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Abstract

Standard theory considers the real exchange rate (RER) as an export determinant. A common limitation of cross-country evidence is the use of effective (REER) or bilateral (BRER) RER indices, both of which have the same values across sectors. The novel contributions of this paper are to propose a variety of goods trade model, to exploit exchange rate variations across sectors by constructing a unique sectoral bilateral RER index (SBRER) for 12 Latin American countries, 21 sectors and 38 trade partners, and to estimate empirically the effect of SBRER movements on Latin American manufacturing exports during 2001-2018. The obtained results show that the SBRER is a statistically significant determinant of aggregate manufacturing exports, whereas the REER coefficient has an unexpected sign and the BRER appears not to be significant. Moreover, sectoral export elasticities indicate that in Latin America mainly low-technology sectors are affected by SBRER movements. Overall, these findings make evident that it is important to consider sectoral heterogeneity regarding trade partners and production costs when estimating RER export elasticities from a macroeconomic perspective and they provide new evidence on the effect of RER movements on Latin American exports.

Keywords: Real Exchange Rate; Manufacturing Exports; Trade; Product Complexity; Latin America

JEL Codes: F14, F31; O14

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1. Introduction

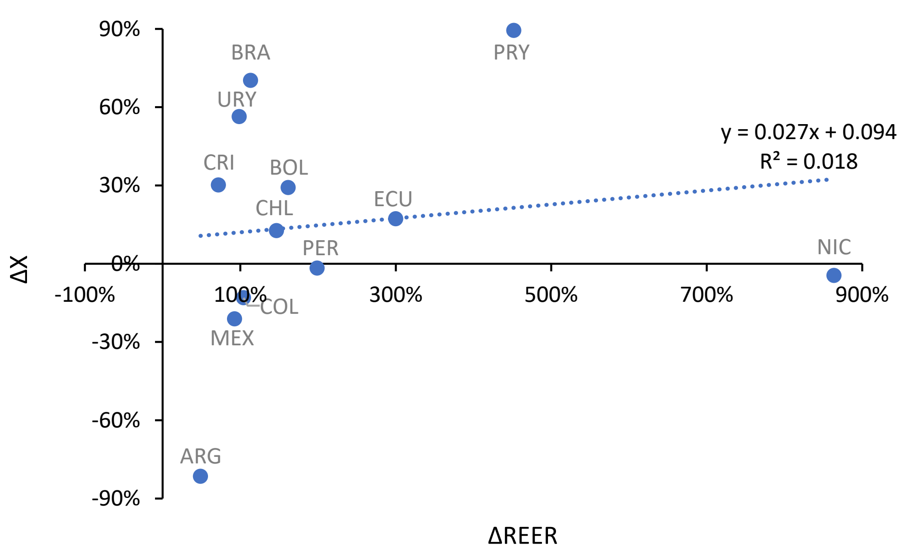
Standard macroeconomic theory considers the real exchange rate (RER) as an indicator of the average price competitiveness of firms. Accordingly, an appreciation (depreciation) of the RER is expected to affect exports of a country negatively (positively). Single country studies that use firm-level data typically provide support for this expected link. For example, Greenaway et al. (2010), Berman et al. (2012), Tang & Zhang (2012), Amiti et al., (2014), Li et al. (2015) and Fornero et al. (2020) show that in Chile, China, Belgium, France and the UK RER movements affect exports at the extensive margin, mainly due to the entry/exit of smaller and less productive firms.

However, especially for developing countries, rich firm-level datasets are often not available and the empirical evidence that uses aggregate data is more mixed with widely varying estimates of the elasticity of exports to RER changes. For example, Thorbecke & Smith (2010) and Sekkat & Varoudakis (2000) find that exchange rate movements affect the export performance of China and Sub-Saharan countries, respectively, whereas Fang et al.'s (2006) results indicate that bilateral exports from Indonesia, Japan, Korea, Philippines, Singapore and Taiwan to the USA are not affected by RER changes. Moreover, Ahmed et al. (2015) and Kang & Dagli (2018) show for a panel of developed and developing countries that the increasing integration of countries in global value chains has led do a decrease of the RER elasticity of exports. Meanwhile the IMF (2015) provides evidence to the contrary (i.e., the results indicate that the relationship between RER movements and exports has remained relatively stable over time).

One common limitation of aggregate data studies is that they consider either a one-dimensional real effective RER index (REER) or a two-dimensional bilateral RER index (BRER). The REER considers inflation-adjusted averages that change over time but are constant with regard to trade partners, while the BRER value is different for each trade partner and year. Both indices have in common that they assume that all industries within a country have the same RER, but industries can have heterogeneous RER movements when they have different trade partners, distinct cost changes and/or diverging degrees of price stickiness (see Carvalho & Nechio (2011) on the latter). The novel contribution of this paper is to exploit this variation between sectors to reassess the relationship between RER movements and manufacturing exports in Latin America, by constructing a sectoral bilateral RER index (SBRER).

Latin America is an interesting case to establish whether the use of different exchange rate measures matters when verifying the impact of RER movements on exports because during the last commodity boom of 2003-2014 the debate about the potential adverse effects of RER appreciation was revived in many countries of the region. More specifically, it is often argued that the boom led to a Dutch disease phenomenon that harmed the manufacturing sector of many countries in the region (see Ocampo, 2017). Moreover, the RER depreciation that followed the end of the commodity boom did not lead to a surge of manufacturing exports – the region's percentage of manufacturing products in merchandise exports dropped by 0.9 points during 2014-2019, according to data from the World Bank (2020). Despite the importance of this debate, we are not aware of a recent empirical paper that studies the relationship between RER movements and Latin American manufacturing exports on a regional scale.

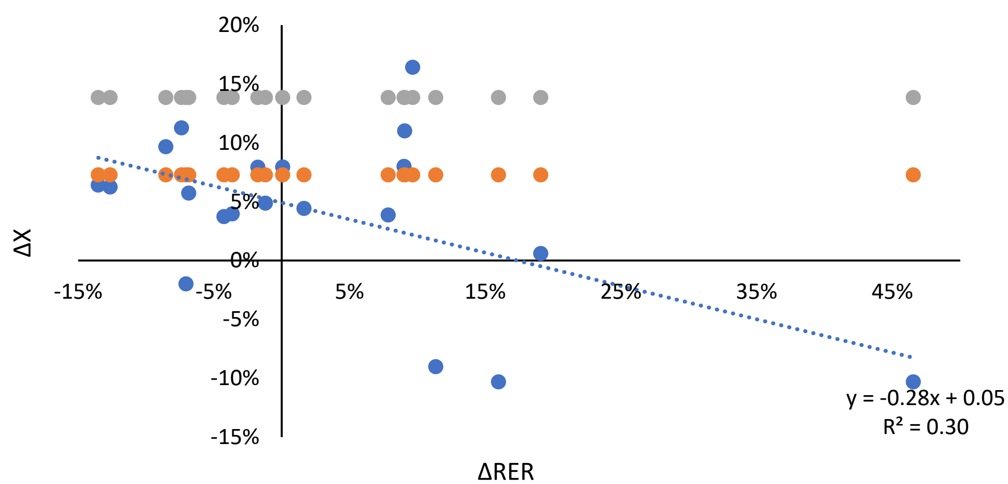
Figure 1: The non-correlation between the REER and Latin American manufacturing exports (2001-2018)



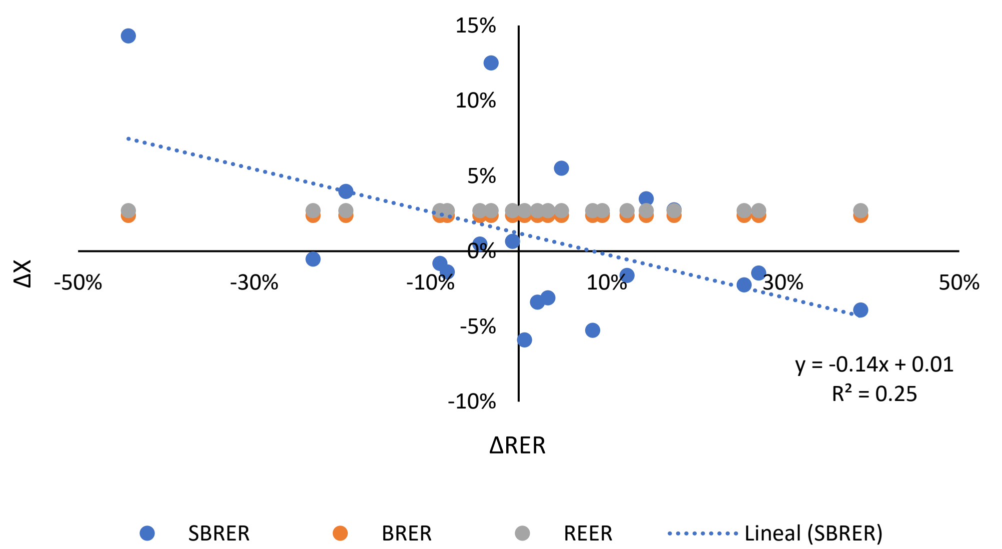
Note: This scatter plot shows the non-correlation between the percentage change in the REER and manufacturing exports (in constant USD) of 12 Latin American countries for the period 2001-2018. An increase in the REER represents an appreciation (see Section 3 for data details).

Figure 2: The correlation between different RER measures and bilateral sectoral manufacturing exports (2001-2018)

b) Brazil



b) Chile



Note: This scatter plot shows the correlation between the percentage change of Brazilian and Chilean real manufacturing exports of 21 sectors to France during 2001-2018, and the respective percentage change in the sectoral bilateral RER (SBRER), bilateral RER (BRER) and REER during the same time period. Each dot represents the change in one manufacturing sector. An increase in the RER measure is an appreciation (see Section 3 for data details).

Contrary to the general perception, Figure 1 suggests that REER movements and Latin American manufacturing export growth are not correlated, and that if any relationship exists it is an inverse one (i.e., most countries experienced a REER appreciation coupled with an increase in exports). This conclusion changes though when one accounts for sectoral heterogeneity. Figure 2 shows the export growth of 21 Brazilian and Chilean manufacturing industries to France and their respective REER, BRER and SBRER movements. It illustrates that sectors within countries have distinct RER movements and that the correlation between the SBRER and bilateral exports is negative (as theoretically expected), whereas there exists no clear relationship between the REER and BRER and sectoral exports.

Of course, this illustration is only indicative that sectoral RER movements matter for export growth. To reassess the relationship more formally, this paper first presents a modification of Reinhart's (1995) trade model to show that, theoretically, sectoral heterogeneity matters for the bilateral exports of developing countries. In a second step, this paper calculates a three-dimensional SBRER for 12 Latin American countries, which considers the variation of producer price differentials and bilateral nominal exchange rates across 21 sectors, 38 trade partners and 18 years. Finally, panel data regressions are used to verify the impact of these 172,368 distinct SBRER observations on Latin American manufacturing exports, and the results are compared with those obtained when using standard REER and BRER measures.

The main findings of the econometrical exercise are in line with the indicative evidence from above: When the REER is used as explanatory variable the coefficient sign suggests an inverse relationship between RER movements and Latin American manufacturing exports (i.e., an appreciation of the REER has a positive impact on exports). When the BRER is used instead, the sign changes but the coefficient is insignificant. Only the SBRER measure has a statistically significant impact on exports with the expected sign. Moreover, we establish sectoral differences regarding the reaction to RER movements. In line with previous evidence, our results suggest that mainly low-technology sectors are affected by SBRER movements. Overall, these findings show that it is important to consider sectoral heterogeneity regarding trade partners and production costs when estimating RER export elasticities from a macroeconomic perspective and they provide new evidence on the effect of RER movements on Latin American exports.

We are not aware of another study with the same scope as ours, yet it is important to mention that some related research exists. For example, Imbs et al. (2005), Robertson et al. (2009) and Mayoral & Gadea (2011) show that the PPP puzzle – i.e., the relatively slow convergence of RER to parity – can be partly solved when sectoral heterogeneity is accounted for. Berka et al. (2018), on the other hand, consider heterogeneous consumer price changes of 146 groups of consumption goods and services to verify the presence of the Balassa-Samuelson effect in the euro area. They find that an increase in sectoral productivity leads to a sectoral appreciation. With regard to trade, Byrne et al. (2008) stress the importance of considering sectoral price indices when deflating export values, and they find that an increase in relative sectoral price differences affects bilateral US trade negatively. Lee & Yi (2005), Dai & Xu (2013), Sato et al. (2013) and Neumann & Tabrizy (2021) go a step further and calculate sectoral REER using industry-level producer price indices. They find that in China, Japan, Korea, Malaysia and Indonesia important differences exist regarding the impact of RER movements on sectoral competitiveness and trade balances. However, they do not account for bilateral effects and they only consider Asian countries. The closest study to ours is a case study about Colombia by Torres García et al. (2018). They also calculate SBRER and find that it is better suited than other measures to derive RER export elasticities, yet prior to our results it was not clear if this finding is generalizable to other Latin American countries.

The remainder of this paper is structured as follows. In the next section (2), we present a multisectoral trade model of export determinants. Section 3 presents the data and methodology used to test econometrically the impact of the three distinct RER measures on Latin American manufacturing exports. Section 4 analyses the obtained regression results. Section 5 concludes.

2. A multisectoral model of export determinants

To study the impact of the real exchange rate (RER) on the bilateral sectoral manufacturing exports of Latin American countries we propose a modification of Reinhart's (1995) developing country trade model. The model uses a simple approach to specify trade, showing that the demand for bilateral exports depends positively on the income of the trade partner and negatively on the relative price of the export good (i.e., on the bilateral RER). By incorporating the existence of a variety of export goods into this model, we are able to demonstrate the importance of accounting for sectoral heterogeneity in empirical studies about export determinants.

To be more specific, in the proposed model bilateral export demand for the manufacturing goods of a developing country is determined considering a maximization problem of foreign country households, which consume a non-tradable domestic good (h_t^*) and a variety of imported goods ($x_j,\ j = 1,2, \dots J$), where j represents the existing varieties. Assuming β is the subjective discount rate, the utility function of the representative foreign consumer is as follows:

$$U = \int_0^\infty e^{-\beta t} U(h_t^*, x_1, \dots, x_J) \quad (1)$$

Supposing furthermore that the domestic good and the imported varieties are imperfect substitutes, the functional form of the utility function can be expressed as

$$U = h_t^{*\alpha} \left\{ \left[x_1^\rho + x_2^\rho + \cdots + x_J^\rho \right]^{\frac{1}{\rho}} \right\}^{(1-\alpha)} \quad (2)$$

Taking the natural logarithm of both sides, the utility function for a given period is given by (3):

$$\ln (U) = \propto \ln (h_t^*) + \frac{(1-\alpha)}{\rho} \ln \sum_{j=1}^{J} x_j^\rho \quad (3)$$

With respect to the flow budget constraint, it is assumed that the foreign consumer possesses a certain quantity of the non-tradable domestic good (q_t^*), that has a price of p^*, and a certain quantity of a variety (l) of tradable goods ($m_l, l = 1,2, \dots L$) that are not consumed domestically but instead exported to the developing country and have a price of p_l^m. The total income of the foreign country, normalized by the available quantities of the non-tradable domestic good, is thus:

$$y_t = q_t^* + \left(\frac{1}{p^*}\right) \sum_{l=1}^{L} p_{lt}^m m_{lt} \quad (4)$$

Assuming that the foreign country is a net lender to the rest of the world that can accumulate assets, it also receives interest (r_t^*) for its total foreign assets (A). Henceforth, the inter-temporal budget restriction of the foreign country is expressed as in (5):

$$\dot{A} = q_t^* + \left(\frac{1}{p^*}\right)\sum_{l=1}^{L} p_{lt}^m m_{lt} + r_t^* A \left(\frac{p_j^x}{p^*}\right)_t - h_t^* - \sum_{j=1}^{J} \frac{p_j^x}{p^*} x_{tj} \tag{5}$$

where p_j^x is the price of the *j-th* imported good.[2] The Hamiltonian of the problem is expressed as follows:

$$H = \alpha \ln(h_t^*) + \frac{(1-\alpha)}{\rho} \ln \sum_{j=1}^{J} x_{tj} + \lambda_t [q_t^* + \left(\frac{1}{p^*}\right)\sum_{l=1}^{L} p_{lt}^m m_{lt} + r_t^* A \left(\frac{p_j^x}{p^*}\right)_t - h_t - \frac{1}{p^*}\sum_{j=1}^{J} p_{jt}^x x_{jt}] \tag{6}$$

The first order condition in respect to the *j-th* imported good of the foreign country $\left(x_{\hat{j}t}\right)$ is

$$\frac{\partial H}{\partial h_t} = \frac{\alpha}{h_t} - \lambda_t = 0 \tag{7}$$

$$\frac{\partial H}{\partial x_{\hat{j}t}} = \frac{(1-\alpha)}{\rho}\frac{1}{x_{jt}} - \lambda_t \left(\frac{p_j^x}{p^*}\right)_t = 0 \tag{8}$$

$$\frac{\partial H}{\partial A_t} = \lambda_t r_t^* \left(\frac{p_j^x}{p^*}\right)_t = \rho\lambda_t - \lambda_t \tag{9}$$

$$\frac{\partial H}{\partial \lambda_t} = q_t^* + \left(\frac{1}{p^*}\right)\sum_{l=1}^{L} p_{lt}^m m_{lt} + r_t^* A \left(\frac{p_j^x}{p^*}\right)_t - h_t^* - \frac{1}{p^*}\sum_{j=1}^{J} p_{jt}^x x_{jt} = 0 \tag{10}$$

Combining (7) and (8) reveals the relationship between the consumption of the non-tradable domestic good and imported goods in the foreign country:

$$h_t^* = \frac{\rho\propto}{(1-\propto)} x_{\hat{j}t} \left(\frac{p_j^x}{p^*}\right) \tag{11}$$

[2] To simplify the model, it is assumed that the return on the assets is expressed in terms of a single import price.

The long-run determinants of the exports of a developing country can be obtained guaranteeing (9) and that $q_t^* = h_t^*$. With this condition, and using (10), the following expression is derived:

$$x_{\hat{j}t}\left(\frac{p_{\hat{j}}^x}{p^*}\right) = \left(\frac{1}{p^*}\right)\sum_{l=1}^{L} p_{lt}^m m_{lt} + r_t^* A\left(\frac{p_{\hat{j}}^x}{p^*}\right)_t - \frac{1}{p^*}\sum_{\substack{j=1 \\ j\neq\hat{j}}}^{J} p_{jt}^x x_{jt} \qquad (12)$$

Taking the natural logarithm of (12) and isolating foreign imports from the $\hat{j}$ good gives (13):

$$\ln(x_{\hat{j}t}) = \ln\left[\left(\frac{1}{p^*}\right)\sum_{l=1}^{L} p_{lt}^m m_{lt} + r_t^* A\left(\frac{p_{\hat{j}}^x}{p^*}\right)_t - \frac{1}{p^*}\sum_{\substack{j=1 \\ j\neq\hat{j}}}^{J} p_{jt}^x x_{jt}\right] - \ln\left(\frac{p_{\hat{j}}^x}{p^*}\right) \qquad (13)$$

Now, defining $X_{t\hat{j}} = \ln(x_{t\hat{j}})$: imports (exports) from the foreign country (developing country); $w_{\hat{j}}^* = \ln\left[\left(\frac{1}{p^*}\right)\sum_{l=1}^{L} p_{lt}^m m_{lt} + r_t^* A\left(\frac{p_{\hat{j}}^x}{p^*}\right)_t - \frac{1}{p^*}\sum_{\substack{j=1 \\ j\neq\hat{j}}}^{J} p_{jt}^x x_{jt}\right]$: disposable income from the foreign country to buy the imported good $X_{\hat{j}}$; and $P_{t\hat{j}} = \ln\left(\frac{p_{\hat{j}}^x}{p^*}\right)_t$: relative price of the good $\hat{j}$ with respect to the price of the non-tradable domestic good, which is equivalent to the bilateral real exchange rate of the good $\hat{j}$ ($RER_{t\hat{j}}$). The equation that summarizes the determinants of the exports of the sector $\hat{j}$ to the foreign country is defined as follows:

$$X_{t\hat{j}} = w_{\hat{j}}^* - RER_{t\hat{j}} + \varepsilon_t \qquad (14)$$

In a nutshell, (14) shows that sectoral bilateral exports of a developing country depend positively on the disposable income of its trade partner and negatively on the sectoral bilateral RER.

3. Data and methodology used

To verify empirically if RER movements affect manufacturing exports of Latin American countries, we examine 12 countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, Nicaragua, Paraguay, Peru, and Uruguay) in the period 2001-2018. This sample is chosen due to data availability and represents approximately 90% of the production of the region and 85% of its population.

We consider three distinct RER measures that have different levels of disaggregation. In line with the theoretical model developed above, the most disaggregate measure is a sectoral bilateral RER index (SBRER). The SBRER is three-dimensional with different values for each manufacturing sector (*s*), trade partner (*b*) and year (*t*). It is expressed as follows:

$$SBRER_{sbt} = \frac{NER^*_{bt}}{NER_t}\frac{P_{st}}{P^*_{sbt}} \quad (15)$$

where $\frac{NER^*}{NER}$ is a nominal exchange rate index, measured as trade partner currency per USD divided by local currency per USD; and $\frac{P}{P^*}$ is the domestic manufacturing producer price index (PPI) with respect to the trade partner PPI. An increase (decrease) of the SBRER represents a real appreciation (depreciation) in a specific sector in comparison to the same sector in a specific export destination.

Empirical studies typically use a two-dimensional bilateral RER index (BRER) to study the relationship between the RER and exports. The BRER value is different for each trade partner (*b*) and year (*t*) but, in contrast to the SBRER, assumes that each sector in a country has the same inflation rate (i.e., in a given *t*, each *s* has the same RER value with respect to a specific *b*). The BRER is calculated as shown in (16):

$$BRER_{bt} = \frac{NER^*_{bt}}{NER_t}\frac{P_t}{P^*_t} \quad (16)$$

The third and most aggregate measure used is the REER index, which considers price adjusted weighted (*p*) averages of bilateral exchange rates:

$$REER_t = \prod_{b=1}^{N}(BRER_{bt})^{p_{bt}} \quad (17)$$

The REER index for the 12 sample countries is readily available from BIS (2020).[3] The SBRER and the BRER, on the contrary, are self-calculated, considering 38 trade partners (*b*) and 21 manufacturing sectors (*s*) at the two-digit level from the International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 3.[4] This classification is

[3] BIS uses consumer prices adjusted time varying weights of 59 bilateral exchange rates for the calculation of the REER, instead of PPI data.
[4] The 21 sectors are: Manufacture of food products and beverages (division 15); Manufacture of tobacco products (16); Manufacture of textiles (17); Manufacture of wearing apparel; dressing and dyeing of fur (18); Tanning and

chosen to be able to account for a relatively long time period, while the two-digit level is the highest disaggregation level for producer price data for most countries. The selection criterion for the 38 trade partners is that, on average, more than 0.5% of the exports of each of our sample countries are destined to these partners.[5] The sum of exports to these destinations represents at least 80% of the exports of each sample country.

To create this unique dataset, we use annual averages of bilateral USD exchange rates that are readily available from BIS (2020). With regard to relative prices, aggregate manufacturing PPI data is used to calculate the BRER, and PPI values at the two-digit level for the SBRER. In both cases, data is retrieved from National Statistics Bureaus, Central Banks, the IMF's International Financial Statistics or the World Bank. In some cases, the data is only available in different product classifications than ISIC Rev. 3 and are homogenized using standard product nomenclature concordance tables (see Table A2 in the Appendix for details).

Unfortunately, PPI data at the two-digit level is not available for all trade partners. In such cases, aggregate manufacturing PPI data is used instead; if this data is also not available, wholesale price data or consumer price data is used. Moreover, for various countries manufacturing PPI data is not available at the two-digit level for all sample years; to impute data for the missing years, the growth rate of aggregate manufacturing PPI, wholesale or consumer price inflation is used. In the instances when not for all sectors specific data is available, we assume that missing sectors have the same PPI as the aggregate manufacturing

dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear (19); Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (20); Manufacture of paper and paper products (21); Publishing, printing and reproduction of recorded media (22); Manufacture of chemicals and chemical products (24); Manufacture of rubber and plastics products (25); Manufacture of other non-metallic mineral products (26); Manufacture of basic metals (27); Manufacture of fabricated metal products, except machinery and equipment (28); Manufacture of machinery and equipment n.e.c. (29); Manufacture of office, accounting and computing machinery (30); Manufacture of electrical machinery and apparatus n.e.c. (31); Manufacture of radio, television and communication equipment and apparatus (32); Manufacture of medical, precision and optical instruments, watches and clocks (33); Manufacture of motor vehicles, trailers and semi-trailers (34); Manufacture of other transport equipment (35); and Manufacture of furniture; manufacturing n.e.c. (36). The sector 23 (Manufacture of coke, refined petroleum products and nuclear fuel) is not included in the sample, given that in Latin America this sector is more related to the exploitation of natural resources than to manufacturing production

[5] The 38 partner countries are: Argentina, Belgium, Bolivia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, France, Germany, Guatemala, Honduras, Hong Kong, India, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Nicaragua, Panama, Paraguay, Peru, Russian Federation, Singapore, Spain, Sweden, Switzerland, Thailand, United Kingdom, United States, Uruguay and Vietnam. Venezuela is not included in the trade partner sample due to data availability and questionable inflation data reliability.

PPI. Table A1 in the Appendix gives an overview of the sources and data used for each country to create the sectoral price database.

In line with the theoretical model presented in Section 2, the following panel data framework is used as a baseline to estimate the impact RER movements have on manufacturing exports:

$$X_{it}^{A} = \alpha_0 REER_{it-1} + \alpha_1 Y_t^{*A} + \vartheta_t + \mu_i + \varepsilon_{it} \quad (18)$$

$$X_{isbt} = \beta_0 RER_{isbt-1} + \beta_1 Y_{bt}^{*} + \omega_{it} + \mu_{isb} + \varepsilon_{isbt} \quad (19)$$

where *i* represents country, *s* stands for the 21 manufacturing sectors, *b* for the 38 trade partners and *t* for the 18 years under consideration; X^A represents the natural logarithm of aggregate manufacturing exports (in constant USD), X is the natural logarithm of manufacturing exports (in constant USD), Y^{*A} is the natural logarithm of the weighted average GDP of the trade partners (in constant USD), Y^* is the natural logarithm of the GDP of the trade partners (in constant USD), $REER$ is the natural logarithm of (17), RER is the natural logarithm of either (15) or (16), ϑ is a time dummy, ω is the interaction of the time dummy and a country dummy, μ are individual fixed effects and ε is an error term. Nominal bilateral export data at the ISIC Rev. 3 two-digit level is readily available in WITS (2020b) and is deflated with the US GDP deflator obtained from the World Bank (2020). The real GDP data is also retrieved from the World Bank (2020). To calculate the weighted average GDP bilateral trade weights of manufacturing exports are used.

The application of the natural logarithm of variables in levels means that the obtained coefficients can be interpreted as long-term RER (α_0; β_0) and income (α_1; β_1) elasticities, respectively. It is also worth pointing out that the maximum number of observations is 172,368 (12*i* * 21*s* * 38*b* * 18*t*). However, only for the $SBRER$ and X, each of them has a distinct value. In the case of the BRER, on the contrary, only 8,208 of the 172,368 observations have a different value (while 164,160 values are repeated) because each *s* has the same value in a given *i* and *t*. Similarly, only 684 observations have a specific value of Y^*, since the trade partners' GDP is the same for each *i* and *s*. The REER, X^A and Y^{*A} are only available for 216 observations, given that they represent aggregated values that only differ between *i* and *t*.

The use of fixed effects models is common in papers that study the impact of RER movements on exports (e.g., Ahmed et al., 2015; Li et al., 2015; Chen & Juvenal, 2016; Neumann & Tabrizy, 2021). The advantage of this methodology is that it allows to control for both unobservable heterogeneity across individuals that is constant over time (μ) and country-specific factors that change annually (ω). The inclusion of the RER as an explanatory variable of exports involves potential econometric issues though. According to theory, trade is a determinant of the nominal exchange rate. Thus, potential endogeneity issues exist between RER and X. Moreover, contemporaneous collinearity might be present between Y^* and RER. To address both issues, the RER variables are included with a one-year lag. To use a time lag is in line with the J-curve theory, which states that firms and consumers take some time to adjust to price changes.[6]

Another potential econometric strategy would be the use of generalized method-of-moments (GMM) estimators. However, given that the sample has a relatively large T, GMM estimators are likely to produce inconsistent estimates.[7] Other alternative solutions, like the fully modified ordinary least squares (FMOLS), mean-group (MG) and pooled mean-group (PMG) estimators are not viable because panel data unit root tests indicate that the export and RER data is stationary (see Table A3 in the Appendix).

With regard to descriptive statistics, Table 1 shows that the mean values of the three RER indices are nearly identical but that a higher level of disaggregation increases the standard deviation and the range of min and max values. The latter indicates that a more precise measurement of the RER might help to reveal important distinctions between sectors that are masked by more aggregate measures. The regression results of the following section will reveal if the differences between the RER measures are sufficiently important to influence the main results obtained from the regressions.

[6] The results are robust when Y^* is considered with a one-year lag instead its contemporaneous value.
[7] Please note that the main findings are robust when a system GMM estimation approach is used. However, the regressions suffer from over-identification issues. Hence, we abstain reporting these results.

Table 1: Descriptive statistics

	Obs	Mean	Std. Dev.	Min	Max
X_t^A	216	22.93	1.67	19.70	26.48
X_{sbt}	172,368	9.78	6.52	-0.14	25.19
$REER_t$	216	4.56	0.23	3.53	5.21
$BRER_{sbt}$	172,368	4.56	0.29	3.02	6.11
$SBRER_{sbt}$	172,368	4.55	0.32	2.44	6.69
Y_t^{*A}	216	29.21	0.52	27.97	30.39
Y_{sbt}^*	172,368	26.56	1.90	22.63	30.51

Note: This table shows the descriptive statistics of the variables used in the baseline regressions.

4. The impact of the RER on Latin American manufacturing exports

4.1 Baseline regressions

Table 2 summarizes the results of the regressions described in (18)-(19). In line with Figure 1 from the introduction, the first regression shows that the REER coefficient has an unexpected sign that suggests a positive impact of an appreciation on exports. In regression (ii), which considers the BRER as the exchange rate proxy, the theoretically expected negative sign appears but the coefficient is not statistically significant. That is to say, both the REER and BRER measures suggest that Latin American manufacturing exports do not react to RER movements as theoretically expected. This finding is also at odds with the empirical findings from firm-level single country studies.

Regression (iii) shows, however, that when instead the SBRER is used as the exchange rate measure the results change entirely in the sense that its coefficient is significant at the 1% level. The coefficient value of 0.24 indicates that a 10% appreciation (depreciation) leads to a 2.4% decrease (increase) in manufacturing exports. This export elasticity is lower than those reported in Torres García et al. (2018) for Colombia (value 0.77) and in Fornero et al. (2020) for Chile (range 0.4; 0.6), for example, but, its value seems reasonable – especially considering the above-mentioned weak reaction of the region's manufacturing exports after the depreciation of the mid-2010s.

Table 2: The impact of the RER on Latin American manufacturing exports

	(i) ***REER***	***(ii)*** ***BREER***	***(iii)*** ***SBRER***
RER_{t-1}	**0.319*** [0.086]	-0.083 [0.321]	**-0.236***** [0.000]
Y^*_t	-1.951 [0.299]	**2.272***** [0.000]	**2.209***** [0.000]
Constant	x	x	x
Individual FE	x	x	x
Time FE	x		
Time*Country FE		x	x
Observations	204	162,792	162,792
Obs. per country	17	13,566	13,566
R-squared	0.7248	0.0766	0.0768

Note: This table summarizes the results of the fixed-effects panel data regressions for 12 Latin American countries. The dependent variable is the log of real manufacturing exports. The second row specifies the RER index that is used as the explanatory variable in each regression. RER refers to the respective real exchange rate index used, Y stands for log of real GDP of the countries' trade partners, individual FE refers to fixed group means, time FE refers to time dummies, time*country FE is the interaction of country dummies with time dummies. The values in parenthesis are p-values; 1%, 5% and 10% levels of significance are indicated by ***, ** and *, respectively.*

Interestingly, in the aggregated REER regression external demand –measured as the weighted average GDP of the trade partners– is not statistically significant and has an unexpected negative sign (column 2). In the bilateral and sectoral export data regressions, on the contrary, the predicted income elasticity is significant with the expected positive sign, suggesting that a 10% increase in external income leads to an approximately 22% increase in manufacturing exports (columns 3-4). Considering that the income elasticity is higher than the SBRER elasticity, the results indicate that Latin American manufacturing exports are more dependent on external income than on RER movements. This finding is in line with Fornero et al.'s (2020) results for Chilean manufacturing exports. Most importantly for our purpose, all of these results suggest that aggregated RER measures can lead to misleading results and that it is important to account for sectoral heterogeneity when estimating export elasticities.

4.2 Robustness checks

The above presented baseline results might suffer from omitted variable bias (although this is not very likely given that we control for individual and time specific effects). We therefore consider the following covariates to check the robustness of the baseline results: an interaction of the SBRER with the logarithm of sectoral manufacturing imports (in constant USD), trade openness, domestic income and commodity prices. The first variable used is a rough proxy for the impact that the integration of the manufacturing sector into global value chains has on the RER export elasticity. A higher integration is expected to affect the elasticity negatively, given that the change in the cost of imported inputs partly offsets the effects of RER movements on foreign prices (Amiti et al., 2014; Ahmed et al., 2015; Kang & Dagli, 2018). The import data is obtained in the same way as the export data from above.

Trade openness, which is measured as the sum of total exports and imports as a fraction of domestic GDP, is used as proxy for barriers to trade. It is common knowledge that exports are negatively affected by trade barriers. Domestic GDP, on the other hand, is a proxy for domestic demand and the potential of a country to adjust production to export demand. Finally, commodity prices are used as a proxy for potential reallocation effects during commodity booms and busts. According to Dutch Disease theory, changing commodity prices lead to the reallocation of production factors between the manufacturing sector and the commodity and service sector and thus affect manufacturing output (Corden & Neary, 1982). Trade openness and domestic GDP data is available from the World Bank (2020), while the commodity price data is retrieved from the IMF (2020).

Table 3 shows that the only variable that has a substantial impact on the baseline results is the interaction of the SBRER with imports. The interaction term is highly significant and positive in all regressions and, as expected, its addition increases the coefficient value of the SBRER compared with the baseline results (-0.35 vs. -0.24). The interpretation of this result is that a 10% increase in manufacturing imports diminishes the reaction of manufacturing export to RER movements by 0.09%. This value is plausible in the sense that it is similar to the one reported by Ahmed (2005): When he interacts the REER with the country's participation in global value chains, the coefficient value is 0.10. To put it differently, these results indicate that when Latin American manufacturing exports have a low (high) content of imported inputs, their average RER elasticity is slightly higher (lower) than that reported in the baseline regression. Trade openness, domestic income and commodity prices, on the other hand, are significant with the expected sign but they do not alter the SBRER coefficient.

Table 3: Robustness checks

	(iv)	*(v)*	*(vi)*	*(vii)*
$SBRER_{t-1}$	**-0.348*** [0.000]**	**-0.348***** [0.000]	**-0.348***** [0.000]	**-0.348***** [0.000]
$SBRER_{t-1} * M_{t-1}$	**0.009***** [0.000]	**0.009***** [0.000]	**0.009***** [0.000]	**0.009***** [0.000]
$Openness_{t-1}$		78.777 [0.120]	**23.029**** [0.018]	-7.183 [0.422]
Y_{t-1}			4.975 [0.204]	**11.710*** [0.076]
$Commodity\ Prices_t$				**-0.104*** [0.069]
Y^*_t	**2.129***** [0.000]	**2.129***** [0.000]	**2.129***** [0.000]	**2.129***** [0.000]
Constant	x	x	x	x
Individual FE	x	x	x	x
Time*Country FE	x	x	x	x
Observations	162,792	162,792	162,792	162,792
Obs. per country	13,566	13,566	13,566	13,566
R-squared	0.0778	0.0778	0.0778	0.0778

Note: This table summarizes the results of the fixed-effects panel data regressions for 12 Latin American countries. The dependent variable is the log of real manufacturing exports. Please see Table 2 notes for more details.

4.2 Sectoral RER export elasticities

The aggregated results from above might mask important differences across sectors. According to theoretical models (Chen & Juvenal, 2016) and previous empirical findings (Thorbecke & Smith, 2010; Torres García et al., 2018; Neumann & Tabrizy, 2021), the responsiveness of exports to RER movements can differ substantially between sectors. One important reason for this sectoral heterogeneity is that exports of low technology products tend to respond more to RER movements, on the grounds that they can be substituted more easily than more complex products and that they tend to have a lower cost share that is paid in the currency of the destination country (because they rely more on local labor and less on imported inputs and have lower distribution costs).

We thus make use of the disaggregated data at hand to explore the specific RER export elasticity from each sector (γ_0) by interacting the respective BRER and SBRER variable with 21 sector dummies ($D_s = \sum_{15}^{36} D_i$):

$$X_{isbt} = D_s * \gamma_0 RER_{isbt-1} + \beta_1 Y_{bt}^* + \omega_{it} + \mu_{isb} + \varepsilon_{isbt} \quad (20)$$

The first observation from the results of this exercise, which are shown in Table 4, is that more sectors react significantly to RER movements when the SBRER is used instead of the BRER (12 vs. 7 sectors). The second observation is that, in line with the baseline regressions in Table 2, the SBRER values are higher than those of the BRER. The third observation is that the elasticities of the different sectors are distinct but their differences are not overly large: The SBRER export elasticity ranges from 0.41 to 0.86 in the sectors that have significant coefficients. Moreover, it is important to note that, as in the other regressions, the value of the income elasticity is substantially higher than the individual RER elasticities, which suggests that the exports from all sectors depend more on external income changes than on RER movements.

Most importantly, and as expected, the results suggest that those sectors that are mainly affected by SBRER movements are those that have a relatively low technological complexity (i.e., tobacco, textiles, wearing apparel, leather dressing and footwear, and wood and paper products). To verify econometrically if the RER elasticity of sectoral exports in Latin America differs according to the technological sophistication of each sector, we use the following regression:

$$X_{isbt} = D_{LMH} * \delta_0 RER_{isbt-1} + \beta_1 Y_{bt}^* + \omega_{it} + \mu_{isb} + \varepsilon_{isbt} \quad (21)$$

where $D_{LMH} = \sum_1^3 D_j$ is a dummy variable that accounts for the average technological sophistication of low-, medium- and high-technology sector groups (δ_0).

Table 4: RER export elasticities by sector

	(viii) *BRER*	*(ix)* *SBRER*
Food products & beverages (15)	0.144	-0.189
Tobacco products (16)	-0.313	**-0.563*** **
Textiles (17)	**-0.686*** **	**-0.862*** **
Wearing apparel & fur dressing (18)	**-0.596** **	**-0.754*** **
Leather dressing, footwear etc. (19)	**-0.737*** **	**-0.687*** **
Wood & wood products etc. (20)	-0.285	**-0.414* **
Paper and paper products (21)	**-0.374* **	**-0.447** **
Publishing & printing (22)	**-0.342* **	**-0.495*** **
Chemicals & chemical products (24)	0.041	0.023
Rubber & plastics products (25)	0.147	0.113
Other non-metallic mineral products (26)	-0.305	**-0.452** **
Basic metals (27)	**1.141*** **	**0.793*** **
Fabricated metal products (28)	0.278	0.071
Machinery and equipment (29)	-0.136	-0.196
Office & computing machinery (30)	-0.161	**-0.610*** **
Electrical machinery and apparatus (31)	0.284	-0.018
Radio, TV & communication equipment (32)	-0.327	**-0.476*** **
Medical, precision & optical instruments (33)	**0.605** **	**0.662*** **
Motor vehicles (34)	-0.200	-0.173
Other transport equipment (35)	0.204	0.252
Furniture & other manufacturing (36)	-0.125	-0.269
Y^*_t	**2.272*** **	**2.211*** **
Constant	x	x
Individual FE	x	x
Time*Country FE	x	x
Observations	162,792	162,792
Obs. per country	13,566	13,566
R-squared	0.0780	0.0784

Note: This table shows the RER elasticity of each manufacturing sector of the sample. The variable description of rows 3-23 (column 1) indicates the individual sector dummy that is multiplied by RER. Please see Table 2 notes for more details.

The technological complexity of each sector is approximated by its average Product Complexity Index (PCI)[8] value from the year 2018. PCI values are available from the Atlas of Economic Complexity (2020) at a three-digit HS4 level. Using the HS Combined to ISIC Rev 3 concordance table from WITS (2020a), we construct a PCI value for each sector by averaging the PCI values of all products that comprise the respective sector. The seven sectors that have the highest PCI value are categorized in the high-technology sector group (Group H; values >0.50), the seven sectors with the lowest PCI value form the low-technology sector group (Group L; <0.15) and the remaining seven sectors are classified as the medium-technology sector group (Group M).[9]

In line with previous literature, Table 5 indicates that RER movements seem to affect mainly exports from low technology sectors in Latin America. While the BRER and the SBRER are significant at the 1%-level in the low-technology group, both are not significant in the medium- and high-technology sector groups. However, the results obtained from the two measures differ insofar as the coefficient size of the SBRER is nearly 50% larger than that of the BRER. To be more precise, the SBRER coefficient indicates that low technology sectors in Latin America have a RER export elasticity of 0.55 (i.e., a 10% depreciation leads to a 5.5% increase in exports), while the BRER suggests an elasticity of 0.37.

In general, all regression results show that the SBRER measure tends to reveal higher elasticities than the BRER measure. This finding is in accordance with the diverging RER elasticities reported by studies that use aggregate data versus those that use disaggregate data (i.e., firm-level studies tend to report higher RER elasticities than macrodata studies). Most importantly, only the SBRER measure has the expected effect in the baseline regression. Overall, these results indicate that it is important to consider cross-sectoral distinctions regarding trade partners and production costs when estimating RER export elasticities from a macroeconomic perspective.

[8] The PCI "ranks the diversity and sophistication of the productive know-how required to produce a product. Products with a high PCI value (the most complex products that only a few countries can produce) include electronics and chemicals. Products with a low PCI value (the least complex product that nearly all countries can produce) include raw materials and simple agricultural products" (Atlas of Economic Complexity, 2020).
[9] The average PCI values for each sector are the following: 18=-1.02; 15=-0.76; 19=-0.70; 16=-0.68; 20=-0.66; 17=-0.31; 36=0.01; 35=0.16; 27=0.26; 26=0.29; 21=0.38; 22=0.39; 25=0.43; 24=0.44; 28=0.50; 34=0.69; 32=0.77; 31=0.78; 30=0.84; 33=0.89; 29=0.96.

Table 5: RER export elasticities according to sectoral complexity

	(x) *BRER*	*(xi)* *SBRER*
Low-technology	**-0.371***** [0.000]	**-0.548***** [0.000]
Medium-technology	0.073 [0.502]	-0.038 [0.690]
High-technology	0.049 [0.648]	-0.134 [0.124]
Y^*_t	**2.272***** [0.000]	**2.214***** [0.000]
Constant	x	x
Individual FE	x	x
Time*Country FE	x	x
Observations	162,792	162,792
Obs. per country	13,566	13,566
R-squared	0.0769	0.0772

Note: This table shows the RER elasticity of sector groups according to their technological complexity. The variables low-, medium- and high-technology are sector dummies that are multiplied by the respective RER measure. Please see Table 2 notes for more details.

5. Conclusions

In this paper we have exploited the variations across manufacturing sectors to determine the importance of RER movements for Latin American manufacturing exports during 2001-2018. Our main finding is that it is important to account for cross-sector variations. The baseline regressions that use the REER and BRER as exchange rate measure show results that are contrary to the predictions of standard trade theories. When instead a measure is used that considers sectoral differences in terms of trade partners and cost evolutions (the SBRER), RER movements become a significant determinant of aggregate manufacturing exports with the expected sign. Moreover, the results indicate that the RER elasticities of exports from individual sectors and sector groups are distinct, and that the more refined SBRER is better suited than the BRER to reveal these distinctions. More specifically, in the Latin American case mainly low-technology exports are affected by RER movements.

These findings indicate that strong RER appreciations, for example due to positive commodity shocks, mainly limit the export growth of the regions labor-intensive manufacturing sectors, and thus only give partial support to the view that a competitive RER can be seen as effective industrial policy tool that fosters economic growth (see e.g., Eichengreen, 2007; Gala, 2007; Rodrik, 2008; Guzman et al, 2018; Bresser Pereira, 2020). To put it differently, when Latin American countries engage in exchange rate management, they have to be aware that this policy will affect individual sectors in distinct ways and will have only limited benefits for technologically complex sectors.

These insights can help policy makers to better identify if the potential benefits of establishing competitive RER outweigh the associated costs (such as increasing import prices and declining real wages). Considering the existing trade-offs, recent research recommends establishing a system of multiple effective exchange rates to target specific sectors (Guzman et al, 2018). While the implementation of multiple exchange rates seems challenging in practice, our findings might be helpful for countries that wish to implement such a policy.

Having said this, for policy purposes it would be important that future research corroborates our findings on a country level, given that our cross-country setting might obscure important distinctions between countries. Finally, it is important to note that the obtained results indicate that external demand is more important for the growth of Latin American manufacturing exports than RER movements. Hence, policy makers of the region should increase their efforts to develop strategies that enable firms to export to the largest economies in the world, given that these countries have large market potential.

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APPENDIX

Table A1: Overview of the PPI Data used for the calculation of the SBRER

ISO3	Used Price Index	Start	End	Divisions w/o Data	Source	Note
ARG	PPI-by division	2001	2018	30	Office for National Statistics (INDEC)	Missing division imputed with aggregate man. PPI
BEL	PPI-by division	2010	2018		Belgian statistical office (Statbel)	2001-2009 two-dig-level data imputed with IFS' PPI growth rate
	PPI-all commodities	2001	2009		International Financial Statistics (IFS)	
BOL	PPI-by division	2001	2014	20,22,26,29-35	Office for National Statistics (INE)	Missing divisions imputed with aggregate man. PPI; 2015-2018 imputed with IFS' CPI growth rate
	CPI	2015	2018		International Financial Statistics (IFS)	
BRA	PPI-by division	2009	2018		Office for National Statistics (IBGE)	2001-2008 two-dig-level data imputed with growth rate of IFS' PPI-AC
	PPI-all commodities	2001	2008		International Financial Statistics (IFS)	
CAN	PPI-by division	2001	2018	28,32	Statistics Canada (StatCan)	Missing divisions imputed with aggregate man. PPI
CHE	PPI-by division	2004	2018		Federal Statistical Office Switzerland	2001-2009 two-dig-level data imputed with IFS' PPI growth rate
	PPI-all commodities	2001	2004		International Financial Statistics (IFS)	
CHL	PPI-by division	2007	2018		Office for National Statistics (INE)	2001-2009 two-dig-level data imputed with aggregate man. PPI
	PPI aggregate manuf.	2001	2006			
CHN	PPI-by division	2012	2018		National Bureau of Statistics	2001-2011 two-dig-level data imputed with IFS' PPI growth rate
	PPI-all commodities	2001	2011		International Financial Statistics (IFS)	
COL	PPI-by division	2006	2018		Office for National Statistics (DANE)	2001-2011 two-dig-level data imputed with IFS' PPI growth rate
	PPI aggregate manuf.	2001	2005			
CRI	PPI-by division	2012	2018	16	Central Bank of Costa Rica	2001-2011 two-dig-level data imputed with IFS' PPI growth rate
	PPI-all commodities	2001	2011		International Financial Statistics (IFS)	
DEU	PPI-by division	2009	2018		Federal Statistical Office Germany	2001-2008 two-dig-level data imputed with IFS' PPI growth rate
	PPI-all commodities	2001	2008		International Financial Statistics (IFS)	
DOM	PPI-by division	2013	2018	32	Office for National Statistics (ONE)	Missing division imputed with aggregate man. PPI; 2001-2012 imputed with CPI growth rate
	CPI	2001	2012		Banco Central de Rep. Dominicana	
ECU	PPI-by division	2001	2018	32	Office for National Statistics (INEC)	Missing division imputed with aggregate man. PPI
ESP	PPI-by division	2001	2018		Instituto Nacional de Estadística (INE)	
FRA	PPI-by division	2001	2018	16	Office for National Statistics (INSEE)	Missing division imputed with aggregate man. PPI
GBR	PPI-by division	2001	2018		Office for National Statistics (ONS)	
GTM	CPI	2010	2018	all	Central Bank of Guatemala	Two-dig-level data imputed with CPI

HKG	PPI-by division	2005	2018	19,20,23-25,28-36	Census and Statistics Department	Missing divisions imputed with aggregate man. PPI; 2001-2004 imputed with CPI growth rate
	CPI	2001	2004		International Financial Statistics (IFS)	
HND	CPI	2001	2018	all	International Financial Statistics (IFS)	Two-dig-level data imputed with CPI
IDN	PPI aggregate manuf.	2010	2018		Badan Pusat Statistik	Two-dig-level data imputed with aggregate man. PPI & wholesale price data
	Wholesale price index	2001	2009		World Bank	
IND	Manufacturing PPI	2001	2018	all	Central Bank of India	Two-dig-level data imputed with aggregate man. PPI
ITA	PPI-by division	2001	2018	16	National Institute of Statistics	Missing division imputed with aggregate man. PPI
JPN	PPI-by division	2001	2018	16,19,22,33-34	Central Bank of Japan	Missing divisions imputed with aggregate man. PPI
KOR	PPI-by division	2001	2018	16,22,25,30-32,34,36	Central Bank of Korea	Missing divisions imputed with aggregate man. PPI
MEX	PPI-by division	2001	2018	21	Office for National Statistics (INEGI)	Missing division imputed with aggregate man. PPI
MYS	PPI-by division	2001	2016	16-22,25,27,28,30,32,34,36	Department of Statistics	Missing divisions imputed with aggregate man. PPI; 2017-2018 imputed with IFS' PPI growth rate
	PPI-all commodities	2017	2018		International Financial Statistics (IFS)	
NIC	PPI-by division	2006	2018	30,32	Central Bank of Nicaragua	Missing divisions imputed with aggregate man. PPI; 2001-2005 imputed with CPI growth rate
	CPI	2001	2005		International Financial Statistics (IFS)	
NLD	PPI-by division	2012	2018		Statistics Netherlands	2001-2011 two-dig-level data imputed with IFS' PPI growth rate
	PPI-all commodities	2001	2011		International Financial Statistics (IFS)	
PAN	PPI-by division	2016	2018	16, 23, 30 & 32	Office for National Statistics (INEC)	Missing divisions imputed with aggregate man. PPI; 2001-2015 imputed with WPI growth rate
	Wholesale price index	2001	2015		World Bank	
PER	Manufacturing PPI	2001	2018	15-36	Office for National Statistics (INEI)	Missing division imputed with aggregate man. PPI
PRY	PPI-all commodities	2001	2018	all	International Financial Statistics (IFS)	Two-dig-level data imputed with aggregate man. PPI
RUS	PPI aggregate manuf.	2001	2018	all	Federal State Statistic Service	Two-dig-level data imputed with aggregate man. PPI
SWE	PPI-by division	2001	2018		Statistics Sweden	
SGP	PPI-by division	2001	2018		Departament of Statistics	
SLV	Manufacturing PPI	2010	2017	15-36	Office for National Statistics	Missing divisions imputed with aggregate man. PPI; 2001-2009 & 2018 imputed with IFS' PPI growth rate
	PPI-all commodities	2001	2018		International Financial Statistics (IFS)	
THA	PPI-by division	2001	2018	36	Trade Policy and Strategy Office (TPSO)	Missing division imputed with aggregate man. PPI
URY	PPI-by division	2001	2018	29, 30, 32-33	Office for National Statistics	Missing division imputed with aggregate man. PPI
USA	PPI-by division	2001	2018		Bureau of Labor Statistics	
VNM	PPI-by division	2009	2018	32		Missing divisions imputed with aggregate man. PPI; 2001-2008 data imputed with aggregate man. PPI
	PPI aggregate manuf.	2009	2008		General Statistics Office of Vietnam	

Note: This table gives an overview of the used price indices and their data sources and describes any imputations that were necessary to have data for all years and sectors. The columns' start and end indicate the years for which the specific data is available.

Table A2: Concordance tables used to homogenize the PPI data

From	To	Country	Source
ISIC Rev. 4 NACE Rev. 2	ISIC Rev. 3	BEL, BRA, CHE, CRI, DEU, DOM, ECU, ESP, FRA, ITA, MYS, NLD, SWE, SGP, THA, VNM	United Nation Statistics Division
NAICS 2017	ISIC Rev. 4	CAN, USA	United States Census Bureau
CPA Rev. 2.1	ISIC Rev. 4	GBR	United Nation Statistics Division
HSIC V2.0	ISIC Rev. 4	HKG	United Nation Statistics Division
KSIC	ISIC Rev. 4	KOR	Korean Standard Statistical Classification
SCIAN 2013	ISIC Rev. 4	MEX	Instituto Nacional de Estadística y Geografía (INEGI)
JSIC Rev. 12	NACE Rev. 2	JPN	EuroStat - RAMON

Note: This table lists the concordance tables used to homogenize the PPI data. If one ISIC Rev. 3 division is equal to various divisions from the source nomenclature, the data are averaged (e.g., when transforming from ISIC Rev. 4 to Rev. 3, the PPI from division 15 is the average PPI from divisions 10-11 and 20 of Rev. 4).

Table A3: Phillips–Perron panel data unit root test statistics

	P	Z	L*	Pm
X_{sbt}	62,600 (0.00)	-125.3 (0.00)	-156.9 (0.00)	222.2 (0.00)
$SBRER_{sbt}$	23,300 (0.00)	-1.80 (0.04)	-7.97 (0.00)	20.98 (0.00)
	with demean option			
X_{sbt}	70,400 (0.00)	-141.8 (0.00)	-175.7 (0.00)	261.9 (0.00)
$SBRER_{sbt}$	24,600 (0.00)	-6.59 (0.00)	-12.3 (0.00)	28.0 (0.00)
	with time trend option			
X_{sbt}	61,700 (0.00)	-117.0 (0.00)	-150.1 (0.00)	217.2 (0.00)
$SBRER_{sbt}$	34,700 (0.00)	-34.6 (0.00)	-45.1 (0.00)	79.4 (0.00)

Note: This table shows the results of Fisher-type Phillips–Perron unit-root tests on X and SBRER (specifying one lag in the Stata command). With one exception, all tests reject the null hypothesis that all panels contain unit roots at the 1%-level (the respective p-values are listed in brackets).