2015 as defined by equation (9). Included are all subcategories with non-zero expenditures in the two relevant time periods.

the underlying index numbers.

Figure 11 plots the distribution of σ_{gt}^T around the time of the global US dollar rally. The sideways moving median and 10th/90th percentile of the data supports our conjecture that stable relative prices do *not* result in large-scale expenditure switching.

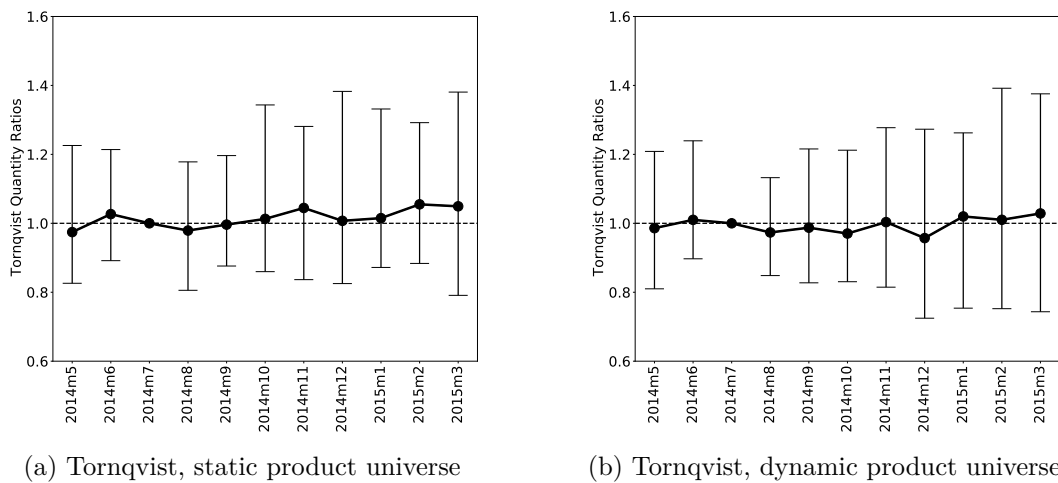


Figure 11: Distribution of quantity index ratios around the US dollar rally

Note: This figure illustrates the distribution of σ_{gt}^T as defined by equations (10) to (12) across different product subcategories g . The medians are denoted by dots. The whiskers define the 90th and 10th percentile of the data, respectively. The left column is based on the static product universe and the right column is based on the dynamic product universe. We restrict the analysis to 51 subcategories (static product universe) and 60 subcategories (dynamic product universe) for which we observe at least 5 domestic and imported products, i.e. the product universe matches with the one used for the price index ratio plots and origin-specific price indices.

6 Extending the focus beyond Colombia

Our findings for Colombia challenge the widely-held view that exchange rate fluctuations have a significant impact on relative prices faced by consumers and correspondingly on expenditure switching from imported to domestically produced products. Specifically, we observe that the retail sector seems to play a complex role in transmitting exchange rate fluctuations to off-the-shelf prices.

In order to assess the robustness and generalizability of our Colombian-specific findings, we aim to extend our analysis to other Latin American countries. By examining whether our results hold true in other countries with different economic characteristics, we can better understand the mechanisms underlying the transmission of exchange rate changes to relative retail prices in the region as a whole.

In what follows, we will construct figures 7 and 11 for Brazil, Chile, Mexico and Peru conducting exactly the same data manipulation steps as described in section 4. In particular, we identify the domestic/foreign origin of each transacted product via barcode characteristics and group together transacted products with identical features in order to capture potential price increases after a relaunch. The number of products by domestic/foreign origin for each country is summarized in table 8.

Brazil			Chile		
	Year	Nr. of Homogeneous Products		Year	Nr. of Homogeneous Products
All Products	2014	126,942	All Products	2014	49,092
All Products	2015	149,187	All Products	2015	48,458
Domestic	2014	118,762	Domestic	2014	32,988
Domestic	2015	139,132	Domestic	2015	32,762
Imported	2014	8,180	Imported	2014	16,104
Imported	2015	10,055	Imported	2015	15,696
Mexico			Peru		
	Year	Nr. of Homogeneous Products		Year	Nr. of Homogeneous Products
All Products	2014	75,699	All Products	2014	46,793
All Products	2015	86,184	All Products	2015	43,408
Domestic	2014	53,951	Domestic	2014	26,167
Domestic	2015	60,865	Domestic	2015	24,222
Imported	2014	21,748	Imported	2014	20,626
Imported	2015	25,319	Imported	2015	19,186

Table 8: Product count by origin

Table 1 shows that US dollar import invoicing shares for Brazil, Chile and Peru. With more than 85 percent import invoicing share in 2014 and 2015, the US dollar plays a dominant role in these countries and thus import prices should have been affected strongly by the US dollar rally. For Mexico, we conjecture that the US dollar import invoicing share is similar to what we observe for the other Latin American countries.

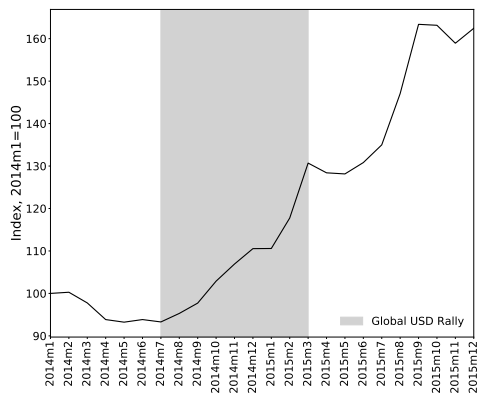
Figure 12a shows that the nominal appreciation of the US dollar against the

Brazilian real (BRL) was as sizable as the US dollar appreciation against the Colombian peso, amounting to more than 40 percent between July 2014 and March 2015. Although the US dollar appreciated to a lesser extent against the Chilean peso (CLP), Mexican peso (MXN) and Peruvian sol (PEN) (see figure 12b to 12d), it remained consistently strong, strengthening by at least 10 percent in all cases.

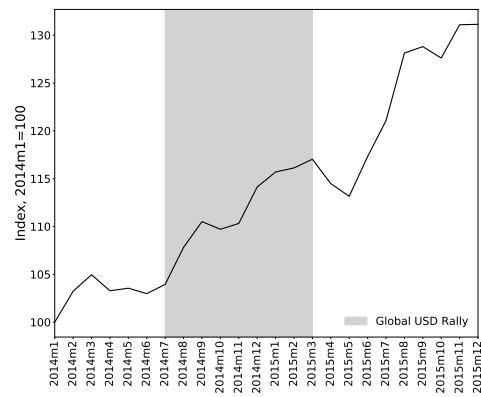
While event studies typically require a stable economic environment to identify the causal impact of an event on economic outcomes, a multi-country analysis can still provide valuable insights even in the presence of heterogeneity across countries. By examining the relationship between exchange rate fluctuations and consumer prices across a diverse set of countries with different economic conditions, we can identify patterns and trends that are robust to idiosyncratic shocks and policy differences. Moreover, the heterogeneity of economic conditions across countries can itself be a source of valuable information. By comparing the responses of different countries to a common shock, we can better understand the factors that contribute to variation in exchange rate pass-through and the factors that may moderate or amplify the impact of exchange rate fluctuations on (relative) prices – provided that there is any variation.

Figures 13 to 16 depict the distribution of subcategory-specific *price ratios* and *quantity ratios* for imported products compared to domestic products of the same subcategory in the four Latin American countries. Specifically, the price ratios (ρ_{gt}^T) are calculated by dividing a Tornqvist price index for imported products by a Tornqvist price index for domestic products, while the quantity ratios (σ_{gt}^T) are obtained by dividing a Tornqvist quantity index for imported products by a Tornqvist quantity index for domestic products. The calculation of both ratios follows the methodology described in equations (3) to (5) and (10) to (12), respectively. The figures show the distribution of these ratios across different product subcategories g , providing insight into the relative pricing and quantity trends for imported versus domestic goods in these countries.

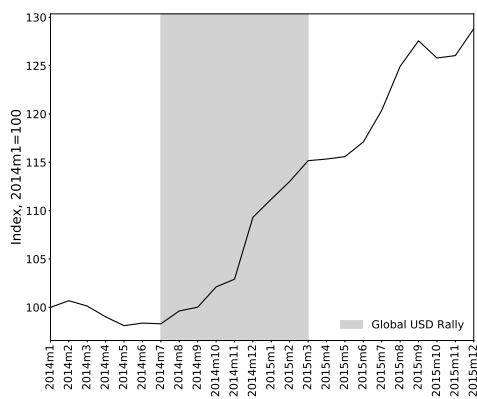
Our findings for Brazil, Chile, Mexico and Peru are consistent with the findings for Colombia. Specifically, we find that the relative prices of imported products over their domestic substitutes remain fairly constant, even in the face of the US dollar appreciation and a diverse set of countries. This contradicts the widely held notion that exchange rate movements generate relative price movements. The fact that our results are consistent across countries supports the idea that the role of the retail sector in transmitting exchange rate fluctuations to off-the-shelf prices is more complex than generally believed. In addition, our findings for Colombia provide evidence that stable relative prices do not result in large-scale expenditure switching.



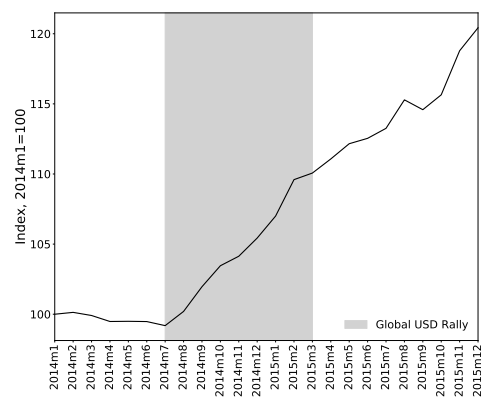
(a) Nominal USD/BRL exchange rate, monthly frequency. Source: IMF



(b) Nominal USD/CLP exchange rate, monthly frequency. Source: IMF



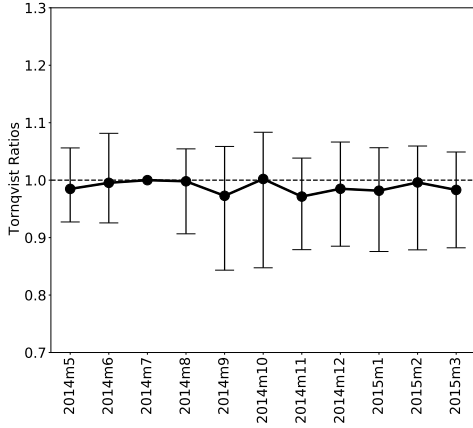
(c) Nominal USD/MXN exchange rate, monthly frequency. Source: IMF



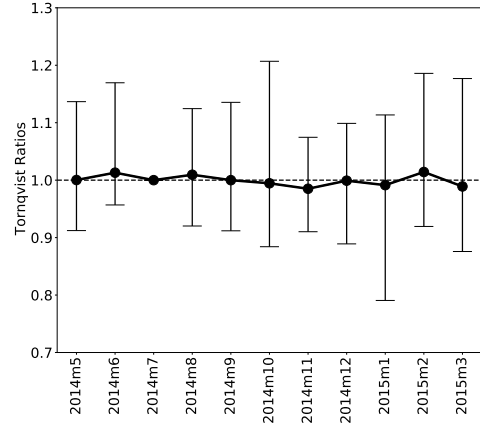
(d) Nominal USD/PEN exchange rate, monthly frequency. Source: IMF

Figure 12: US dollar exchange rates, 2014-2015

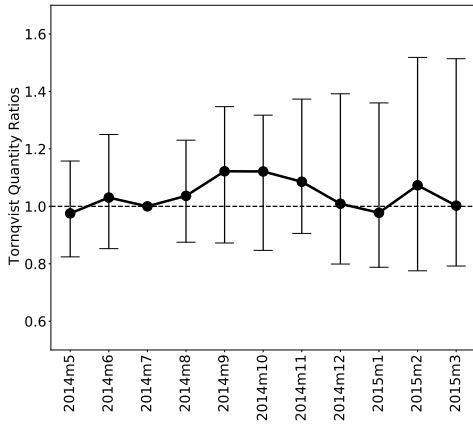
Importantly, we find that this result holds true for the other Latin American countries in our sample as well, which highlights the need for further research to understand the mechanisms driving the stability of relative prices across countries and over time.



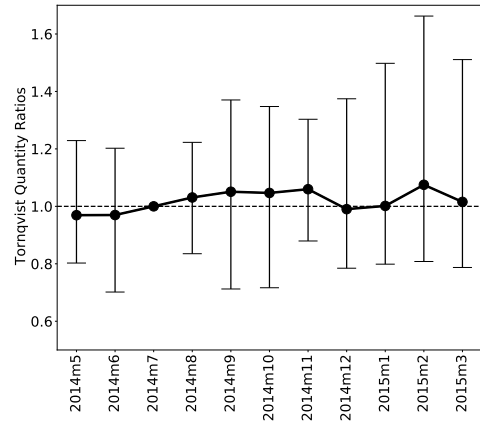
(a) Tornqvist price ratio, static product universe



(b) Tornqvist price ratio, dynamic product universe



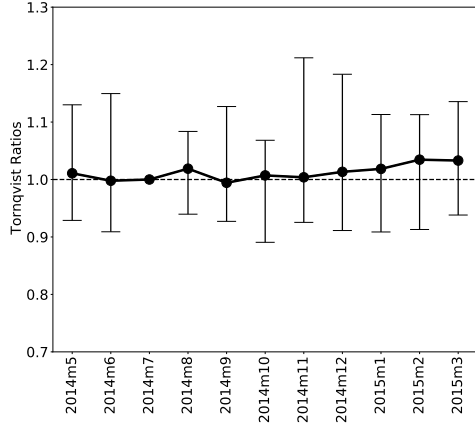
(c) Tornqvist quantity ratio, static product universe



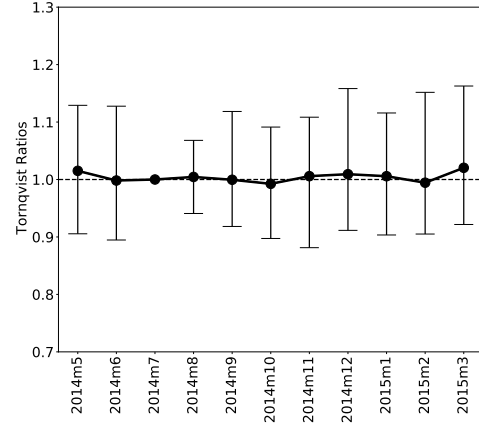
(d) Tornqvist quantity ratio, dynamic product universe

Figure 13: Distribution of price and quantity index ratios around the US dollar rally in Brazil

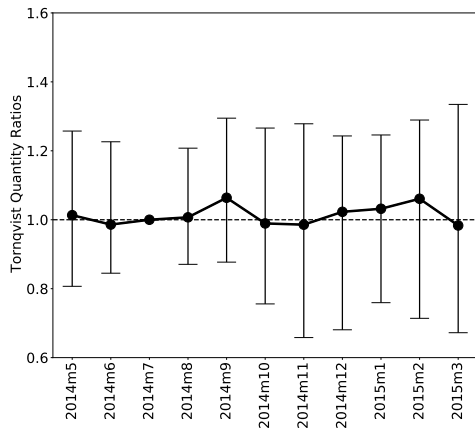
Note: This figure illustrates the distribution of ρ_{gt}^T and σ_{gt}^T across different product subcategories g for Brazil. The medians are denoted by dots. The whiskers define the 90th and 10th percentile of the data, respectively. The left column is based on the static product universe and the right column is based on the dynamic product universe. We restrict the analysis to 30 subcategories (static product universe) and 42 subcategories (dynamic product universe) for which we observe at least 5 domestic and imported products.



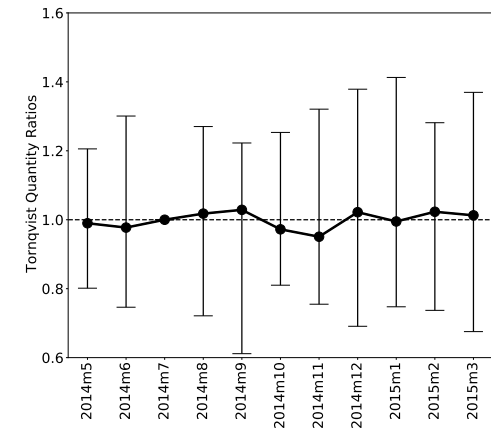
(a) Tornqvist price ratio, static product universe



(b) Tornqvist price ratio, dynamic product universe



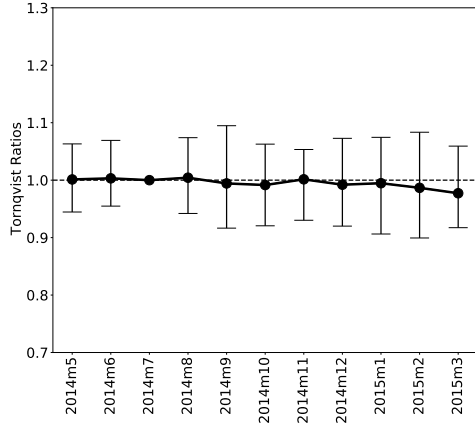
(c) Tornqvist quantity ratio, static product universe



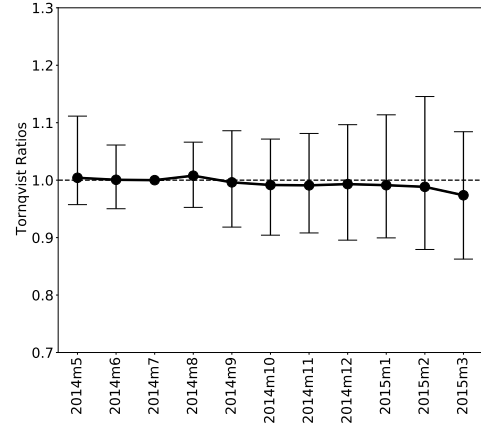
(d) Tornqvist quantity ratio, dynamic product universe

Figure 14: Distribution of price and quantity index ratios around the US dollar rally in Chile

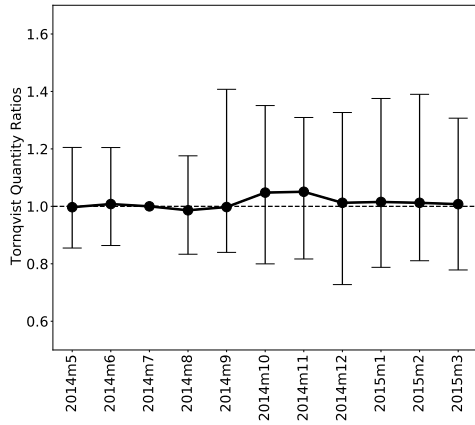
Note: This figure illustrates the distribution of ρ_{gt}^T and σ_{gt}^T across different product subcategories g for Chile. The medians are denoted by dots. The whiskers define the 90th and 10th percentile of the data, respectively. The left column is based on the static product universe and the right column is based on the dynamic product universe. We restrict the analysis to 51 subcategories (static product universe) and 60 subcategories (dynamic product universe) for which we observe at least 5 domestic and imported products.



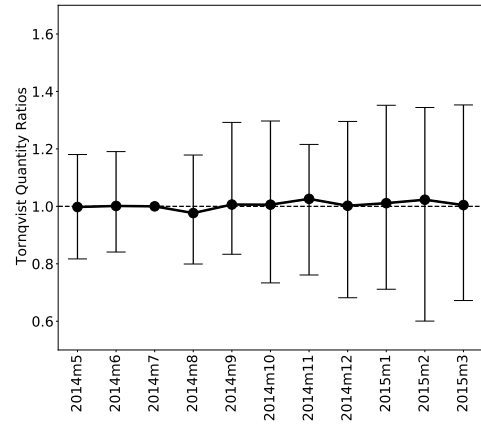
(a) Tornqvist price ratio, static product universe



(b) Tornqvist price ratio, dynamic product universe



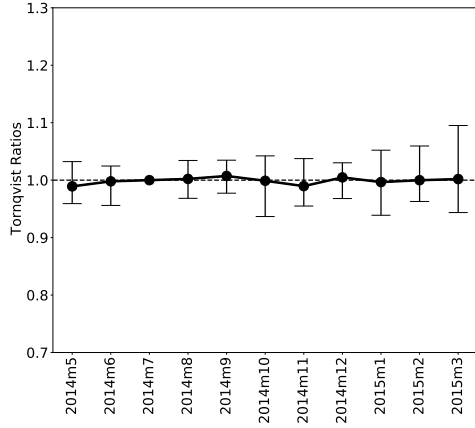
(c) Tornqvist quantity ratio, static product universe



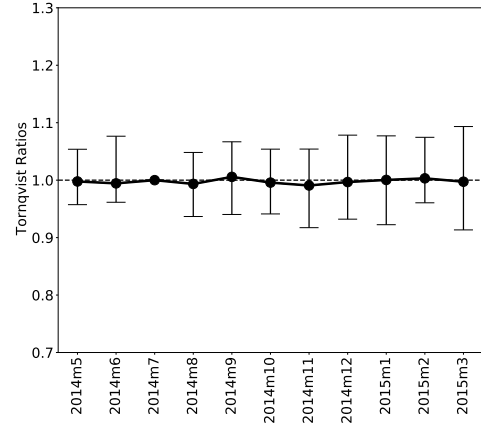
(d) Tornqvist quantity ratio, dynamic product universe

Figure 15: Distribution of price and quantity index ratios around the US dollar rally in Mexico

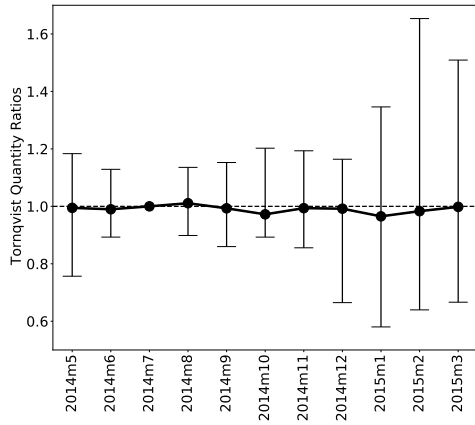
Note: This figure illustrates the distribution of ρ_{gt}^T and σ_{gt}^T across different product subcategories g for Mexico. The medians are denoted by dots. The whiskers define the 90th and 10th percentile of the data, respectively. The left column is based on the static product universe and the right column is based on the dynamic product universe. We restrict the analysis to 60 subcategories (static product universe) and 70 subcategories (dynamic product universe) for which we observe at least 5 domestic and imported products.



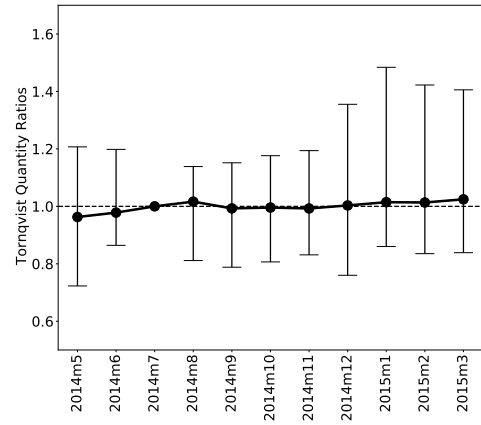
(a) Tornqvist price ratio, static product universe



(b) Tornqvist price ratio, dynamic product universe



(c) Tornqvist quantity ratio, static product universe



(d) Tornqvist quantity ratio, dynamic product universe

Figure 16: Distribution of price and quantity index ratios around the US dollar rally in Peru

Note: This figure illustrates the distribution of ρ_{gt}^T and σ_{gt}^T across different product subcategories g for Peru. The medians are denoted by dots. The whiskers define the 90th and 10th percentile of the data, respectively. The left column is based on the static product universe and the right column is based on the dynamic product universe. We restrict the analysis to 32 subcategories (static product universe) and 40 subcategories (dynamic product universe) for which we observe at least 5 domestic and imported products.

7 Summary and conclusions

There is a wide-spread conjecture that exchange rate fluctuations affect the border prices of imported products, and that – despite the dampening effect of the “retail wedge” – they influence both the aggregate price level and the price structure faced by consumers. Our empirical results question the second part of this line of arguments: while imported products may become more expensive than their domestic substitutes at the border, we do not observe this variation in relative prices at the retail level. As a consequence, the impact of exchange rate fluctuations on inflation and spending patterns may be very different from the impact that is suggested by the analysis of border prices.

More specifically, our analysis demonstrates that despite a significant depreciation of the currencies of five Latin American countries (Brazil, Chile, Colombia, Mexico, and Peru) against the US dollar, which is the dominant invoicing currency of imported products in the region, relative prices of close substitutes at the retail level remain remarkably stable. We provide evidence to support the conjecture that this stability in relative prices limits the extent of expenditure switching from imported to domestic products, even in the face of cost shocks to border prices of imported products due to a strong and exogenous US dollar rally.

Our results suggest that the role of the retail sector in transmitting exchange rate fluctuations to shelf prices faced by consumers is complex and goes beyond acting as a mere “buffer”. In fact, retailers seem to have an incentive to avoid variations in relative prices. As a consequence, they accept a lower markup for imported products, which they eventually compensate by increasing the prices of *both* imported and domestic products. This conjecture is in line with recent research of Cole and Eckel (2018) who describe optimizing retailers as accounting for both relative prices *within* the shop and *vis-à-vis* competing retail outlets.¹⁶ While Cole and Eckel (2018) emphasize the importance of a “multi-product firm” interpretation of the retail industry for the transmission of *tariffs*, our findings highlight the relevance of this interpretation for ERPT to consumer prices. Moreover, our results suggest that retailers solve a dynamic optimization problem that goes beyond the static framework presented by Cole and Eckel (2018). We thus believe that a better grasp of price-setting mechanics and dynamics at the retail level is crucial for understanding the effect of exchange rate fluctuations on consumer price inflation.

¹⁶Further analyses with an explicit focus on retailers are provided by Besanko, Dubé, and Gupta (2005) and Hellerstein (2008).

References

- Auer, Raphael, Ariel Burstein, and Sarah M. Lein (2021). “Exchange Rates and Prices: Evidence from the 2015 Swiss Franc Appreciation”. In: *American Economic Review* 111.2, pp. 652–86. DOI: 10.1257/aer.20181415. URL: <https://www.aeaweb.org/articles?id=10.1257/aer.20181415>.
- Bems, Rudolfs and Julian di Giovanni (2016). “Income-Induced Expenditure Switching”. In: *American Economic Review* 106.12, pp. 3898–3931.
- Besanko, David, Jean-Pierre Dubé, and Sachin Gupta (2005). “Own-Brand and Cross-Brand Retail Pass-Through”. In: *Marketing Science* 24.1, pp. 123–137. URL: <http://www.jstor.org/stable/40056943>.
- Bonadio, Barthélémy, Andreas M Fischer, and Philip Sauré (Mar. 2019). “The Speed of Exchange Rate Pass-Through”. In: *Journal of the European Economic Association* 18.1, pp. 506–538. DOI: 10.1093/jeea/jvz007.
- Boz, Emine, Camila Casas, Georgios Georgiadis, Gita Gopinath, Helena Le Mezo, Arnaud Mehl, and Tra Nguyen (May 2022). “Patterns of invoicing currency in global trade: New evidence”. In: *Journal of International Economics* 136, p. 103604. DOI: 10.1016/j.jinteco.2022.103604.
- Boz, Emine, Gita Gopinath, and Mikkel Plagborg-Møller (Nov. 2017). *Global Trade and the Dollar*. Tech. rep. DOI: 10.3386/w23988.
- Braun, Rahel and Sarah M. Lein (2021). “Sources of Bias in Inflation Rates and Implications for Inflation Dynamics”. In: *Journal of Money, Credit and Banking* 53.6, pp. 1553–1572. DOI: <https://doi.org/10.1111/jmcb.12848>. eprint: <https://onlinelibrary.wiley.com/doi/pdf/10.1111/jmcb.12848>. URL: <https://onlinelibrary.wiley.com/doi/abs/10.1111/jmcb.12848>.
- Breinlich, Holger, Elsa Leromain, Dennis Novy, and Thomas Sampson (Oct. 2021). “The BREXIT vote, inflation and U.K. living standards”. In: *International Economic Review* 63.1, pp. 63–93. DOI: 10.1111/iere.12541.
- Burstein, Ariel, Martin Eichenbaum, and Sergio Rebelo (Aug. 2005). “Large Devaluations and the Real Exchange Rate”. In: *Journal of Political Economy* 113.4, pp. 742–784. DOI: 10.1086/431254.
- Burstein, Ariel and Gita Gopinath (2014). “International Prices and Exchange Rates”. In: *Handbook of International Economics*. Elsevier, pp. 391–451. DOI: 10.1016/b978-0-444-54314-1.00007-0.
- Campa, Jose and Linda Goldberg (2005). “Exchange Rate Pass-Through into Import Prices”. In: *The Review of Economics and Statistics* 87.4, pp. 679–690. URL: <https://EconPapers.repec.org/RePEc:tpr:restat:v:87:y:2005:i:4:p:679-690>.

- Chessa, Antonio G. (2016). *A comparison of price index methods for scanner data*. Article 1/2016. Eurostat.
- Chessa, Antonio G., Johan Verburg, and Leon Willenborg (2017). *A new methodology for processing scanner data in the Dutch CPI*. Article.
- Cole, Matthew T. and Carsten Eckel (2018). “Tariffs and markups in retailing”. In: *Journal of International Economics* 113, pp. 139–153. DOI: 10.1016/j.jinteco.2018.04. URL: <https://ideas.repec.org/a/eee/inecon/v113y2018icp139-153.html>.
- Corsetti, Giancarlo and Luca Dedola (2005). “A macroeconomic model of international price discrimination”. In: *Journal of International Economics* 67.1, pp. 129–155. URL: <https://EconPapers.repec.org/RePEc:eee:inecon:v:67:y:2005:i:1:p:129-155>.
- Diewert, W. Erwin and Peter von der Lippe (2010). “Notes on Unit Value Index Bias”. In: *Jahrbücher für Nationalökonomie und Statistik* 230.6, pp. 690–708. DOI: doi:10.1515/jbnst-2010-0606. URL: <https://doi.org/10.1515/jbnst-2010-0606>.
- Dubois, Pierre, Rachel Griffith, and Martin O’Connell (2022). “The Use of Scanner Data for Economics Research”. In: *Annual Review of Economics* 14.1, pp. 723–745. DOI: 10.1146/annurev-economics-051520-024949. eprint: <https://doi.org/10.1146/annurev-economics-051520-024949>. URL: <https://doi.org/10.1146/annurev-economics-051520-024949>.
- Eurostat (2022). *Guide on multilateral methods in the Harmonised Index on Consumer Prices (HICP) - 2022 edition*. Manual. DOI: 10.2785/873932.
- Frankel, Jeffrey, David Parsley, and Shang-Jin Wei (Sept. 2011). “Slow Pass-through Around the World: A New Import for Developing Countries?” In: *Open Economies Review* 23.2, pp. 213–251. DOI: 10.1007/s11079-011-9210-8.
- Frankel, Jeffrey A. and Andrew K. Rose (1996). “Currency crashes in emerging markets: An empirical treatment”. In: *Journal of International Economics* 41.3. Symposium on Mexico, pp. 351–366. ISSN: 0022-1996. DOI: [https://doi.org/10.1016/S0022-1996\(96\)01441-9](https://doi.org/10.1016/S0022-1996(96)01441-9). URL: <https://www.sciencedirect.com/science/article/pii/S0022199696014419>.
- Gopinath, Gita, Emine Boz, Camila Casas, Federico J. Díez, Pierre-Olivier Gourinchas, and Mikkel Plagborg-Møller (2016). *Dominant Currency Paradigm*. Working Paper 22943. National Bureau of Economic Research. DOI: 10.3386/w22943. URL: <http://www.nber.org/papers/w22943>.
- (Mar. 2020). “Dominant Currency Paradigm”. In: *American Economic Review* 110.3, pp. 677–719. DOI: 10.1257/aer.20171201.

- Gopinath, Gita and Oleg Itskhoki (Dec. 2021). *Dominant Currency Paradigm: A Review*. Tech. rep. DOI: 10.3386/w29556.
- Harms, Philipp, Mathias Hoffmann, and Christina Ortseifer (2015). “The Home Bias in Equities and Distribution Costs”. In: *Scandinavian Journal of Economics* 117.1, pp. 983–1018.
- Hellerstein, Rebecca (2008). “Who bears the cost of a change in the exchange rate? Pass-through accounting for the case of beer”. In: *Journal of International Economics* 76.1, pp. 14–32. DOI: <https://doi.org/10.1016/j.jinteco.2008.03.007>. URL: <https://www.sciencedirect.com/science/article/pii/S0022199608000299>.
- Kaminsky, Graciela, Saul Lizondo, and Carmen M. Reinhart (Mar. 1998). “Leading Indicators of Currency Crises”. In: *IMF Staff Papers* 45.1.
- Nakamura, Emi and Jón Steinsson (Dec. 2012). “Lost in Transit: Product Replacement Bias and Pricing to Market”. In: *American Economic Review* 102.7, pp. 3277–3316. DOI: 10.1257/aer.102.7.3277. URL: <https://www.aeaweb.org/articles?id=10.1257/aer.102.7.3277>.