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Abstract[*]

We develop a methodology to construct real effective exchange rates that incorporate two distinctive elements not accounted for in the traditional measures: i) competition in third markets and ii) adjustments for similarity in export baskets between exporters and their competitors. In addition to constructing competition-adjusted real effective exchange rates at the aggregate country level, we develop similar measures at the country-product, country-destination, and country-product-destination level. We then build a novel and public dataset where we apply this methodology to compute monthly adjusted REERs for a panel of 120 countries and 769 products. As an application, we use the dataset to examine the changes in export competitiveness in countries in Latin America and the Caribbean between May 2014 and February 2016, a period characterized by substantial movements in exchange rates. We find that using traditional measures of real effective exchange rates misallocates between one third and one half of the relevant weights, and it leads to an important underestimation of the loss in export competitiveness. Furthermore, we find that there are very significant differences across products and destinations with regards to changes in export competitiveness.

JEL classifications: F10, F31

Keywords: Real effective exchange rate, Competitiveness, Trade

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1 Introduction

The real effective exchange rate (REER) is the most commonly used measure for assessing a country's international competitiveness. It tracks the evolution of price (or cost) competitiveness of a country with respect to its trading partners. Traditionally, REERs were calculated as the geometric weighted average of bilateral real exchange rates between pairs of countries, using trade shares as weights. In this paper, we deviate from the traditional measure. First, we develop a methodology for computing REERs at the aggregate country level that incorporates two elements not accounted for in the traditional measure: i) competition in third markets and ii) adjustments for similarity in export baskets between exporters and their competitors. While other authors have developed alternative competition-adjusted REERs at the aggregate country level (see, for example, McGuirk, 1986; Zanello and Desruelle, 1997; Bayoumi et al., 2006), our measures introduce novel elements into the computation of third market competition. Moreover, the adjustment for similarity in export baskets is entirely new. Second, in addition to competition-adjusted real effective exchange rates at the aggregate country level, we extend the methodology to develop measures at the product, destination and product-destination level. To the best of our knowledge, none of these more disaggregated competition-adjusted REERs have been developed before.

The third contribution is empirical, as we build a new dataset where we apply this methodology to compute adjusted REERs at the country, country-product and country-destination levels using data on exchange rates, prices, production and bilateral trade for 120 countries and 769 products at the 4-digit Standard International Trade Classification (SITC) level (Revision 2). We make this dataset publicly available. Lastly, to illustrate the usefulness of our methodological contribution, as well as to highlight an application of the new dataset, we show the impact of these adjustments on the exchange rate weights and patterns for countries in Latin America and the Caribbean between May 2014 and February 2016 at the aggregate, product, destination and product-destination levels. This period is convenient to explore the relevance of using our competition-adjusted real effective exchange rates, as it was characterized by widespread and large nominal as well as real exchange rate depreciations vis-à-vis the US dollar.

Our results show that the weights for the adjusted REER measure are significantly different from the traditional weights of REERs that leave out the competition in third markets, leading to important differences in the evolution of countries' export competitiveness. On average, 49 percent of the weights corresponding to Latin America and the Caribbean countries shift as a result of the adjustment, while 44 percent of the weights shift in the case of the world sample.[1]Moreover, different products within countries exhibit very different experiences in terms of their exchange rate competitiveness, justifying our effort to develop REERs at the product level. Similarly, we find that our destination-level competition-adjusted REERs differ substantially from the more traditional bilateral real exchange rates, which only consider the evolution of prices and nominal exchange rates in each pair of countries. Concretely, for countries in Latin America and the Caribbean, the weight assigned to each destination country is, on average, 0.45 as opposed to one as in the traditional bilateral real exchange rate case.[2] The same figure is 0.37 for the complete sample.

The economic intuition as to why the two adjustments that we develop help refine the assessment of a country's international competitiveness is simple. Traditional measures that use trade shares as weights

[1]This means that nearly half of the weights used to calculate traditional REERs are reallocated to other trading partners when adjusting for third-country competition and export basket similarity.

[2]In other words, in calculating the competition-adjusted REER of country A in country B, exporters from country A face competition from producers in country B (accounting on average for less than half of the weight) and exporters from third countries (accounting on average for more than half of the weight). In contrast, traditional measures only consider the destination country (and thus assign all the weight to this country) when computing bilateral REERs.

make an important implicit assumption: when a country exports a good to a specific trading partner, it is competing only with producers in the destination market. This assumption, however, is problematic (see, for example, McGuirk, 1986; Chinn, 2006). When Mexican producers export color TVs to the United States, they are not just competing with US producers. They are also competing with Chinese manufacturers. While China may not be an important export destination for Mexico, it is an important competitor in third markets. Thus, it makes sense for the Chinese currency to have a significant weight in the calculation of Mexico's real effective exchange rate. If two countries had completely different export baskets, however, the fact that they both export to the same third country would not imply that they actually compete. This is where the adjustment for export basket similarity comes in. The fact that Mexico and China have fairly similar export baskets makes competition in third markets between these two countries more relevant.

Related Literature - The idea of taking into account competition in third markets is not new. The earliest efforts in this regard go back to the Multilateral Exchange Rate Model (MERM) of the IMF. The MERM, first presented in Artus and Rhomberg (1973) and then refined in Artus and McGuirk (1981), was a macroeconomic model set up to assess the link between countries' real effective exchange rates and resulting current account balances. The MERM-weighted index departed from the traditional trade-based weights used at the time. Instead, countries were weighted in proportion to the impact that, according to the MERM model, a 1 percent increase in the price of each foreign currency would have on the home country trade balance. In addition to considering whether countries competed in third markets in very broad categories of products (such as semifinished manufactures, SITC 5-6, or finished manufactures, SITC 7-9), MERM considered price elasticities of demand and supply for different types of products, relying on the Armington (1969) assumption that similar goods from different countries are imperfect substitutes, and thus face finite elasticities of demand. MERM-weighted REERs and REERs based on similar models were influential in their time. They were reported in the IMF's International Financial Statistics (IFS) for 18 developed countries between 1973 and 1989, and Rhomberg (1976) reports that they were also the basis for REER data published by the UK Treasury, the Bank for International Settlements, the Council of Economic Advisors, and the OECD. However, as reported by Boughton (1997), the static nature of the MERM model made it obsolete in the mid-1980s. The MERM model was phased out, and with it, MERM-weighted REER indices were lost as well.

The IMF continued to be at the forefront of efforts to measure real effective exchange rates including competition in third markets. In 1983, the Fund created the Information Notice System (INS) to fulfill the mandate stipulated in Article IV to "exercise firm surveillance over the exchange rate policies of members" (Zanello and Desruelle, 1997). Real effective exchange rates calculated for the INS, based on theoretical work by McGuirk (1986), as well as changes over time in country coverage and methodology, are discussed in detail in Zanello and Desruelle (1997) as well as in Bayoumi et al. (2006). To date, the latter represents the Fund's current methodology to calculate REERs, which are published regularly in the IFS. Commodities are treated as global goods, where countries compete at the level of the world market, rather than at the country market level. For the case of manufacturing, the Fund incorporates competition in the domestic (import) market and double export weights, accounting for competition with each trading partner in that partner's market, as well as in third markets. REER methodologies used by the Bank for International Settlement (Klau, 2006) or the European Central Bank (Buldorini, 2002) are similar in flavor to that of the Fund.

While our work is motivated by these earlier contributions, it also deviates from them in important ways. The first difference relates to the way in which we introduce domestic production into the calculation of our adjusted REERs. When considering, for example, Mexican exports of manufactures to the United States, any approach that incorporates competition in third markets will need to establish the extent to which Mexican exporters of manufactures to the United States are facing competition from US domestic producers, vis-à-vis producers from other countries such as South Korea or China. In order to distribute weights appropriately, it is necessary to compare US domestic production of manufactures to imports of manufactures from third countries. The existing REERs discussed above use gross output as a measure of domestic production. In doing so, intermediate inputs used in the production of manufactures may be counted multiple times, leading to an overestimation of the weight of the destination country (in this example, the United States), and thus an underestimation of the third-market competition effect. In the specific case of Mexican exports to the United States, competition from third markets is underestimated by 15 percent. By using value added production data instead, we avoid this undesirable feature of competition-adjusted REERs.[3]

Second, another important shortcoming of existing REERs is that there is no attempt to differentiate across different types of manufactures, which are treated as a representative product. Thus, if Germany exports cars and Honduras exports garments to the US market, insofar as both products are classified as manufactures, producers of these dissimilar products would be considered direct competitors. The implicit assumption is that the elasticity of substitution between German cars and Honduran shirts is equal to that between German shirts and Honduran shirts. By introducing an adjustment for similarity of export basketsand using disaggregated trade data at the 4-digit SITC level, we move away from this undesirable representative good approach.[4,5]

Third, while existing measures are only available at the aggregate country level, we develop competition-adjusted REERs at the country-product, the country-destination, and the country-product-destination level, in addition to our aggregate country level measures. Fourth, our competition-adjusted REERs are available for a wider set of countries (120), compared to those in that are reported in the IFS database (94). In particular, in the case of Latin America and the Caribbean countries we use in our analysis, our data cover 23 countries, while those in the IFS covers 13.

The rest of the paper is structured as follows. Section 2 explains the methodology used to compute the AREER at the country and country-product level as well as the country-destination and country-product-destination level. Section 3 describes the datasets that are publicly available as well as the main sources used in building them. Section 4 presents the analysis of the 2014-16 episode of widespread nominal exchange rate depreciations in Latin America and the Caribbean. Finally, Section 5 concludes, and discusses policy implications and avenues for further research.

[3] Recently, some authors such as Bems and Johnson (2017), Bayoumi et al. (2013) and Patel et al. (2014) have proposed formulas that focus directly on trade in value added, reflecting the increasing importance of global value chains. This is an important consideration, which accounts for the fact that imports from one country could in fact contain inputs produced in another, something that is not captured in our measures that assign weights depending on the country from which products are directly imported. The input-output data necessary to implement these formulas have limited country coverage, particularly in the Latin American and the Caribbean countries that we use in the application of our methodology. We hope to be able to address this important issue in the future, as more data become available.

[4] By adjusting for export basket similarity, we are assuming that the elasticity of substitution between cars and shirts, or any other pair of goods for that matter, is zero, regardless of country of origin. While this may be an extreme assumption, we believe that it is more realistic than the alternative.

[5] Bennett and Zarnic (2009)also departs from this representative product approach. Instead, it introduces what the authors call a heterogeneous product approach, which defines market competition at the 4-digit International Standard Industrial Classification (ISIC) product level. But they apply this approach to study REERs of just four southern European countries, namely Greece, Italy, Portugal and Spain. Our work, in contrast, covers a much wider range of developed and developing countries.

2 Adjusted Real Effective Exchange Rates

2.1 AREER at the Country Level

2.1.1 Adjusting for Competition in Third Markets

The real effective exchange rate of a country is generally defined as the geometric average of its bilateral real exchange rates with each of its trading partners.[6] More formally,

$$REER_i = \prod_{j=1}^{n} \left(\frac{\epsilon_{ij} P_i}{P_j} \right)^{w_{ij}} = \prod_{j=1}^{n} RER_{ij}^{w_{ij}}, \tag{1}$$

where ϵ_{ij} is the nominal exchange rate between countries i and j (price of i's currency in terms of j's currency), n is the number of i's potential trading partners, P_i and P_j are the price levels in local currency of countries i and j, RER_{ij} is the real bilateral exchange rate between countries i and j, and w_{ij} is the weight that corresponds to country j in the calculation of country i's REER. Notice that we have defined the REER so that an increase is an appreciation.[7] Traditional measures of REER use export shares as weights:[8]

$$w_{ij}^{tr} = \frac{X_{ij}}{\sum_j X_{ij}} = \frac{X_{ij}}{X_{i.}}, \tag{2}$$

where X_{ij} are exports from i to j, and X_i are total exports from i. Thus, if 71.4 percent of all Mexican exports have the United States as destination, $w_{MEX,US}^{tr}$ would be equal to 0.714 in the calculation of Mexico's REER. As noted in the introduction, however, this traditional measure has serious shortcomings. As the example of Mexican color TV producers makes clear, when a country exports a product to a destination, exporters are not just competing with producers of that product in that destination. They also compete with producers from other countries who export to the same destination. In order to address this problem, we propose a measure of REER that takes into account not just export shares, but also competition in third markets.[9] We call this measure adjusted real effective exchange rate, or AREER.

To build on the intuition on how our AREER works, it is helpful to go back to the example of the share in Mexico's AREER that corresponds to Mexican exports to the US market. Rather than assigning a weight of 0.714 to the United States, as would be the case with the traditional measure, the share corresponding to the US market is divided into two portions. One portion, which we denote $\alpha_{US,MEX}$, representing the share of US absorption of (non-Mexican) tradables satisfied by domestic producers, is still assigned to the United States. The rest, $(1 - \alpha_{US,MEX})$, corresponding to the share of imports in the US absorption of (non-Mexican) tradables, is assigned to countries other than Mexico that export to the United States, in proportion to their export shares. More formally, α_{ji} is defined as

$$\alpha_{ji} = \frac{Y_j - \tau_j X_j}{Y_j - X_j + M_{j,-i}}, \tag{3}$$

where Y_j is the value added of tradables in country j, τ_j is the percentage of domestic value added in country

[6] When calculating effective exchange rates it is standard practice to use geometric averages rather than arithmetic averages, which have undesirable features. For example, while a percentage change in the geometrically averaged effective exchange rate between two periods is independent of the base period, the choice of the base period affects REERs when an arithmetic average is applied.

[7] Throughout the discussion, the time subindex will be omitted for simplification.

[8] Some measures of REER consider the shares in both exports and imports. Given the focus on export competitiveness, in this paper we will use export shares only.

[9] As discussed in the introduction, other authors such as McGuirk (1986) have already introduced REERs that take into account competition in third markets, based on Armington's (1969) demand system.

j's exports (X_j), and $M_{j,-i}$ are country j's imports that do not originate in country i ($\sum_{k\neq i}^{n} M_{jk}$, where M_{jk} are the imports from country k to j). Thus, the denominator, $(Y_j - X_j + M_{j,-i})$, is the total absorption of tradables in country j that does not originate in country i, and α_{ji} is the proportion of this absorption that is locally sourced. Notice that, in the numerator of (3), we only subtract from the production of tradables the portion of exports of country j that corresponds to local value added. For example, if a country imports car engines and exports cars, the engines are not accounted for in Y_j, and thus should not be counted either when substracting total exports in the numerator. Figure 1 provides intuition for this calculation for the case of the United States, showing how the relevant α for the calculation of Mexico's AREER, that is equal to 54 percent ($\alpha_{US,MEX}$, as shown in panel a of the Figure), differs from that relevant to Colombia, that is 50.6 percent ($\alpha_{US,COL}$, as shown in panel b), due to the Mexican share in US imports being larger than that of Colombia (13 percent for Mexico versus 1 percent for Colombia).

[Figure 1 about here.]

Continuing with the Mexico-United States example, the weight of the United State corresponding to its role in the US market is then $\alpha_{US,MEX} w^{tr}_{MEX,US}$. But in order to compute the weight of the United States in Mexico's AREER, which we call $w^1_{MEX,US}$, we need to add a second component, which accounts for the weight of the United States in all other Mexican export markets. Thus, more generally, the total weight of country j in country i's competition adjusted REER will be given by

$$w^1_{ij} = \alpha_{ji}\frac{X_{ij}}{X_i} + \sum_{\substack{k=1\\k\neq i,j}}^{n} (1-\alpha_{ki})\frac{X_{ik}}{X_i}\frac{M_{kj}}{M_{k,-i}} = \alpha_{ji} w^{tr}_{ij} + \sum_{\substack{k=1\\k\neq i,j}}^{n} (1-\alpha_{ki})\, w^{tr}_{ik}\frac{M_{kj}}{M_{k,-i}}. \tag{4}$$

The first term in equation (4) captures the direct competition between producers from countries i and j in market j. The second term captures the competition between producers from country i and producers from country j in third markets k. Notice that equations (2) and (4) are equivalent when all α_{ji} are equal to one. In that case, the AREER reduces to the traditional REER.

Table 1 illustrates graphically how this works for Mexico. Countries k in the top row are the most important destinations for Mexican exports. The percentages immediately below represent the importance of each market in Mexico's exports, and are the weights corresponding to the traditional REER calculation. For instance, 71.4 percent of total Mexican exports go to the United States, 6.5 percent to Canada, and only 2.7 percent to China. Countries j in the rows represent Mexico's competitors in each destination market k. The percentages in the diagonal (where $j = k$) represent the alphas for each of these destinations, from the point of view of Mexican exporters (that is, the $\alpha_{j,MEX}$).

[Table 1 about here.]

Let us consider the United States' weight in Mexico's AREER depicted in the first row. The first cell, 54 percent, corresponds to $\alpha_{USA,MEX}$ and represents the share of US absorption satisfied by its domestic producers (Figure 1 panel a). The second cell, 36.9 percent, is the share of the United States in Canada's non-Mexican absorption of tradables. This comes from multiplying $(1 - \alpha_{CAN,MEX})$, which is equal to 64.4 percent, by the US share in non-Mexican Canadian imports or $\frac{M_{CAN,USA}}{M_{CAN,-MEX}}$, which is 55.7 percent. Similarly, the third cell (2.7 percent) represents the US share in China's non-Mexican absorption, and so forth. The total weight corresponding to the United States in the calculation of the AREER of Mexico is obtained by multiplying each of the cells of the United States' row by the importance of each destination market in

Mexico's exports and adding these horizontally. Thus, the United States' weight would be 54% * 71.4% + 36.9% * 6.5% + 2.8% * 2.7% +... and so on, for a total weight of 42.3 percent, as indicated in the last column. The first term of this summation (54% * 71.4% = 38.6%) corresponds to the first term in equation (4), that is, the weight of US producers as competitors of Mexican exporters in the US market alone. The rest (3.7 percent) corresponds to the second term in equation (4) or the role of the United States as a competitor to Mexican exporters in third markets. A comparison of the adjusted and the traditional weights for the United States (42.3 percent vs. 71.4 percent) clearly shows that the adjustment we make by taking into account third market competition is not trivial. In contrast to this fall in the weight of the United States, a country like China significantly increases its weight, going from 2.7 percent in the traditional case to 12.2 once we account for competition in third markets. Obviously, Chinese producers are much more important than US producers as competitors of Mexican producers in third markets.

As can be seen from the discussion of equation (3), our measure of α_{ji}, the share of local absorption of tradables, and thus our AREERs, use production data in value-added terms. This differs from the REERs reported by the IMF, the BIS, or the ECB, which use gross output instead, under the implicit assumption of no intermediate inputs. Once intermediate inputs are taken into account, using gross output results in double counting.[10] By using production in value-added terms, we avoid this double counting, which can represent an important portion of gross output, and would lead to an overestimation of the α_{ji}. For instance, using information from the World Input-Ouput Database (Timmer et al., 2015) for the year 2013, the share of manufacturing gross output that corresponds to intermediate inputs from the local manufacturing sector was 33.6 percent for Brazil, 42.3 percent for Mexico, and 32.7 percent for the United States. For the latter country, this would lead to an $\alpha_{US,MEX}$ of 60.8 percent rather than 54 percent, an overestimation of 12.6 percent.

2.1.2 Adjusting for Similarity of Export Baskets

So far, we have addressed one important problem with traditional REER measures: they do not account for competition in third markets. However, we have assumed that two countries exporting to the same destination compete between them, regardless of the composition of their export baskets. This is clearly an undesirable assumption. Two countries may export completely different products to the same destination. In that case, they are not really competing. In this section, we introduce an additional adjustment to our REER weights in order to account for export basket similarity. We do so using an index developed by Finger and Kreinin (1979), which defines export similarity S_{ij} between country i and j across a basket of P goods as follows:

$$S_{ij} = \sum_{p=1}^{P} \min\left(\frac{x_{ip}}{X_i}, \frac{x_{jp}}{X_j}\right), \tag{5}$$

where x_{ip}/X_i represents the share of good p in country i's total exports and P is the total number of products exported by at least one country in the sample of n countries. Obviously, the level of aggregation matters in this case. As we will discuss in more detail in section 3, we use data on exports at the four digit SITC Rev. 2 level. S_{ij} takes higher values the more similar the participation of each product p is in the export basket between i and j. To obtain the final weights for each country for the AREER, adjusting for both competition and similarity, the competition-adjusted weights are multiplied by the similarity index. Since

[10] For example, if a firm in the United States manufactures microchips and another uses these to manufacture computers, the value of the microchips will be counted twice when measuring gross manufacturing output.

the similarity index varies between 0 and 1, as a result of the multiplication the sum of the weights for the AREER computation in country i will no longer be 1. For this reason, the weights are renormalized so that they add up to 1:

$$w_{ij}^{2} = \frac{S_{ij} w_{ij}^{1}}{\sum_{j} S_{ij} w_{ij}^{1}}. \tag{6}$$

Once we adjust for competition in third markets and similarity, the adjusted real effective exchange rate becomes

$$AREER_i = \prod_{j=1}^{n} RER_{ij}^{w_{ij}^{2}}. \tag{7}$$

2.1.3 Manufacturing AREER

So far it has been assumed that equation (4) applies to all tradable goods, including not only manufactures but also commodities. As with the MERM model discussed above, this equation also relies on the Armington (1969) assumption that similar goods from different countries are imperfect substitutes, and thus face finite elasticities of demand. While this seems like a reasonable assumption for manufactures, which tend to be differentiated, it may not be ideal for the case of commodities. If prices of homogeneous goods are set in integrated global markets, then two countries producing the same commodity could be considered to be competing, regardless of whether they sell them in different markets. In order to address this issue, we produce two additional versions of the AREER index. The first one, AREER-M, leaves commodities out, and calculates weights focusing exclusively on trade of manufactured products (thus the M). The second one, which we will discuss in the next subsection, follows Bayoumi et al. (2006) and combines different sets of weights for manufacturing and commodities into a single composite index.

An equation similar to (4), but focused exclusively on manufactured trade flows, could in principle be used to obtain the weights corresponding to AREER-M, w_{ij}^{m}. However, it is necessary to modify α_{ji}, the share of absorption of tradables satisfied by domestic producers, in the following way:

$$\alpha_{ji}^{m} = \frac{Y_j^m - \tau_j^m \kappa_j X_j^m}{Y_j^m - \left(\tau_j^m \kappa_j + \left(1-\tau_j^m\right) \overline{\kappa}_{-j}\right) X_j^m + M_{j,-i}^m}. \tag{8}$$

Recall that in the numerator of equation (3) we multiplied exports by their share of domestic value added τ_j before subtracting these exports from the total value added in tradables Y_j. In calculating the weights for manufacturing, we face the following problem: we would like to be subtracting *manufactured* local value added in manufacturing exports. But τ_j^m is *total* local value added in manufacturing exports. If a country exports cars and part of the local value added is natural rubber for the tires, we face the problem that the rubber would be included in the second term of the numerator, but not in the first (since natural rubber production is not part of Y_j^m). In order to exclude natural rubber and other non-manufactures from the second term, we introduce an additional factor, κ_j, which measures the participation of the manufacturing sector in total value added of country j. The implicit assumption is that κ_j proxies reasonably well the importance of the value added of manufacturing in the export value of that same sector in country j. Thus, $\tau_j^m \kappa_j X_j^m$ approximates the value added by the local manufacturing sector in the manufacturing exports of j.

An additional adjustment needs to be done in the denominator in order to obtain the total absorption of manufactures. Consider a country that imports steel to produce and export cars. Imports of steel are not accounted for in $M_{j,-i}^m$ but, without the necessary adjustment, would be counted as part of the exports of cars. To solve this problem, we multiply $\left(1-\tau_j^m\right)$, the non-local portion of value added in exports, by $\overline{\kappa}_{-j}$, which captures the average share of the manufacturing sector in value added in countries where manufacturing imports from j originate, weighted by manufacturing import shares. In this case, $\left(1-\tau_j^m\right)\overline{\kappa}_{-j}X_j^m$ measures the proportion of manufacturing exports of j added through manufacturing imports from other countries.[11]

2.1.4 A Composite AREER

In this subsection we present a variation of the index that combines different weights for trade in manufactures and commodities into a single composite index, which we denote AREER-MC. Following Bayoumi et al. (2006) the total weight corresponding to country j for country i's exchange rate is:

$$w_{ij}^{mc} = \lambda_i^m w_{ij}^m + \lambda_i^c w_{ij}^c, \tag{9}$$

where λ_i^m and λ_i^c represent the share of manufacturing and commodities in the export basket of i.[12] w_{ij}^m is calculated as discussed in the previous section, and w_{ij}^c is defined as in Bayoumi et al. (2006):

$$w_{ij}^c = \sum_c \frac{X_j^c}{\sum_{\substack{k=1 \\ k\neq i}}^n X_k^c} \frac{X_i^c}{\sum_c X_i^c}. \tag{10}$$

The weight of country j for the calculation of commodity AREER in country i is the sum over all the commodities of two factors. The first one is the share of country j in the total world exports of that commodity (excluding those of country i itself), $X_j^c/\sum_{\substack{k=1 \\ k\neq i}}^n X_k^c$. The second one is the share of that commodity in total commodity exports of country i, $X_i^c/\sum_c X_i^c$. Note that equation (10) assumes that competition in commodity markets occurs globally.[13]

2.2 AREER at the Country-Product Level

The methodology used to calculate AREER at the country and sector levels can also be used to calculate country-product-specific AREERs. Producers of different products within a country export to different destinations, where they compete with exporters of different origins. Thus, the evolution of export competitiveness in a country can vary significantly across products, even within the same sector. Consider for example the case of coffee and flower exporters in Colombia, a country whose currency depreciated substantially since mid-2014 until early 2016. In both cases, the most important destination market is the United States. In coffee, the main competitor is Brazil, another country that depreciated substantially. In contrast, the main competitor in flowers is Ecuador, a dollarized economy which experienced considerable real appreciation as the US dollar strengthened within that period. Thus, producers of these two products experienced substantially different changes in exchange rate competitiveness in the last few years. Calculating AREERs at the country-product level will allow us to document these issues, as well as study the impact of real exchange rates on exports at the product level in future work. We are not aware of any papers that have

[11] Notice that an alternative to the equation (8) would have been to define τ_j^m as the share of the value added in manufacturing exports originated in the domestic manufacturing sector. We did not adopt this strategy because it requires detailed "global" input-output tables that are generally available for a limited group of countries, most of them developed ones (OECD, 2013; Timmer et al., 2015).

[12] Following Bayoumi et al. (2006), we defined manufacturing and commodities such that λ_i^m and λ_i^c add up to one.

[13] Unlike the equation used by Bayoumi et al. (2006), which does not exclude exports from country i in the denominator of the first factor, the expression (10) adds up to one for all i. Thus, it is not necessary to perform any additional normalization to the weights, as done by these authors.

proposed real exchange rate measures at the product level, whether using traditional or adjusted weights. In that regard, we see this as an important contribution of this paper.

Taking equation (1) as a starting point, we can calculate the REER at the country-product level. In particular,

$$REER_{ip} = \prod_{j=1}^{n} RER_{ij}^{w_{pij}}, \tag{11}$$

where w_{pij} represents the weight that country j receives in the calculation of the REER of country i for product p. Analogue to the REER at the country level, w_{pij} can be calculated in the traditional way, that is,

$$w^0_{pij} = \frac{x_{pij}}{\sum_j x_{pij}} = \frac{x_{pij}}{x_{pi}}. \tag{12}$$

In this case, the weights correspond to the share of exports to each destination country in country i's total exports of good p.[14] As in the calculation of traditional REERs at the country level, these weights implicitly assume that producers from country i only compete with producers in the destination country. Departing from this undesirable assumption, it is possible to calculate product-specific weights that adjust for competition in third markets:

$$w^1_{pij} = \alpha_{pji}\frac{x_{pij}}{x_{pi}} + \sum_{\substack{k=1 \\ k\neq i,j}}^{n} (1-\alpha_{pki})\,\frac{m_{pkj}}{m_{pk,-i}}\frac{x_{pik}}{x_{pi}}, \tag{13}$$

with α_{pji} representing the share of j's domestic production in its total absorption of good p (not originating in i). Note that the equation does not include any adjustment for export similarity since it is now defined at a high level of product disaggregation.

Following the discussion on manufactures, it is possible to define α_{pji} as follows:

$$\alpha_{pji} = \frac{y_{pj} - \tau_{pj}\kappa_{pj}x_{pj}}{y_{pj} - \tau_{pj}\kappa_{pj}x_{pj} + m_{pj,-i}} \tag{14}$$

where y_{pj} represents the value added of product p in j, τ_{pj} the share of exports of that product which is added locally, and κ_{pj} the participation of industry p in the local value added of j's exports of that product. Notice that in both the numerator and denominator it is necessary to include κ_{pj} because $\tau_{pj}x_{pj}$ captures the contribution of all domestic sectors in j's exports of product p, whereas y_{pj} only captures the value added of p in j (without counting the contribution of other sectors within country j).[15] Notice, that contrary to (8), this equation does not correct by the value added in exports of p that is imported from within the sector (i.e., the factor $\left(1-\tau^m_j\right)\overline{\kappa}_{-j}X^m_j$ in equation (8)), under the reasonable assumption that, at the product level, p is not used as input in its own production (i.e., you do not use imported cars as an input to produce cars).

Computing κ_{pj} requires detailed input-output data comparable across countries and products that is only

[14] We use lowercase letters for variables disaggregated to the product level.

[15] Going back to the example of the auto industry, x_{pj} would be country j's exports of cars. τ_{pj} captures the domestic content of the exports of cars (for example, if the engines are imported, it would capture the value of the car minus the value of the engine in proportion to the value of the car). But if the production of cars in country j also involves buying domestic leather produced in a different industry, then κ_{pj} captures the proportion of the domestic content of car exports that is added exclusively within the car industry. In other words, in this example κ_{pj} would be the value of the car minus the value of the (foreign) engine minus the value of the (domestic) leather, all divided by the value of the car plus the value of the leather.

available for a small subset of countries. However, under the (admittedly strong) assumption that the ratio between the gross output and value added of good p is equal to ξ_p for all origins, it can be shown that α_{pji} can be rewritten as follows (see mathematical appendix):

$$\alpha_{pji} = \frac{y^*_{pj} - x_{pj}}{y^*_{pj} - x_{pj} + \xi_p m_{pj,-i}}, \tag{15}$$

with y^*_{pj} representing the gross output of good p in country j, and $m_{pj,-i}$ the imports of j (not originating in i) of the same good. In contrast to equation (14), this expression for α_{pji} does not depend on κ_{pj} and, therefore, it is considerably easier to implement empirically. In section 3, we will discuss how we approximate ξ_p and α_{pji}.

2.3 AREER at the Country-Destination Level

The methodology developed to calculate AREER at the country level can also be used to derive country-destination-level AREERs, such as the Mexican AREER in the US market. These measures can be quite useful for producers, policymakers and researchers alike. Producers may want to focus their export efforts in markets in which they are gaining competitiveness. Conversely, they may want to price to market so as to prevent the temporary loss of a market in which they have lost exchange rate competitiveness (Berman et al., 2012; Burstein and Gopinath, 2015). Policymakers, in turn, may want to take into account destination level AREERs, for example, to focus their export promotion efforts on trading partners in which these efforts are more likely to bear fruit. Researchers may want to use country-destination-level AREERs to study the impact of exchange rate competitiveness on trade using gravity models with bilateral trade data.[16] While all these actors can use traditional bilateral RERs to address these issues, a destination-level AREER offers a more precise measure of a country's competitiveness in each of its markets. Here we just extend these traditional bilateral measures to incorporate competition from third countries. Our measures are "bilateral" in the sense that they refer to the real exchange rate of country i in market j. But they are multilateral in that they take into account the fact that producers in country i exporting to country j are also competing with producers of similar products from other countries. We call these measures destination-level AREERs, or $AREER_i^j$.

As a starting point, we define the country-destination-level AREER as follows:

$$AREER_i^j = \prod_{\substack{k=1 \\ k \neq i}}^{n} RER_{ik}^{w_{ik}^j} = RER_{ij}^{w_{ij}^j} \prod_{\substack{k=1 \\ k \neq i,j}}^{n} RER_{ik}^{w_{ik}^j}, \tag{16}$$

where w_{ij}^j is the weight of country j in $AREER_i^j$ and w_{ik}^j is the weight assigned to country k in the same computation. Since in these destination-level AREERs we are just considering exports to country j, the weight corresponding to the destination country itself will be $w_{ij}^j = \alpha_{ji}$, that is, the share of absorption of tradables (not originated in i) in j satisfied by domestic producers. Likewise, we specify w_{ik}^j in the following way:

$$w_{ik}^j = (1 - \alpha_{ji}) \frac{M_{jk}}{M_{j,-i}},$$

where the share of absorption of tradables satisfied by imports (not originated in i) or $(1 - \alpha_{ji})$ is distributed

[16] Until now, all the existing empirical literature looking at the impact of real exchange rates on trade using bilateral data, reviewed for example by Auboin and Michele (2013), relies on traditional bilateral real exchange rates.

according to the importance of each country k in the destination market j.[17] From these definitions it follows that w_{ij}^j captures the degree of competition between producers in countries i and j in market j, while w_{ik}^j captures the competition of i with each third country k in the destination country j.[18]

Notice that if $\alpha_{ji} = 1$, then $w_{ij}^j = 1$, $w_{ik}^j = 0$, and $AREER_i^j$ reduces to RER_{ij}, which is the traditional bilateral real exchange rate. In other words, if $\alpha_{ji} = 1$, producers in country i only compete with their counterparts from country j in that particular market, and thus the traditional bilateral real exchange rate applies. It can be shown that the country-level AREER can be calculated as the weighted geometrical average of the destination-level AREERs, with the weights assigned to each destination being the traditional real exchange rate weights, $X_{ij}/X_{i.}$, that is, the share of each destination country in country i's exports (see Mathematical Appendix).

Similar to AREERs at the country level, AREERs at the country-destination level can also be modified to take into account similarity of export baskets between the exporting country and its competitors. Furthermore, weights assigned to each competitor in the destination country can be computed with manufacturing data only or as a composite index of the weights for manufactures and commodities. Given that those adjustments resemble those implemented in the AREER at the country level (subsection 2.1), we do not discuss how they are extended to the country-destination case.

2.4 AREER at the Country-Product-Destination Level

Following equation (16), it is possible to define an adjusted real effective exchange rate at the country-product-destination level. In particular,

$$AREER_{ip}^j = RER_{ij}^{w_{pij}^j} \prod_{\substack{k=1 \\ k \neq i,j}}^{n} RER_{ik}^{w_{pik}^j} = RER_{ij}^{\alpha_{pji}} \prod_{\substack{k=1 \\ k \neq i,j}}^{n} RER_{ik}^{(1-\alpha_{pji})\frac{m_{pjk}}{m_{pj,-i}}} \tag{17}$$

where w_{pij}^j is the weight that country j receives in country i's exchange rate for product p in market j, thus corresponding to the competition between producers from countries i and j in market j for product p. Conversely, w_{pik}^j captures the competition between producers from county i and each third country k in the product market p of country j. Unlike the aggregate AREER, the AREER at the country-destination-product level does not require adjustments by export similarity since it is assumed that the disaggregation used for p does not allow us to calculate the similarity index defined above.[19] As discussed in the previous section for the case of the country level AREER, it is also possible to calculate the product level $AREER_{ip}$ as the weighted average of the product-destination level AREERs, using the shares of country i's exports to each destination as weights.

[17] M_{jk} are country j's imports from country k, while M_{j-i}, are country j's imports from the world, except those from country i.

[18] For ease of exposition we have not included in the discussion the adjustment for similarity. However, all results discussed in this article regarding the destination-level AREERs incorporate that additional adjustment, as discussed in Subsection 2.1.2 above.

[19] If p corresponds to aggregate data at the sector level, however, it is possible to implement a similarity correction similar to the one used at the country level.

3 Data

3.1 Data Sources

To compute bilateral real exchange rates, we use monthly average nominal exchange rates and end-of-the-month consumer price indices (CPI) from the International Monetary Funds' International Financial Statistics (IFS). For Latin America and the Caribbean, we complement those cases with missing information with official data sources from national central banks and statistical offices. We use CPI data, instead of other measures such as unit labor cost (ULC) and producer price indices (PPI), due to their availability and standard calculation methodology across countries. For this reason, our AREERs measure price competitiveness in opposition to cost competitiveness (Chinn, 2006).

Bilateral export and import data for the calculation of the weights come from the BACI product-level international trade database, reported by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). This database reconciles declarations of exporters and importers in the United Nations Commodity Trade Statistics Database (COMTRADE) (Gaulier and Zignago, 2010). In our computations, we include information for 120 countries and 769 classes of goods (P) (4-digit SITC Rev. 2) for the year 2013. As is standard in the literature, we use export data that excludes exports of foreign goods to ensure that our competitiveness measures are not being driven by reexports. For the calculation of α_{ji}'s, however, trade data needs to be comparable to our measure of aggregate local production, which comes from the World Development Indicators (WDI). Since there are discrepancies between aggregate trade data from WDI and BACI, we weight bilateral exports and imports from this last source in order to match the aggregate exports and imports reported in WDI.[20]

Regarding production, the value added of tradables at the country level is approximated with industrial and agricultural GDP from WDI for the year 2013 (Y_j in (3)). To construct country-product-specific output data (y^*_{pj} in (15)), we rely on data from the United Nations Industrial Development Organization (UNIDO), which contains information on value added and on gross output at the 4-digit International Standard Industrial Classification (ISIC) Rev. 3 level for the period 1990 onward. To match the production information with trade data at 4-digit SITC Rev. 2 for the calculation of the α_{pji}, we use the correspondence table between ISIC Rev. 3 and 4-digit SITC Rev. 3, available in Eurostat, and the crosswalk between SITC Rev. 3 and SITC Rev. 2. In cases in which there are multiple ISIC categories that match a single SITC code, production is simply aggregated. In cases in which a single ISIC production activity matches multiple SITC trade categories, we distribute the production among the corressponding trade categories according to the proportion of exports of each product within the ISIC activity in 2013.[21] Given that UNIDO has significant differences in product and time coverage across countries, when the production information corresponding to the year 2013 is not available, we use the last year with available information for each country-product pair.[22] Additionally, we complement UNIDO data with information on production of agricultural commodities from the Food and Agriculture Organization of the United Nations' Statistics Division (FAOSTAT).[23] To measure ξ_p, we compute the ratio between the value added and the gross output for all the countries and products with available information. ξ_p is thus approximated as the average for each p of these ratios.

[20] Specifically, we multiply the bilateral exports from BACI by the factor $\frac{X_i}{\sum_j X_{ij}}$, where X_{ij} are the exports from i to j as reported in BACI and X_i are i's total exports from WDI.

[21] In this last case, the implicit assumption is that the share of each product in production is similar to its share in exports.

[22] For consistency, in such cases we use trade data for the same year for the calculation of the α_{pji}.

[23] Since production and trade data of agricultural commodities is highly disaggregated, matching the FAOSTAT production data with the SITC Rev. 2 trade information does not pose further challenges.

Information on the local value added in exports at the country and country-sector (2-digit GTAP classification) level (τ_j in (3)) comes from Blyde (2014), based on Purdue University's Global Trade Analysis Project database for the year 2007 (Aguiar et al., 2016). At the country level, we complement the data using information from the OECD-WTO Trade in Value Added (TiVA) database also for the year 2007 (OECD, 2013). To construct a database of value-added exports at the 4-digit SITC Rev. 2 level, we use the crosswalks available in World Integrated Trade Solutions (WITS) between GTAP and HS2 and, subsequently, between HS2 and SITC Rev. 2. In those cases where more than one value-added exports ratio (VAX) at the sector level maps to one SITC category, we compute a simple average to approximate the VAX for that product. In total, we match 43 different GTAP sectors to our product-level export data.

Computing country-product-level AREERs for a given country i and product p requires data on all α_{pji} corresponding to that country and product.[24] This in turn requires information on local production of product p in every other country. When this information is missing, α_{pji} is missing, and we need to impute it.[25] To do this, we use boosted regression, as proposed by Hastie et al. (2009) and James et al. (2013). The imputation method is discussed in detail in Appendix B.

3.2 Data Dissemination

We use the methodology and data sources described above to build three novel datasets for competition- and similarity-adjusted REERs at the country, country-product and country-destination level.[26] These datasets are publicly available.[27] All datasets include AREERs that treat manufactures and commodities symmetrically (i.e, AREER). Moreover, at the country and country-destination level we provide the AREER-M, which uses only manufacturing trade flows, and the AREER-MC, which combines different weights for trade in manufactures and commodities into a single composite index. Furthermore, for ease of comparison we provide bilateral exchange rates (real and nominal) and traditional real effective exchange rates at the country and country-product level. All databases have information for 120 countries and exhibit monthly periodicity, spanning the period between January 2014 and (at the time of this writing) July 2017. We plan to update the time coverage periodically as monthly CPI and exchange rate data become available. Moreover, all three databases use fixed weights based on trade data for 2013.[28] The dataset at the country-product level provides information for 769 products at 4-digit SITC Rev. 2 classification.

4 A Case Study: Latin America and the Caribbean during a Period of Strong Exchange Rate Movements

In this section, we focus on the period between May 2014 and February 2016, characterized by strong nominal and real exchange rate movements in most of Latin America and the Caribbean as well as in the

[24] For example, computing Mexico's AREER for cars requires information on the local share in the absorption of cars in every other trading partner.

[25] While the number of missing observations for domestic production is very large, they tend to correspond to small countries that have correspondingly small weight in country's export baskets. In the case of manufactures, countries with missing production data account on average for 26 percent of exports in the entire sample.

[26] Note that because of its high dimensionality, we only computed the dataset at the country-product-destination level for some products, including our example of color TVs (SITC Rev. 2 category 7611) discussed below. Specific data at the country-product-destination level are available upon request.

[27] The data can be found at `https://sites.google.com/site/andresfernandezmartin8/research`.

[28] While using fixed weights is appropriate for the small time period covered so far, eventually we plan to update the weights using the Laspeyres chained-linked methodology.

United States, in order to illustrate the value of our adjusted REER measures.[29] Figure 2 presents the change in real exchange rates during this period. Fifteen out of the 23 countries included in our Latin America and the Caribbean sample experienced real depreciation, although the size of the depreciation varies substantially from country to country. In many cases, depreciation was very substantial, particularly in Colombia, Brazil, and Mexico. In contrast, five countries experienced real appreciation. During this same period, the currency of Latin America and Caribbean countries' main trading partner, the US dollar, appreciated by 21.2 percent percent, using the traditional REER. The diverse exchange rate experience in Latin America and the Caribbean as well as in the rest of the world generates the potential for the changes in weights introduced by any alternative methodology to lead to noticeable differences in exchange rate competitiveness, in comparison to those that would emerge by using traditional REERs. One of the key drivers of these differences is precisely the comparatively lower weight of the United States in the computation of the AREERs of Latin American and the Caribbean. In what follows, we illustrate these issues by analyzing exchange rate weights and patterns at the country, country-destination, country-product, and country-product-destination levels.

[Figure 2 about here.]

4.1 AREER at the Country Level

Before analyzing the evolution of real exchange rates, it is useful to look at the changes in weights associated with the adjustments for competition in third markets and export basket similarity. Figure 3 compares how weights used in the computation of the AREER and REER differ for select countries.[30] Panel a) reports the results for Mexico. In line with the examples provided throughout the article, the traditional REER weight for the United States is 71.4 percent, as the United States is the destination of 71.4 percent of Mexican total exports. Once we take into account competition in third markets and export basket similarity, however, the weight corresponding to the United States in Mexico's AREER declines to 47.5 percent, a decline of 24 percentage points. Conversely, China's weight increases from 2.7 percent to 11 percent, since it is not an important destination of Mexican exports, but competes with Mexican exporters in other markets, and in similar products. Notice that most countries in the Figure for Mexico gain weight in the adjusted index, compensating for the huge loss corresponding to the United States. The only exception among the 10 most important countries presented in the Figure is Spain, which is more important as an export destination than as a competitor in third markets. Panels b) and c) in the Figure suggest that the pattern is more or less similar in other countries, such as Colombia and Ecuador.[31] In this last case, the weight of the United States is cut by two-thirds, which, as we will see below, has an important impact on the evolution of the Ecuadorean real exchange rate.

[Figure 3 about here.]

[29] This period maximizes the change in real bilateral exchange rates of Latin American and Caribbean countries vis-à-vis the dollar, as well as the appreciation of the dollar as measured by the traditional REER.

[30] The AREER we used for this figure is the first one discussed in Section 2, that is, the one that treats manufactures and commodities symmetrically. Corresponding figures for the other two versions of our aggregate index (AREER-M and AREER-MC) yield qualitatively similar results, and are available upon request.

[31] Colombia is the country with the largest real depreciation in the region. Ecuador, which is dollarized, experienced a large real appreciation and, as we will see below, is the country that exhibits the largest difference when using AREERs rather than REERs.

Figure 4 summarizes the change in the structure of weights between the AREER and REER indices across Latin America and Caribbean countries (see also Table A1 in the Appendix). The bars, which are symmetric around the origin (since any country's weight gain is compensated by another country's weight loss), show the extent of reallocation of weights for each country, under each of our three measures of aggregate AREERs, vis-à-vis traditional REERs. Panel a) shows that the reallocation for Mexico (28 percentage points) is more or less typical in the degree to which weights shift when switching from traditional weights to AREER weights. As shown in Table A1 in the Appendix (column 1), the shift in weights for countries in Latin America and the Caribbean average 31.2 percent, while the corresponding figure for the world sample is 32.8 percent. These are major shifts in weights, which can potentially lead to important differences in the pattern of real exchange rates.

Figure 4 also shows that there is a great deal of variation in the magnitude of weight changes within Latin America and the Caribbean. Shifts in weights range from 15.6 percent in Bolivia to 48.5 percent in Haiti. These shifts are even greater for our AREER-M and AREER-MC measures, ranging from 24.6 (Costa Rica) to 60.7 percent (Suriname) in AREER-M, and from 26.5 (Costa Rica) to 73.7 percent (Suriname) in AREER-MC.[32] Average shifts in wheight are similar for the world sample as a whole. The blue and red bars show the weight gains and losses for the United States and China, respectively. On average, the US weight losses amount to 10.5 percentage points (AREER), 7.8 percentage points (AREER-M) and 16.4 percentage points (AREER-MC). China, in contrast, gains on average 3.6, 6.9 and 0.4 percentage points in weight, respectively. It is interesting that, while China gains considerable weight in countries such as Mexico with which they compete in third markets, it loses substantial weight in countries such as Brazil, Chile and Uruguay, for which it represents an important export destination.

[Figure 4 about here.]

How do these changes in weights translate into differential exchange rate patterns? Figure 5 shows the changes in the REER (in blue in the Figure) and the different versions of the AREER (in red).[33] Thus, they illustrate how the changes in the weights discussed above influenced export competitiveness in the period between May 2014 and February 2016. Notice that while most countries experienced real bilateral depreciation vis-à-vis the US dollar during this period (Figure 2), the majority of them actually exhibited substantial real effective appreciation, leading to losses in export competitiveness. Only three countries—Colombia, Brazil and Mexico—experienced substantial real depreciation, regardless of how it is measured. There are, however, differences between the behavior of REER and our AREER measures. In particular, on average, economies in Latin America and the Caribbean appreciated more markedly than the traditional REER suggests. According to our first measure (AREER), depicted in panel a), Latin American and Caribbean currencies appreciated on average 7.9 percent from May 2014 to February 2016; the corresponding figure for the REER is only 5.1 percent. In fact, each country in the figure, with the exception of Paraguay, loses relative competitiveness when using AREER rather than REER, either because the depreciation is smaller, or the appreciation larger. At the other extreme, for Ecuador, appreciation increases from 20.5 percent under REER to 33.2 percent under AREER, a very significant change that can have a huge impact on the ability of firms to compete. Even the average change from 5.1 percent appreciation

[32]The greater shift in weights for AREER-MC may be linked to the fact that, for the commodity component of this index that is important for large commodity exporters in the region, weights shift from commodity importers (in the traditional REER) to commodity exporters, since it is with the latter that Latin America and Caribbean countries are competing in the world market that is relevant for the AREER-MC computation.

[33]Table A2 in the Appendix shows the change in the competitiveness from May 2014 to February 2016 when comparing the REER with the different versions of the AREER.

to 7.9 percent appreciation may have a significant impact on the ability of firms to compete when markets are very competitive and markups are small. While the differences are smaller in the case of our measure focused on manufactures (AREER-M), they are largest in the case of AREER-MC, where the average appreciation increases from 5.1 to 9.1 percent.

[Figure 5 about here.]

Figure 6 captures the evolution of our first AREER index during the period under study, in solid red, for Mexico, Colombia and Ecuador, the same countries for which we showed the shift in weights in Figure 4 above. For comparison, the plots also report the evolution of the nominal exchange rate against the US dollar (solid black), the bilateral real exchange rate with the United States (dashed black) and the traditional REER without adjusting for competition or similarity (solid blue). All four variables are normalized to 100 at the beginning of the period of analysis. Notice that in the three cases shown, as we discussed above, the AREERs are always higher (i.e., appreciate more or depreciate less) than the traditional REER's. This is the case for most countries in Latin America and the Caribbean, as the weight of the US dollar -a currency that has appreciated substantially over this period- tends to decrease with the competition and similarity adjustment. The additional loss of competitiveness due to the adjustment ranges in these three countries from 2.8 percent in Mexico to 12.7 percent in Ecuador.

[Figure 6 about here.]

4.2 AREER at the Country-Destination Level

Figure 7 illustrates the change in the weights used in the construction of the country-destination-level AREER, that is, the real effective exchange rates of a country in a specific destination. For illustration purposes, we focus on the United States as a destination for Mexico and on Canada as a destination for Argentina. Traditional bilateral real exchange rates (RER), which would be the obvious traditional alternative to our country-destination-level AREERs, would assign a weight equal to 100 percent to the destination country, since third market competition would not be considered. Each bar in the figures shows the weight assigned to the destination and third-market competitors. Using the country-destination-level AREER reduces the weight of the United States from 100 to 58.5 percent, in the case of Mexico, reassigning these weights to Mexico's most important competitors in the US market, mainly China and Canada. In the case of Argentina, Canada's weight as a destination is reduced from 100 percent to 37.8 percent, and reassigned mainly to the United States, Argentina's main competitor in the Canadian market. Notice that the United States is a more important competitor in Canada than Canada itself, and thus has a slightly larger weight. How do these destination country weights look more generally? In fact, for the world sample as a whole, the average weight of the destination country in its own market (that is, the average α_{ji}) is 37.2 percent for the AREER, 45.0 percent for the AREER-M and 22.8 percent for the AREER-MC, as shown in Table 2.

To see how these changes in the weights translate into the AREER at the country-destination-level, consider Figure 8. Each panel shows the change in the country-destination-level AREER between May 2014 - February 2016 for the ten most important export destinations (in order) for Mexico (a) and Argentina (b). Vertical red lines correspond to the change in AREER at the country level (for Mexico and Argentina, respectively). In panel a), the country-destination-level AREER depreciated less than the bilateral RER in some of Mexico's most important destination markets, notably in the United States, China and India.

Since the RER only reflects competition from producers in destination markets, this implies that Mexico's third-country competitors in these destination markets experienced depreciations as well, counteracting competitiveness-enhancing effects stemming from Mexico's own depreciation during that period. In contrast, Mexican producers barely lost competitiveness in Brazil and Colombia, despite the significantly larger depreciation in these two countries, as part of the weight shifted from these destinations to other competitors. In the case of Argentina (panel b), Canada offers an interesting illustration: while using bilateral RER would point to a loss of competitiveness of 7.6 percent, the destination AREER shows that Argentina has a gain of competitivenss of 2.7 percent in the Canadian market, as a large share of weight is reassigned to the United States.[34]

[Figure 7 about here.]

[Figure 8 about here.]

[Table 2 about here.]

4.3 AREER at the Country-Product Level

To illustrate the relevance of country-product-level AREERs, we will focus on Argentina. Figure 9 shows the shift in weights for the product-level AREER vis-à-vis the product-level REER for the 15 most important export products in this country, according to their share in 2013 total exports. As can be seen, taking into account third market competition changes significantly the structure of weights.[35] Concretely, the average weight shift is 61 percent for the products reported in Figure 9 and 63 percent for the 714 products exported by Argentina and included in the computations. However, these averages hide important across-product variation, with categories such as chemicals and trucks and vans showing shifts in their weights of less than 30 percent, and copper ores and gold shifting more than 90 percent of the weight.

[Figure 9 about here.]

How do these changes in the structure of weights translate into changes in competitiveness? Figure 10 summarizes the change in the product-level REER and AREER for the period May 2014-February 2016 for Argentina. Each bubble corresponds to one 4-digit SITC product, with the size of each bubble being proportional to the share of the product in the country's exports for the 15 products reported in Figure 9. Two findings stand out: first, there is huge variation in the evolution of the AREER at the product level, with most products, including all the most important ones, showing changes in the AREER between -10 and 20 percent.[36] This shows that, while most products lost competitiveness during this period, about one third of the products actually became more competitive. Second, the difference in the structure of weights between the REER and AREER at the product level leads to important differences in the evolution of the exchange rate competitiveness when measured with product-level AREERs, rather than product-level REERs. An extreme example is that of barley, a product with a relatively high shift in weights, which experienced a loss

[34] Not surprisingly, panel a) shows that Mexico also achieved higher competitiveness in Canada, for similar reasons.

[35] Recall from section 4.3 that adjustment for export basket similarity is not relevant at the product level.

[36] Among the most important products, the one that lost the most competitiveness is cars, particulalry when using REER, since 95 percent of exports go to Brazil, a country that experienced substantial depreciation. The loss of competitiveness is somewhat smaller with AREER, since Argentina also competes in the Brazilian market with other countries.

of competitiveness according to the AREER measure, but gains according to REER. This can be explained by a redistribution in the weights from Saudi Arabia (the main destination for the Argentinian exports of barley and a country that experienced a real appreciation against the United States) to Ukraine and Rusia (the main competitors in the Saudi barley market, both countries with the largest real depreciations during the period under consideration). In contrast, a product like cars, with a relativley low shift in weights, is much closer to the 45 degree line. While we chose to focus on Argentina for illustrative purposes only, the standard deviations reported in Table 3, column 3 show that the dispersion of product-level AREERs in this country is not an exception, but rather close to the norm.

[Figure 10 about here.]

[Table 3 about here.]

4.4 AREER at the Country-Product-Destination Level

Recall that, in the introduction, we motivated the need to adjust for third-country competition in the computation of real effective exchange rates using the example of Mexican color TV producers competing with Chinese producers in the US market. To end this case study, we come back full circle to this example as a way to discuss the relevance of our country-product-destination level AREERs. Figure 11 shows the composition of the absorption of color TVs in the United States by country of origin. As we can see in the figure, Mexico (depicted in yellow) is the main supplier, followed closely by China (depicted in brown). Out of the non-Mexican TVs, the United States (in blue) is only responsible for 3.3 percent of absorption. So this is the weight of the United States in the country-product-destination level AREER corresponding to Mexican TV's in the United States. As can be seen in Figure 12, by far the largest weight corresponds to China, which is responsible for supplying 73 percent of non-Mexican color TVs to the US market.[37] Accounting for China, and other suppliers, significantly impacts the competitiveness of Mexican TVs in the US market. As seen in panel b), while competitiveness would have improved by 25.9 percentage points under traditional bilateral RERs, the gain in competitiveness after accounting for third market competition is just 19.9 percent. The main reason for the discrepancy is that, during the same period, the bilateral real exchange rate of China vis-à-vis the United States also depreciated, in this case by 6.4 percent.

[Figure 11 about here.]

[Figure 12 about here.]

5 Concluding Remarks

In this paper, we develop new measures of real effective exchange rates that consider competition in third markets, as well as similarity of export baskets between countries, in the definition of the relevant weights. In addition to competition-adjusted real effective exchange rates at the aggregate country level, we extend

[37] It is worth pointing out that Korean companies such as Samsung and LG have production facilities in Mexico, from which they export to the United States.

the methodology to develop measures at the country-product, country-destination, and country-product-destination levels. To the best of our knowledge, none of these more disaggregated competition-adjusted REERs have been developed before.

We build a new dataset where we apply this methodology to compute monthly adjusted REERs at the country, country-product, and country-destination levels using data on exchange rates, prices, production, and bilateral trade for 120 countries and 769 products at the 4-digit SITC level (Revision 2). We make this dataset publicly available. Lastly, to illustrate the usefulness of our methodological contribution and our dataset, we show the impact of these adjustments on the exchange rate weights and patterns for countries in Latin America and the Caribbean between May 2014 and February 2016 at the country, country-product, country-destination, and country-product-destination levels. This is a period characterized by substantial movement in both nominal and real exchange rates in the countries in the Latin American and Caribbean region, as well as a large real appreciation in the United States.

Our results for aggregate exchange rates show that the weights for the adjusted AREER measure are significantly different from the traditional REER weights that leave out competition in third markets, leading to important differences in the evolution of countries' export competitiveness. On average, between 31 and 49 percent of the weights corresponding to Latin America and the Caribbean countries shift as a result of the adjustment, depending on the AREER used. For the world sample, the average shift in weight ranges between 32 and 44 percent, depending on the AREER specification. This means, that, by leaving aside competition in third markets and export basket similarity, traditional measures of the real effective exchange rate misallocate between one third and one half of the weights. A country like the United States, which is important as an export destination but not so relevant as competitor in third markets, loses on average between 8 and 16 percentage points in weight, depending on the specification. Meanwhile, China gains significant weight for countries such as Mexico and most of Central America, where it is an important competitor, but loses weight in countries such as Brazil, Chile, and Uruguay, for which it is an important export destination.

This shift in the relevant weights affects the evolution of countries' exchange rate competitiveness during the period under study. In general, accounting for competition in third markets and similarity led to larger losses of competitiveness. While real appreciation for countries in Latin America and the Caribbean during this period amounted to 5.1 percent on average using traditional REER, the loss of competitiveness ranges between 6.3 and 9.1 percent using our measures, depending on the specification. While these additional losses vary from country to country, 18 out of 23 countries in Latin America and the Caribbean experience diminished competitiveness vis-à-vis traditional measures, regardless of specification.

At the country-destination level, using our competition adjusted measures reduces the weight of the destination country from 100 percent (as in traditional bilateral RERs) to an average ranging between 23 and 45 percent, depending on the specification. The shift in weights significantly alters the pattern of exchange rate competitiveness in specific destination markets. A case in point is that of Argentina's relevant AREER vis-à-vis Canada. While using bilateral RERs which allocate 100 percent of the weight to the destination country would result in a loss of competitiveness of 8 percent, Argentina actually gained competitiveness in the Canadian market according to our destination-level AREER, as much of the weight shifts from Canada to the United States.

Our results also show that products within countries exhibit very different experiences in terms of their exchange rate competitiveness. The reason is that the structure of weights,which depends on which countries a given country trades with in each product and with whom it competes in those markets, differs significantly across products. Thus, while aggregate shocks that affect a country's exchange rates may reduce the competitiveness of some products, the same shocks may enhance the competitiveness of others. For example, in Argentina, most products experienced changes in AREER between -10 and 20 percent, with a standard deviation of 7 percentage points. These dissimilar experiences justify our efforts to develop competition-adjusted REERs at the country-product and the country-product-destination levels.

While we think our paper makes significant contributions to the measurement of real effective exchange rates, it does have shortcomings. One of them is that, unlike recent work by Bems and Johnson (2017), Bayoumi et al. (2013), and Patel et al. (2014), it does not account for trade in value added, which would be desirable given the increasing role of global value chains in world trade. This is an important consideration, which accounts for the fact that imports from one country could contain inputs produced in others. This is not captured in our measures, which assign weights according to the countries from which products are directly imported. At the time of this writing, however, the input-output data necessary to develop measures that account for trade in value added have limited country coverage, particularly in developing countries which are the focus of our interest. We hope to be able to address this limitation in the future, as more data become available.

Another shortcoming is that our analysis does not take into account trade in services. This is an important limitation, in particular for countries such as those in the Caribbean, in which services comprise an important share of exports. Unfortunately, while there are some data on bilateral trade in services, the quality of these data is questionable. Finally, while we work with CPI inflation data, at least for AREERs at the product level, it would be more appropriate to work with disaggregated price (or cost) data, relevant for each of the products considered. Once again, our choice in this case is driven by data availability. In spite of these shortcomings, we believe that the benefits of introducing our AREER measures for such a wide range of countries far outweigh the costs associated with those limitations.

Our competition-adjusted exchange rates can be useful for policymakers as well as researchers. At the aggregate level, our measures provide policymakers with a tool to track exchange rate competitiveness more accurately by accounting for exchange rate movements not just vis-à-vis trading partners, but also countries with which they compete in third markets. This may help understand why aggregate exports may not be responding according to expectations, if expectations are built on the basis of traditional measures. Relatedly, from a macroeconomic perspective, using our measures may provide more accurate expectations on the speed of external adjustment of the current account. In the period under consideration, thinking in terms of bilateral RERs (which depreciated substantially for most countries in the region) led to undue expectations of quicker adjustment, when in fact the AREERs were in most cases actually appreciating.

At the more disaggregated level, information on real exchange rates at the product and product-destination level may be a useful tool in helping to guide export promotion policies. Such policies may help firms maintain markets where competitiveness has declined, or alternatively to help break into new markets in products that have gained competitiveness. Focusing promotion efforts on the latter may offer more "bang for the buck" for those in charge of export promotion policies. In addition, these measures may help policymakers establish which export sectors are suffering and may benefit from support. For instance, loss of exchange rate competitiveness could potentially be used as a criteria for policies such as the US Trade Adjustment Assistance program.

Researchers should also benefit from having more accurate aggregate measures of exchange rate competitiveness, as well as measures of AREER at the country-destination, country-product, and country-product-destination levels. For example, our country-destination level measures can be used to study the impact of real exchange rates on exports within the context of a gravity model, in place of the traditional bilateral RER measures that are a less accurate characterization of the competitiveness of a country's exports in specific destinations.

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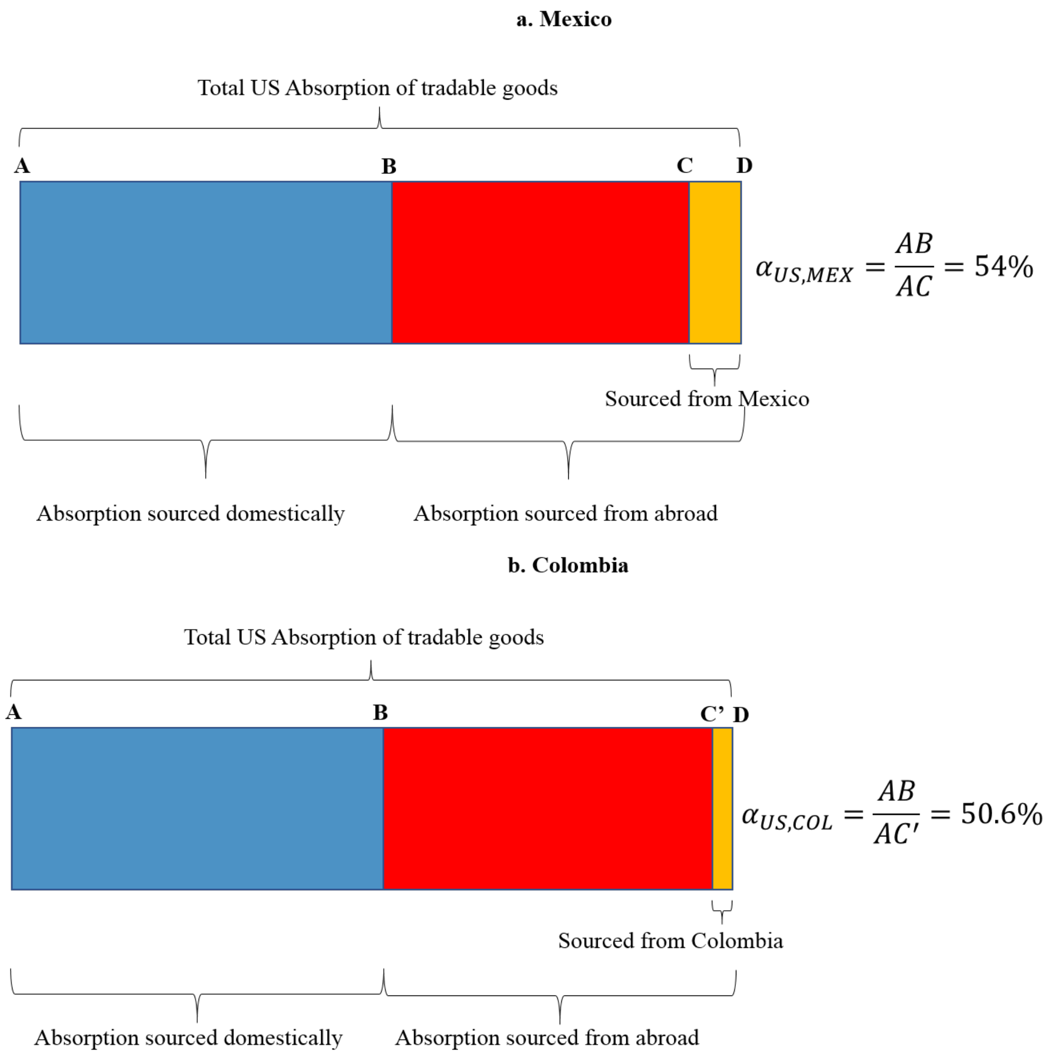
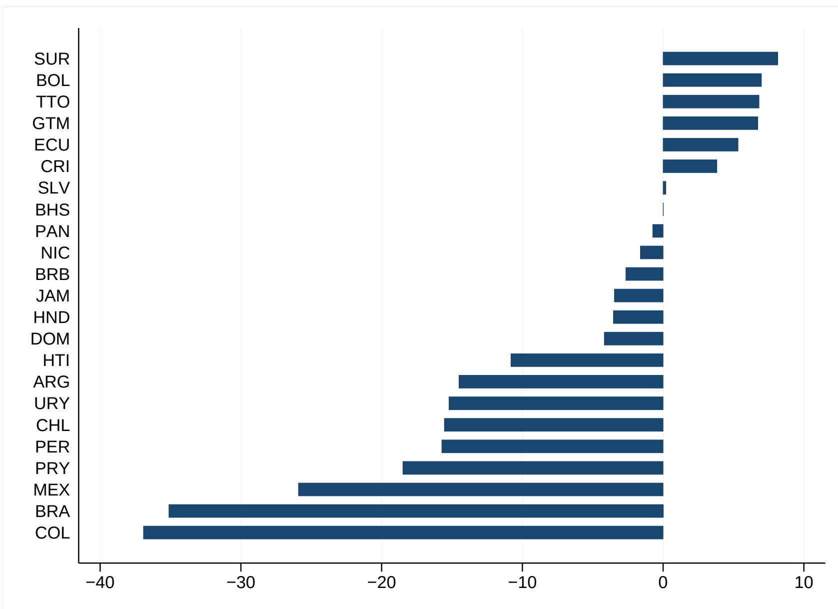
Figure 1: Calculating $\alpha_{US,MEX}$ and $\alpha_{US,COL}$



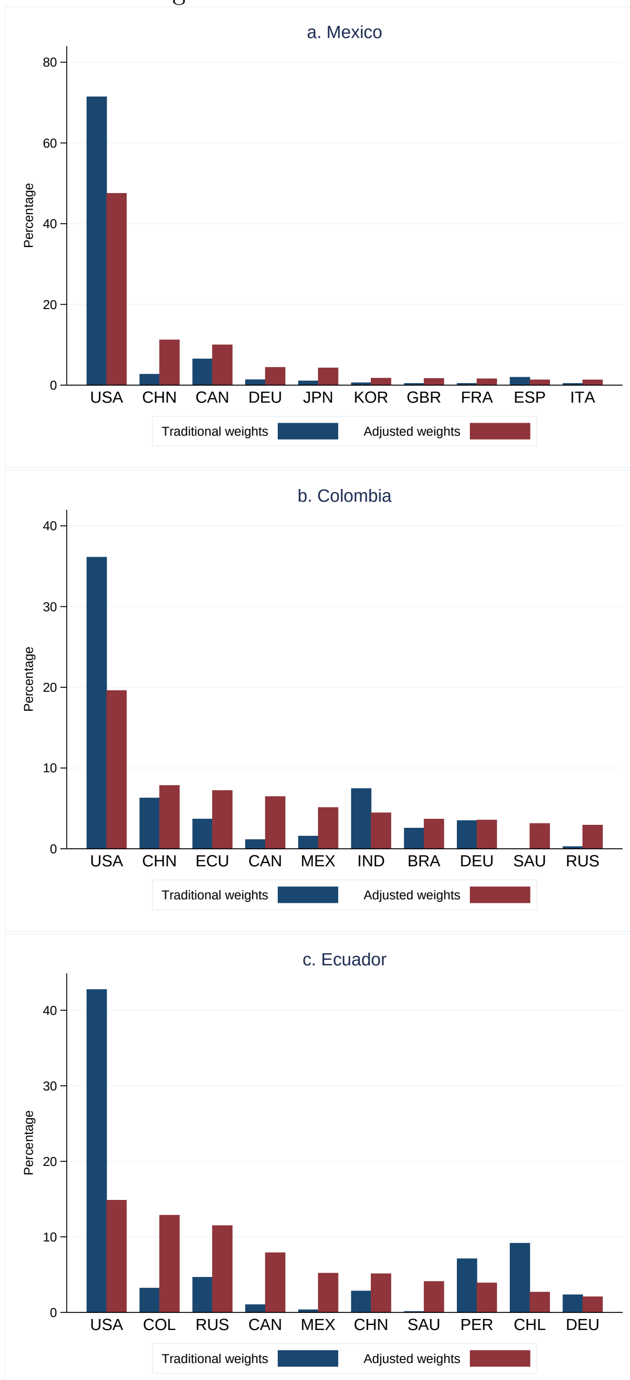
Source: Authors' calculations based on: Bilateral trade flows for 2013 from BACI database (Gaulier and Zignago, 2010), as reflected in Hausmann et al. (2013); industrial and agricultural GDP from the World Bank's World Development Indicators; and local value added in exports from Blyde (2014).

Figure 2: Change in Bilateral Real Exchange Rates in Latin America and the Caribbean (May 2014-February 2016)



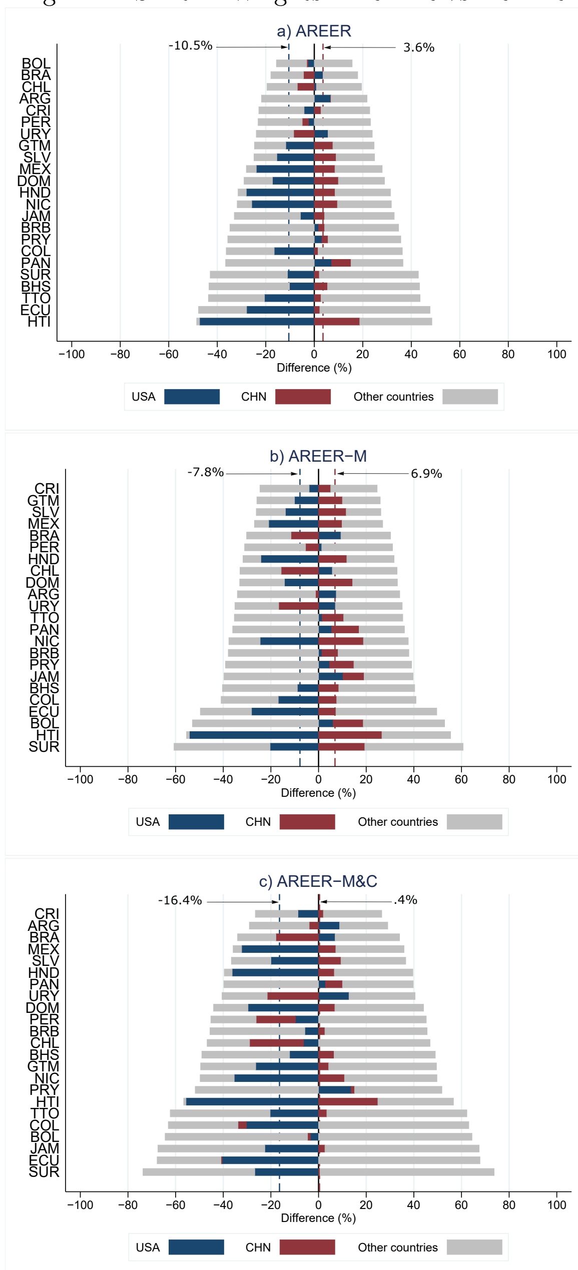
Note: Each bar shows the percentage change in the real exchange rates against the US dollar from May 2014 to February 2016.

Figure 3: Shift in Weights in Selected Countries: AREER vs. REER



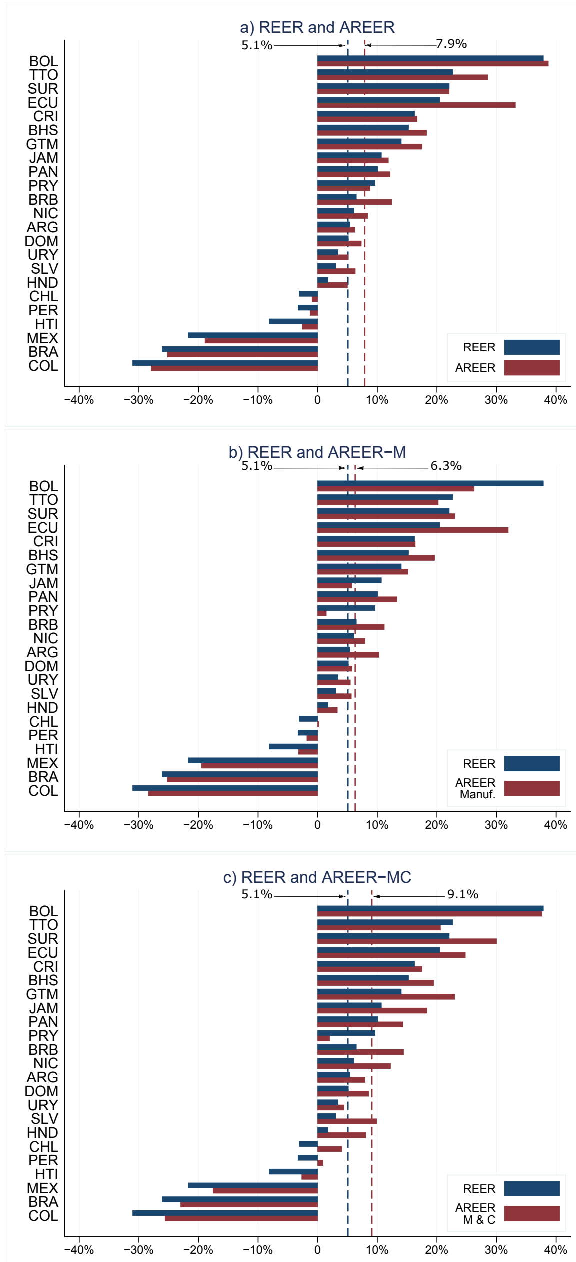
Note: Each bar shows the difference in the weight assigned to each trading partner for the traditional REER and the AREER.

Figure 4: Shift in Weights: AREER vs. REER



Note: Each bar shows the differences in the weights assigned to competitors in the AREER and the REER, with positive (negative) differences meaning that the weight assigned to that country is bigger (smaller) in the AREER than in the REER. The bars are symmetric around the origin since any country's weight gain is compensated by another country's weight loss.

Figure 5: Change in the AREER and REER in Latin America and the Caribbean: May 2014 - February 2016



Note: Each bar shows the percentage change in the exchange rates from May 2014 to February 2016. Vertical lines depict simple averages across countries.

Figure 6: AREER over Time, May 2014 - February 2016

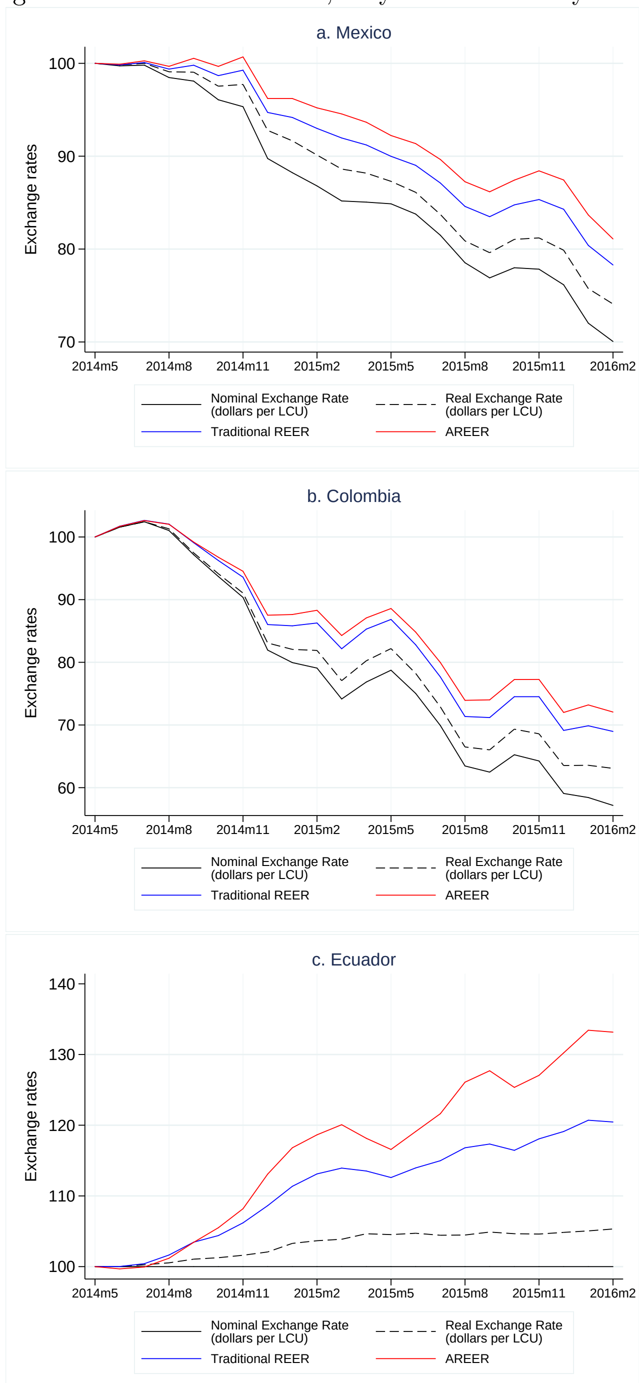
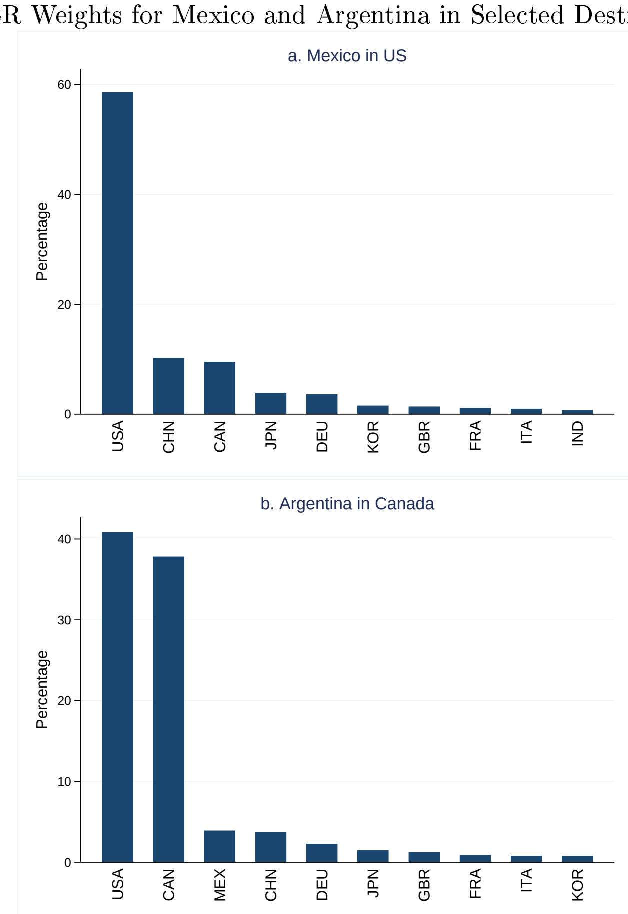
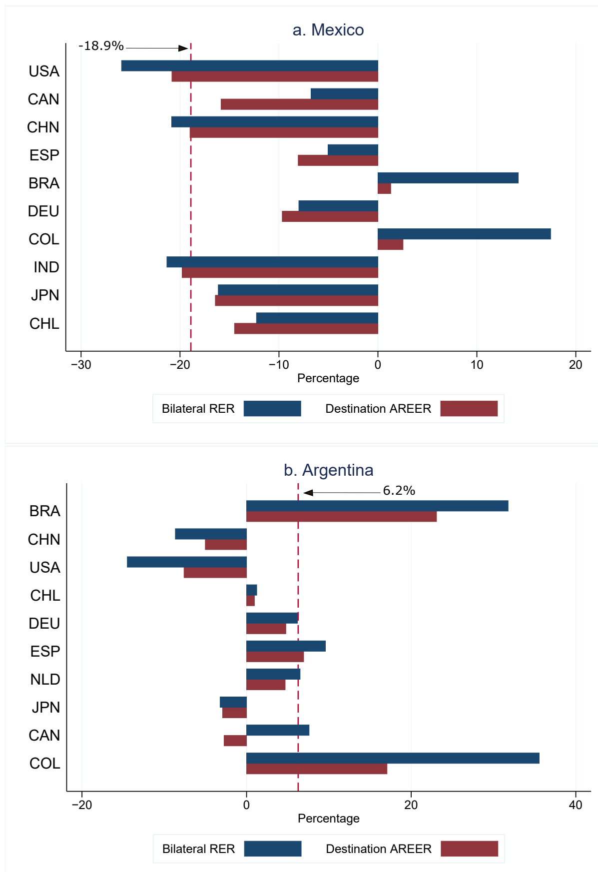


Figure 7: AREER Weights for Mexico and Argentina in Selected Destination Countries



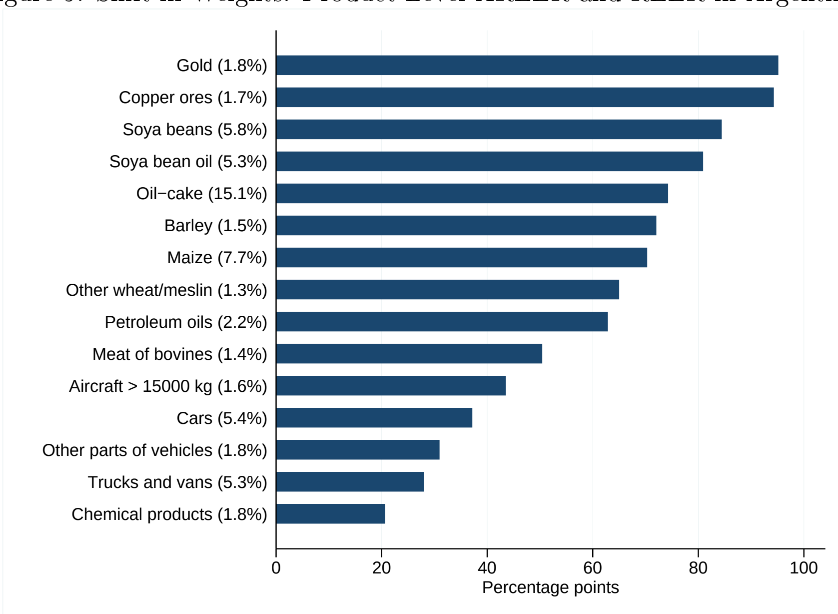
Note: Each bar shows the weight assigned to the destination country vis-à-vis the third-market competitors in the destination-level AREER. The bilateral RER uses a weight of 1 for the destination market.

Figure 8: Change in the Country-Destination-Level AREER: 10 Most Important Destinations, May 2014 - February 2016



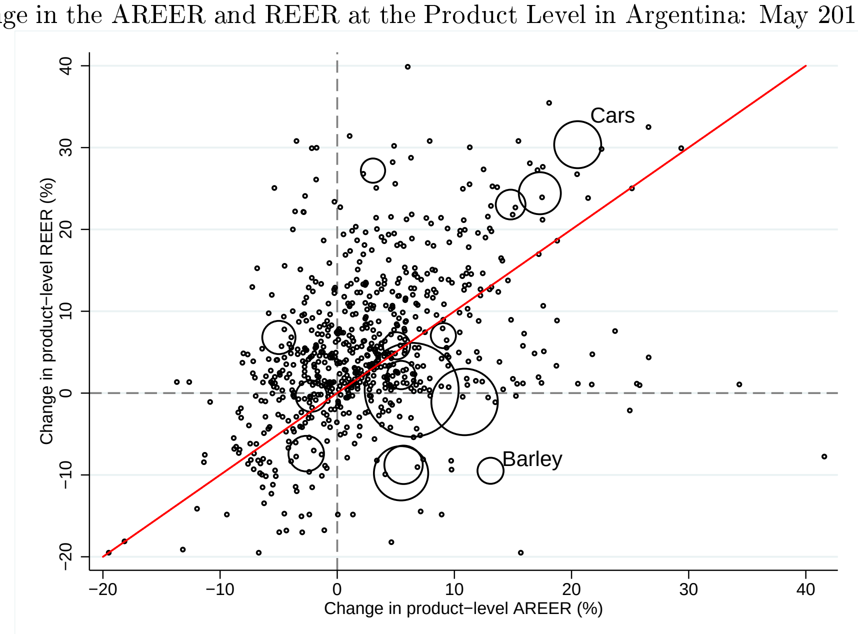
Note: Each panel shows the change in the destination-level AREER between May 2014 and February 2016 for the 10 most important destination of the exports of Mexico (panel a) and Argentina (panel b). Vertical red lines correspond to the change in the country-level AREER.

Figure 9: Shift in Weights: Product-Level AREER and REER in Argentina



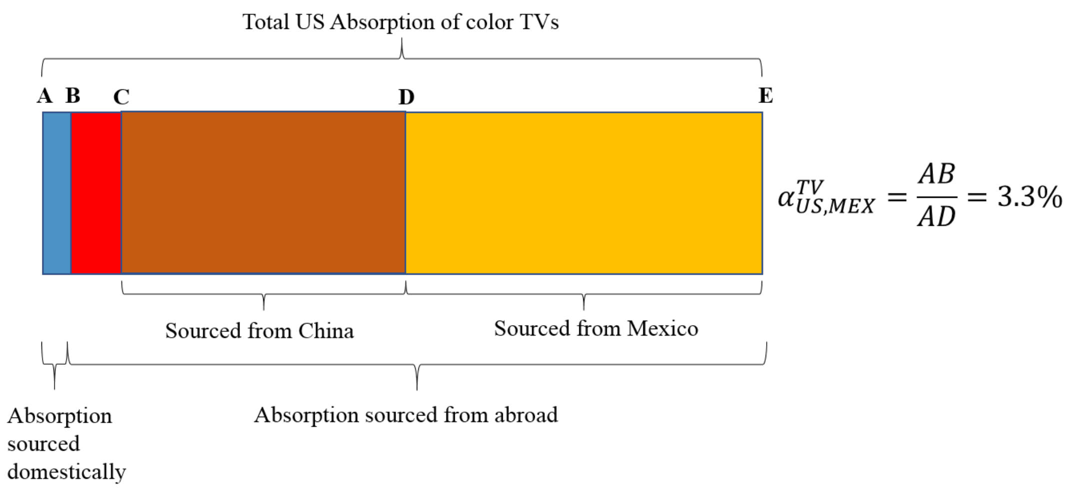
Note: Each bar shows the change in the structure of weights between the AREER and REER at the product level for the 15 most important products in Argentina, according to its export share in 2013 (in parenthesis).

Figure 10: Change in the AREER and REER at the Product Level in Argentina: May 2014 - February 2016



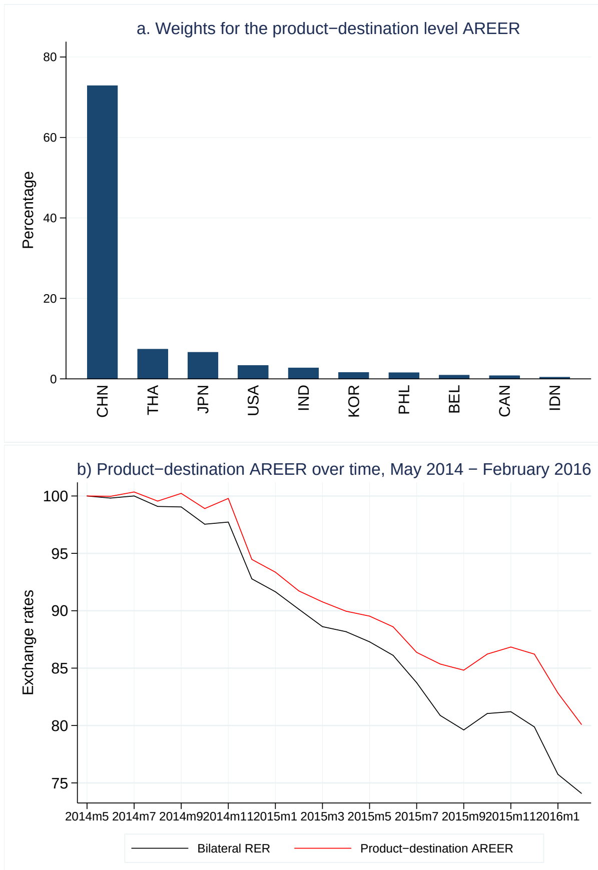
Note: Each bubble corresponds to a 4-digit SITC Rev. 2 category. The size of the bubbles for the 15 products reported in Figure 9 is proportional to the share of the product in the 2013 Argentinian exports. For the rest of the products the size of the bubbles was fixed. 45° degree line is in red.

Figure 11: US Absorption of Color TVs



Source: Authors' calculations based on: Bilateral trade flows for 2013 from BACI database (Gaulier and Zignago, 2010), as reflected in Hausmann et al. (2013); and production data from UNIDO.

Figure 12: AREER at the Product-Destination Level: Mexican Color TVs in the United States



Note: Panel (a) shows the weights used in the computation of the AREER for Mexican TVs in the US market. Panel (b) shows the evolution of the AREER at the product-destination level and the bilateral RER (dollars per Mexican Peso) for the period May 2014-February 2016.

Table 1: Calculating Competition-Adjusted Weights for Mexico

	k \ j	USA	CAN	CHN	ESP	···	j's weight coming from:		
		71.4	**6.5**	**2.7**	**2.0**	···	j's market	Third markets	World
j's share in k's tradable demand	USA	54.0	36.9	2.8	2.8	···	38.6	3.7	**42.3**
	CAN	8.1	35.6	0.5	0.3	···	2.3	5.9	**8.2**
	CHN	11.5	8	73.7	5	···	2	10.2	**12.2**
	ESP	0.3	0.2	0.1	34.1	···	0.7	0.4	**1.1**
	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮

Note: Countries k in the top row are the four most important destinations for Mexican exports. Numbers immediately below represent the share of each of these countries in Mexico's total exports. Countries j in the first column represent Mexico's competitors in third markets. Percentages in the cells when $j = k$ are $\alpha_{j,MEX}$, the share of j's absorption of (non-Mexican) tradables satisfied by domestic producers. Percentages in the cells when $j \neq k$ represent $(1 - \alpha_{j,MEX})\, w^{tr}_{MEX,j}$. The last three columns show the weights capturing Mexico's direct competition with j's domestic producers ($\alpha_{j,MEX} \cdot w^{tr}_{MEX,j}$), the weights capturing Mexico's competition with j in third countries ($\sum_{\substack{k=1 \\ k \neq i,j}}^{n} (1 - \alpha_{ki})\, w^{tr}_{ik} \frac{M_{kj}}{M_{k,-i}}$), and the competition-adjusted weights for Mexico ($w^{1}_{MEX,j}$).

Table 2: Average Weight Assigned to the Destination Country

Exporter country	(1) AREER	(2) AREER-M	(3) AREER-MC
Argentina	48.9	46.5	18.8
Barbados	36.1	37.0	23.0
Bolivia	63.4	55.4	5.3
Brazil	47.1	48.6	18.6
Chile	51.4	55.9	9.0
Colombia	38.0	48.1	9.4
Costa Rica	43.9	46.9	39.0
Dominican Republic	42.6	44.7	26.7
Ecuador	38.3	51.2	4.1
Guatemala	45.6	45.6	18.6
Haiti	41.2	34.1	32.4
Honduras	46.1	47.9	29.5
Jamaica	36.5	44.0	9.2
Mexico	53.4	55.8	43.1
Nicaragua	45.7	41.9	25.7
Panama	39.0	40.1	24.5
Paraguay	52.3	47.7	10.3
Peru	43.9	51.3	8.5
Salvador	51.4	50.9	38.5
Suriname	35.3	37.9	4.9
The Bahamas	35.8	45.0	31.1
Trinidad and Tobago	40.6	52.0	22.1
Uruguay	51.4	51.1	16.9
Average LAC	44.7	46.9	20.4
Average RoW	35.5	44.5	23.4
Average World	37.2	45.0	22.8

Note: Column (1) shows the average weight assigned to the destination in the exporter country's destination-level AREERs, where each destination is weighted according to its share in exports. Column (2) reports the same quantity when the AREER is computed with only manufacturing goods and column (3) when commodities are included following the method proposed by Bayoumi et al. (2006). The last three rows show the simple average of the figures at the country level.

Table 3: Change in Exchange Rates at the Product Level: May 2014 - February 2016

	(1) mean*	(2) mean	(3) sd	(4) p25	(5) p75
Argentina	7.1	2.8	7.0	-1.9	5.9
Barbados	11.6	9.1	7.2	4.7	12.7
Bolivia	17.8	24.6	8.5	18.7	28.4
Brazil	-23.2	-24.7	4.3	-27.0	-23.3
Chile	1.8	-1.5	5.8	-5.2	1.3
Colombia	-29.3	-29.6	4.2	-32.2	-27.6
Costa Rica	17.6	15.1	7.3	10.2	18.9
Dominican Republic	7.8	8.6	7.5	3.8	12.0
Ecuador	26.1	24.8	9.7	18.9	28.9
Guatemala	20.9	18.6	7.0	13.8	22.4
Haiti	-5.0	0.6	6.4	-4.4	4.8
Honduras	6.6	6.8	7.0	2.0	10.5
Jamaica	16.9	8.5	6.0	4.5	12.0
Mexico	-17.8	-16.9	5.0	-20.0	-14.5
Nicaragua	7.8	7.9	6.8	3.5	11.9
Panama	12.0	11.8	8.4	6.5	15.6
Paraguay	7.1	-1.6	7.5	-6.5	2.0
Peru	0.7	-2.2	6.7	-6.1	0.8
Salvador	8.1	9.7	6.8	4.8	13.6
Suriname	30.9	26.6	7.3	22.0	31.3
The Bahamas	15.1	12.8	6.7	8.6	16.6
Trinidad and Tobago	25.1	18.6	7.8	13.0	22.9
Uruguay	4.0	0.8	8.0	-4.2	4.3
Average LAC	7.4	5.7	6.9	1.2	9.2
Average RoW	0.9	0.2	6.3	-3.6	2.9
Average World	2.1	1.2	6.4	-2.7	4.1

Note: Column (1) reports weighted means of the change in the product-level AREER, where the weights are the share of each product in country's exports. Columns (2)-(5) report unweighted statistics. The last three rows show the simple average of the figures at the country level.

Online Appendix *"Competition-Adjusted Measures of Real Exchanges Rates"*

by Stein, Fernandez, Rosenow, and Zuluaga

A Mathematical Appendix

A.1 AREER at the Country-Product Level

In Subsection 2.2 we claimed that equations (14) and (15) are equivalent under the following two assumptions:

1. The ratio between the gross output and value added of product p (y^*_{pj} and y_{pj}, respectively) is equal to ξ_p for all origins, that is, $\frac{y^*_{pj}}{y_{pj}} = \xi_p > 1$ for all j.

2. Product p is not used as an input in its own production.

The above results can be proved as follows:

$$\begin{aligned}
\alpha_{pji} &= \frac{y_{pj} - \tau_{pj}\kappa_{pj}x_{pj}}{y_{pj} - \tau_{pj}\kappa_{pj}x_{pj} + m_{pj,-i}} \\
&= \frac{\xi_p y_{pj} - \xi_p \tau_{pj}\kappa_{pj}x_{pj}}{\xi_p y_{pj} - \xi_p \tau_{pj}\kappa_{pj}x_{pj} + \xi_p m_{pj,-i}} \\
&= \frac{y^*_{pj} - x_{pj}}{y^*_{pj} - x_{pj} + \xi_p m_{pj,-i}}.
\end{aligned}$$

The third line follows from assumption 1, and the result that $\xi_p \tau_{pj}\kappa_{pj}x_{pj}$ is equal to x_{pj}. To see this last equality, note that x_{pj} can be decomposed into four terms: (1) the value added in exports that is originated in j's industry p, that is, $\tau_{pj}\kappa_{pj}x_{pj}$; (2) the value added in exports originating from the industry p of other countries, $(1-\tau_{pj})\,\kappa_{p,-j}x_{pj}$, (3) the value of local intermediate inputs, $\tau_{pj}\,(1-\kappa_{pj})\,x_{pj}$, and (4) the value of foreign intermediate inputs, $(1-\tau_{pj})\,(1-\kappa_{p,-j})\,x_{pj}$. From assumption 2, it follows that $(1-\tau_{pj})\,\kappa_{p,-j}x_{pj}$ is equal to zero (since product p is not used as an input in its own production) and, therefore, all the value added in x_{pj} originated in industry p should be sourced in country j, which by the assumption 1 implies that $\xi_p \tau_{pj}\kappa_{pj}x_{pj}$ is equal to x_{pj}.

A.2 AREER at the Country-Destination Level

In subsection 2.3 we claimed that the country-level AREER can be calculated as the weighted (geometrical) average of the country-destination-level AREERs, with the weights assigned to each destination being the traditional real exchange rate weights. To show that, we start rewriting equation (16) for all the destination for which country i exports as follows:

$$\left(AREER_i^j\right)^{\frac{X_{ij}}{X_i}} = RER_{ij}^{\alpha_{ji}\frac{X_{ij}}{X_i}} \prod_{\substack{k=1\\k\neq i,j}}^{n} RER_{ik}^{(1-\alpha_{ji})\frac{M_{jk}}{M_{j,-i}}\frac{X_{ij}}{X_i}}, \forall j \neq i. \tag{18}$$

Multiplying the $n-1$ equations defined in (18), we have the following expression:

$$\prod_{\substack{j=1\\j\neq i}}^{n}\left(AREER_i^j\right)^{\frac{X_{ij}}{X_i}} = \prod_{\substack{j=1\\j\neq i}}^{n}\left(RER_{ij}^{\alpha_{ji}\frac{X_{ij}}{X_i}}\prod_{\substack{k=1\\k\neq i,j}}^{n}RER_{ik}^{(1-\alpha_{ji})\frac{M_{jk}}{M_{j,-i}}\frac{X_{ij}}{X_i}}\right)$$

$$= \prod_{\substack{j=1\\j\neq i}}^{n}\left(RER_{ij}^{\alpha_{ji}\frac{X_{ij}}{X_i}}\prod_{\substack{k=1\\k\neq i,j}}^{n}RER_{ij}^{(1-\alpha_{ki})\frac{M_{kj}}{M_{k,-i}}\frac{X_{ik}}{X_i}}\right)$$

$$= \prod_{\substack{j=1\\j\neq i}}^{n}\left(RER_{ij}^{\alpha_{ji}\frac{X_{ij}}{X_i}+\sum\limits_{\substack{k=1\\k\neq i,j}}^{n}(1-\alpha_{ki})\frac{M_{kj}}{M_{k,-i}}\frac{X_{ik}}{X_i}}\right)$$

$$= \prod_{j=1}^{n}RER_{ij}^{w_{ij}^1}.$$

The second line is obtained after expanding the product and rearranging the factors for the real exchange rate of each country j. The third line groups the components associated with each trade partner. Finally, the fourth line follows directly from equations (2) and (4) in the main text.

B Imputation Method

Since our equation for the country-product-level AREER requires having information for all the variables included in the computation, it was necessary to impute α_{pji} for all cases with missing data. We use the following four-step imputation procedure:

1. Compute country j's local absorption of p as follows: $\alpha_{pj} = \dfrac{y^*_{pj} - x_{pj}}{y^*_{pj} - x_{pj} + \xi_p m_{pj}}$. Notice that this expression allows reducing (temporarily) the dimensionality of the procedure (from three to two dimensions).

2. Estimate the residuals $r_{pj} = \alpha_{pj} - \gamma_p$, where γ_p is the in-sample mean of α_{pj} for product p (the estimated fixed effect associated with p).

3. Build a predictive model for r_{pj} using information on exports ($\ln x_{pj}$ and x_{jp}/X_j), imports ($\ln m_{pj}$ and m_{jp}/M_j), local value added in exports (τ_{pj}), country-level absorption (α_j), year fixed effects and regional fixed effects.[38] We do not include product fixed effects in this step to not overfit the data.

4. Using the results from the previous two steps, compute equation (15).

To improve predictive accuracy, we use boosted regression as described in Hastie et al. (2009) and James et al. (2013) in the fourth step. Boosted regression is a machine learning algorithm that sequentially fits regression trees, where the information used to estimate each model comes from the updated residuals of previous iterations and from a random subsample of the training data (bagging). Predictions from this method are

[38] We include dummies for the following regions: East Europe, Western Europe, Latin American and the Caribbean, Middle East and North Africa, South Saharan Africa, South Asia, and East Asia and the Pacific. The base category is North America.

then constructed as the (weighted) sum of the estimations from all individual trees. In comparison to a linear model, boosted regression is a more flexible algorithm, well suited to capture non-linear relationships between the outcome and the predictors without overfitting the data. Additionally, boosting has outperformed other methods in terms of predictive accuracy (see, for example, the simulation study reported in Schonlau (2005) or the results described in Hastie et al. (2009)).

C AREER at the Country Level: Differences in Competitive Structure

Table A1 provides an overview by exporter of the differential structure of competitors between the AREER indicators and the REER.

[Table A1 about here.]

D AREER at the Country Level: Implication for AREER

Table A2 provides an overview by exporter on how changes in these weights influence the AREER vis-à-vis the REER between May 2014 and February 2016. Columns 3 and 4 report variations of the AREER, computing weights for manufactured goods (AREER-M) and adjusting them additionally for commodities (AREER-MC).

[Table A2 about here.]

Table A1: Change in the structure of weight: AREER vs. REER

	(1) AREER	(2) AREER-M	(3) AREER-MC
Argentina	21.8	34.1	29.1
Barbados	34.8	37.9	45.6
Bolivia	15.6	52.9	64.4
Brazil	17.9	30.2	34.0
Chile	19.5	33.0	46.8
Colombia	36.3	40.9	63.1
Costa Rica	22.9	24.6	26.5
Dominican Republic	29.0	33.1	44.1
Ecuador	47.7	49.6	67.8
Guatemala	24.7	25.9	49.5
Haiti	48.5	55.4	56.6
Honduras	31.4	31.7	39.6
Jamaica	33.0	39.7	67.4
Mexico	28.0	26.9	35.9
Nicaragua	31.8	37.7	49.7
Panama	36.6	36.1	39.8
Paraguay	35.7	39.1	51.8
Peru	23.2	31.0	45.2
Salvador	24.9	26.1	36.6
Suriname	42.9	60.7	73.7
The Bahamas	43.4	40.4	49.0
Trinidad and Tobago	43.6	35.4	62.3
Uruguay	23.9	35.1	40.5
Average LAC	31.2	37.3	48.6
Average RoW	32.8	33.4	43.5
Average World	32.5	34.1	44.5

Note: Column (1) shows the change in the structure of weights when comparing the AREER with the (traditional) REER. Column (2) shows the same difference when the AREER is computed with only manufacturing goods and column (3) when commodities are included following the method proposed by Bayoumi et al. (2006). The last three rows show the simple average of the figures at the country level.

Table A2: Change in Exchange Rates: May 2014 - February 2016

	(1) AREER	(2) AREER-M	(3) AREER-MC
Argentina	0.9	4.9	2.5
Barbados	5.9	4.7	7.9
Bolivia	0.8	-11.6	-0.2
Brazil	0.9	0.9	3.1
Chile	2.1	3.3	7.1
Colombia	3.1	2.6	5.4
Costa Rica	0.4	0.1	1.3
Dominican Republic	2.2	0.6	3.4
Ecuador	12.7	11.5	4.3
Guatemala	3.5	1.1	9.0
Haiti	5.6	4.9	5.5
Honduras	3.2	1.6	6.3
Jamaica	1.2	-5.0	7.7
Mexico	2.8	2.2	4.2
Nicaragua	2.3	1.9	6.1
Panama	2.1	3.2	4.2
Paraguay	-0.8	-8.2	-7.6
Peru	2.0	1.5	4.2
Salvador	3.3	2.6	6.9
Suriname	-0.0	0.9	7.9
The Bahamas	3.0	4.4	4.2
Trinidad and Tobago	5.9	-2.4	-2.1
Uruguay	1.7	2.1	1.0
Average LAC	2.8	1.2	4.0
Average RoW	-0.7	-0.8	0.6
Average World	-0.1	-0.4	1.3

Note: Column (1) shows the change in competitiveness from May 2014 to February 2016 when comparing the AREER with the (traditional) REER. Column (2) shows the same difference when the AREER is computed with only manufacturing goods and column (3) when commodities are included following the method proposed by Bayoumi et al. (2009). The last three rows show the simple average of the figures at the country level.