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Current account and real exchange rate equilibrium: the case of manufacturing in Mexico, 2001-2019*

Equilíbrio em conta-corrente e câmbio real: o caso da manufatura no México, 2001-2019

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RESUMO: Neste artigo, seguimos Bresser-Pereira et al. (2021) e estimar para o México uma série da taxa de câmbio real (RER) que equilibra a conta-corrente do México para o período 2001q1-2019q4. Neste processo, levamos em consideração vários determinantes, incluindo variáveis de política e indicadores financeiros, a evolução dos termos de troca, bem como uma aproximação para os efeitos Balassa-Samuelson, entre outros. Nossos resultados mostram que na maior parte do período analisado houve uma tendência de tendência à supervalorização, com a TCR flutuando acima do seu nível de equilíbrio. Com métodos de cointegração e técnicas dinâmicas de mínimos quadrados ordinários (DOLS), examinamos os efeitos da desvalorização e desvalorização da taxa de câmbio na manufatura; desagregados em três setores: i) intensivos em tecnologia, ii) intensivos em recursos naturais e iii) atividades intensivas em mão de obra. No geral, nossos resultados indicam que a taxa de câmbio real tem uma influência significativa na taxa de expansão do PIB industrial real do México.
PALAVRAS-CHAVE: Equilíbrio cambial real; conta-corrente; atividade fabril; México.

ABSTRACT: In this paper, we follow Bresser-Pereira et al. (2021) and estimate for Mexico a a series of the real exchange rate (RER) that balances the current account for Mexico for the period 2001q1-2019q4. In this process we take into account numerous determinants, including policy variables and financial indicators the evolution of the terms of trade, as well as a proxi for the Balassa-Samuelson effects, inter alia. Our results show that in most of the period analyzed there has been a trend tendency towards overvaluation, with the RER fluctuating above its equilibrium level. With cointegrating methods, and dynamic ordinary least squared (DOLS) techniques, we examined the effects of exchange rate under

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and overvaluation on manufacturing; disaggregated in three sectors: i) technology intensive, ii) natural resource intensive and iii) labor intensive activities. Overall, our results indicate that the real exchange rate has a significant influence on the rate of expansion of Mexico's manufacturing real GDP.
KEYWORDS: Real exchange rate equilibrium; current account; manufacturing activity; Mexico.
JEL Classification: C22; E44; F31; O24.

INTRODUCTION

The Structuralist perspective[1] has put forward a number of relevant contributions on the role of the real exchange rate (RER) as a determinant of economic growth, both in the short run as well as in the long run. It argues that, in the short run, a real exchange rate depreciation – via a reduction in real wages and a regressive impact on the distribution of income – tends to slow down consumption and thus to reduce the rate of expansion of output. In the long run, however, a depreciated exchange rate tends to favor economic growth by stimulating the economy's international price competitiveness and, much more important, by boosting fixed capital formation and thus labor productivity in the tradeable sector vis-a-vis the non-tradeable one. In other words, from this perspective, a depreciated RER will favor a long-term transformation of economy's productive structure that is conducive to its more dynamic insertion in the global markets. This transformation will alleviate, if not altogether eliminate, the balance of payments' constraint on the domestic economy's long-term growth.

Ros (2015), and Frankel and Ros (2006) defined this process as the *development channel* of transmission of the effects of the real exchange rate on economic growth. In the analytical model they put forward, firms' profit margins are influenced by the evolution of the terms-of-trade and real wages. Assuming technological change to be endogenously determined – *à la Kaldor-Robinson* – they argue that currency depreciations tend to boost long-run profits through the rise in labor productivity. In the absence of such endogeneity, however, the exchange rate depreciations would be effective only in the short run, and not in the long run as workers' demand for higher wages will revert the movement in the real exchange rate.

The New Developmentalism (ND) School – represented by Bresser-Pereira, Oreiro, Marconi, Nassif, Gala, Araujo inter alia – has also made key contributions – theoretic al and empirical – to better understand the role of the RER in structural transformation and economic development. Among these contributions stand out the methodologies put forward to calculate the real exchange rate equilibria and, thus, to identify periods of over or undervaluation. The current account equi-

[1] See Frenkel and Ros (2006), Ros (2015), Rapetti (2009, 2012, 2013), Rapetti and Skott (2012), Razmi (2012), Oreiro and Sousa (2018), among others.

librium exchange rate is the level of RER that balances the country's current account of the balance of payments intertemporally (Bresser-Pereira, 2008).[2] In a similar line of research they introduced the notion of an "industrial-equilibrium real exchange rate" (Marconi, 2012; Bresser-Pereira, Oreiro and Marconi, 2014), defined as the, say, level of the real exchange rate required to promote net exports via a transformation of the productive structure.

ND stress that maintaining an overvalued real exchange rate – above its "equilibrium" level – tends to cause a *Dutch disease* cum premature deindustrialization in the economy. The overvaluation pushes investment to reallocate more to the non-tradable sectors – primary and services – than to the tradeable ones (Bresser-Pereira et al., forthcoming). And, the change in relative prices makes more attractive for local firms and household to buy foreign goods and services instead of domestic ones. Ros and Skott (1998) examine the phenomenon of premature deindustrialization in developing countries associated with trade liberalization cum massive foreign capital inflows that lead to a real exchange rate overvaluation. There is a vast literature on the impact of terms-of-trade booms – and recently on financiarization – on exchange rate the overvaluation. See inter alia Ros (2015) and Botta (2017).

Oreiro (2009) and Santana and Oreiro (2018) integrate the ND approach with the Kaldorian one and build an analytical model with the following characteristics: i) it recognizes the weight of the balance of payments constraint on domestic economic expansion; ii) it incorporates a transmission mechanism between movements in the real exchange rate and the economy's long-run rate of expansion, and iii) it includes the Kaldor-Verdoorn insights to capture the sensitivity of labor productivity to economic growth. Their model emphasizes the transmission channel of monetary policy via the exchange rate and concludes that a higher inflation target would tend to depreciate the currency in relation to the "industrial equilibrium level" and would thus stimulate fixed capital accumulation and higher economic growth.

Ribeiro, McCombie, and Lima (2017), based on a post-Keynesian-Kaleckian model on a balance-of-payments constrained economy, arrive at somewhat different conclusions.They argue that currency depreciations make imported intermediate inputs more expensive and, thus, deteriorate the industry's price competitiveness. At the same time, following Diaz-Alejandro (1963) and Krugman and Taylor (1979), they stress that depreciations tend to redistribute income from wages to profits and argue that the effect of exchange rate depreciations on consumption is ambiguous, and ultimately depends on the relative propensities to consume of workers and of entrepreneurs. They conclude that depreciations tend to have recessive effects on economic growth but favorable ones on net exports of goods and services.

Razmi (2012), on his analysis of policies to accompany exchange rate depreciations, suggests a freeze of manufacturing wages (in real terms) in the short term, so that companies benefit from higher external demand without generating neither

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[2] Whether it does so at a socially acceptable rate of long-run economic growth is a question that must be carefully analyzed in every case.

a redistributive conflict nor a decline in private consumption. Rapetti (2012) arrives to similar proposal and recommends accompanying exchange rate depreciations with demand policies to prevent price increases in the non-tradable sectors and to coordinate wage increases in line with productivity gains.

From an empirical point of view, there is extensive research on the effect of the real exchange rate on different macroeconomic variables. It is fair to say that with Rodrik (2008), a renewed interest in the subject arose, and soon after empirical works on this issue proliferated. Numerous authors replicated Rodrik's study and concluded that a depreciated real exchange rate is positive for economic growth, especially for developing countries. In this regard, Razmi et al. (2012), Levy-Yeyati and Sturzenegger (2007), Rapetti et al. (2009), Ros (2015), Ibarra (2011, 2015) stress the importance of the "investment channel". Eichengreen (2007) and Ros and Frenkel (2006) find evidence of a positive relationship between a depreciated real exchange rate and a higher rate of expansion of employment. Aguirre and Calderon (2005), and Razin and Collins (1997) find that, although the above-mentioned effect is positive, it is not linear and above certain levels of undervaluation it becomes negative.

It is important to note that although many authors recognize the importance of structural change on these matters, the notion or definition of it is not always the same. For example, Mcmillan and Rodrik (2011) define it as the, say, residual of total labor productivity growth due to the reallocation of labor from traditional to modern sectors. Freund and Pierola (2012) link such change to the diversification of exports. Cimoli et al. (2013) focus instead on the technological intensity of products sold abroad. On this matter, Caglayan and Demir (2019) find that the RER positively affects activities with medium-low skill level, but those of high skill level are less responsive. In contrast, Agosin et al. (2011) find no such relationship, besides a negative impact of the volatility of the RER on export diversification.

Among developing countries, Mexico is an interesting case, with an abundance of empirical studies already carried out on the relation between RER and economic growth. Karmin and Rogers (1997), López et al. (2011), and Blecker (2009), focusing on the Mexican case, find a negative relationship between exchange rate depreciation and output growth.[3] On the other hand, Ros, (2008, 2016), Ibarra (2008, 2015), Garcés, (2002) and Caglayan and Torres, (2011) fin evidence for the Mexican that an exchange rate undervaluation has a positive effect on investment and economic growth.

Rodrik (2008) refers to Mexico as an anomaly, especially since 1981, when the correlation between growth and undervaluation became a negative one and suggests that such behavior may perhaps reflect the influence of short-term capital inflows on output growth. He finds an association between periods of capital inflows with currency appreciations and consumption-driven growth booms. Conversely, when capital flows reverse, the currency depreciates, economic activity slows down

[3] However, the econometric technique they used cannot adequately capture long-run relationships.

and may even contract. In a sense, Rodrik (2008) identified the volatility and size of financial flows as a major challenge to the implementation of exchange rate policies to foster economic growth in the country.

In line with this view, Nalin and Yajima (2020a and 2020b) argue that an essential element for Mexico is the negative net foreign exchange rate position of the non-financial sector due to the outstanding issuance of foreign debt. It actually increased virtually at an exponential pace in the context of the low-interest-rates experienced since the end of the international financial crisis of 2009-2010. They argue that an exchange rate depreciation promotes fixed capital accumulation and structural change but only under very specific conditions. They arrive to the important policy recommendation that the financial cost of exchange rate acute and drastic swings on the private sector's balance sheet should be carefully monitored and contained.

Abounding on this topic, the objective of this paper is to examine the effect of the exchange rate on Mexico's economic growth. We do so from the perspective of the RER equilibrium, explained above. The first step was to estimate the current account exchange rate equilibrium for the Mexican economy during 2001-2019 with the ND methodology (Bresser-Pereira et al, 2021). The next one was to identify the RER deviations from such equilibrium level. The last task was to estimate the impact of real exchange rate misalignment on Mexico's manufacturing dynamics, distinguishing three sectors in it according to the factor intensity of their production processes: i) intensive in technology, ii) intensive in natural resources, and iii) intensive in labor.

The work is divided as follows. After this introduction the second section presents the results of our calculations of Mexico's current account equilibrium exchange rate. The following section identifies the periods of RER misalignment to proceed in section four to estimate the impact of such misalignment on manufacturing activity. Section five goes on to estimate the long-run relationship between exchange rate misalignments and manufacturing and, finally, section six puts forward the conclusions.

MEXICO: CURRENT ACCOUNT EQUILIBRIUM EXCHANGE RATE: AN EMPIRICAL ANALYSIS

The current account equilibrium exchange rate, as explained above, is defined as the level of the real exchange rate that, say, guarantees that the current account is balanced in an intertemporal perspective. In brief, this methodology relies in estimating a vector error correction model to calculate the long-term relationship between the real exchange rate and a set of determinants that includes proxis of the economy's structural characteristics, policy instruments and financial variables. Following Bresser-Pereira et al. (2020), we selected five determinants for the calculation of the Current Account Equilibrium Exchange Rate (REER_CA) in Mexico:

$$REEER\_CA = l\left(RER, \underset{-}{TOT}, \underset{+}{CA}, \underset{-/+}{IDIF}, \underset{+}{EMBI}, \underset{-}{TNT}\right) \quad (1)$$

Where,

- *RER* is the log of the real exchange rate rate vis-à-vis with a basket of 111 commercial partners calculated by the Bank of Mexico.
- *TOT* is the logarithm of the terms of trade. We expect improvements in *TOT* to appreciate *RER*. Higher *TOT* leads to a higher level of income and pressure on non-tradable prices. Data is available in the international trade statistics of the Bank of Mexico.
- *CA* is the logarithm of the monotonic transformation of the current account to GDP so that the figure is always positive. We expect a positive association between *RER* and *CA*. In the long run, a higher (more depreciated) real exchange rate should increase competitiveness and generate an import-substitution effect, and thus reduce the current account deficit. Data are available in the Bank of Mexico Balance of Payment Statistics.
- *IDIF* is the logarithm of the one-year nominal interest rate differential between Mexico and the United States. Higher *IDIF* should attract foreign capital and thus tend to appreciate the currency. However, the sign may be negative if the, say, *fear of floating* effect prevails (Calvo & Reinhart, 2002). Data is obtained from the BIS Central Bank Policy Rate Database.
- *EMBI* is the logarithm of the Emerging Market Bond Index, a proxy for the country's risk premium. Higher *EMBI* should tend to be associated with a depreciation of the *RER* due to domestic assets selloffs, typical of periods of great uncertainty.
- *TNT* :is the logarithm of the ratio of relative prices of tradable to non-tradable goods in Mexico and United States, a proxy used to account for the Balassa-Samuelson effect. The construction of the index follows MacDonald (1999) and represents the relationship between the consumer price index (*CPI*) and the producer price index (*PPI*) for the domestic country (Mexico) and the foreign country (United States). The *CPI* index measures the evolution of non-tradable prices of countries as it mainly accounts for prices of services and goods traded domestically. Conversely, the *PPI* index approximates the evolution of tradable goods used by the industrial sector. That is:

$$TNT = \frac{IPC_t/IPP_t}{IPC_t^*/IPP_t^*} \quad (2)$$

The asterisk refers to United States variables. An increase in the TNT index indicates an increase in the ratio of the prices of non-tradable vis--à-vis tradeable goods in Mexico relative to the corresponding ratio in the United States. We expect the index to show a negative correlation with the*RER*.

Econometric Estimation of the Current Account Equilibrium Exchange Rate

We apply Johansen's (1999) cointegration techniques to the set of data above described. The first step is to verify that all variables are not stationary in their mean and variance (Enders, 2012). We perform the canonical Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results are reported in the Annex showing that all variables are I(1) processes; thus we can continue with the subsequent steps of the cointegration estimation of the VECM. The estimated coefficients are reported in equation 3.

$$\begin{aligned} RER = {} & 6.23 + 0.004 * trend - \underset{(-2.42)}{0.536 * TOT_t} - \underset{(1.08)}{0.30 * TNT_t} \\ (t) & \\ & + \underset{(1.67)}{4.14 * CA} - \underset{(-3.19)}{0.21 * IDIF} + \underset{(0.77)}{0.08 * EMBI} + e_t \\ ECM = {} & -0.32, \quad t = -4.67 \end{aligned} \tag{3}$$

The Eigenvalue Rank Test for (3) indicates the existence of one cointegrated vector, in other words, it identifies a long-term relationship among the set of variables considered in the RER model. The estimated error correction mechanism (*ECM*) is negative and statistically significant, thus implying convergence over the long run. Note that the magnitude of the *ECM* (-0.32) suggests that the convergence process occurs slowly over time.

According to the Residual Serial Correlation LM test, error terms from equation (3) are not serially correlated. Additionally, the White test for heteroscedasticity fails to reject the null hypothesis of homoscedasticity in the residuals, while the Lutkepohl test shows residuals distribute normally. We can conclude that, from a merely statistical perspective, equation (3) is correctly specified. We proceed to analyze the economic meaning of its estimates.

As identified by the ND theoretical framework, the current account balance (as % of GDP) is reported to have a robust long-run, positive association with RER. Its estimated coefficient – incidentally the largest of all – is statistically significant at the 10% level. This result suggests that a real exchange rate undervaluation tends to be associated with a long-run improvement in the current account (as % of GDP).

TOT also has a significant relationship with the RER. An increase in it (an improvement) is linked to an appreciation of the RER over the long-run. As expected, the coefficient is negative, highly significant, and shows that an increase of 10% in TOT generates a RER appreciation of 5.36% over the long run. The coefficient estimated for the one-year nominal interest rate differential is negative and statistically significant; a sing that its ability to attract foreign capital to the domestic bond market tends to appreciate the RER.[4] The sign of the TNT coefficient is

[4] As Gallagher (2012) argued, higher yields and the opportunity to gain from carry-trade operations attract international investors to the financial markets of emerging economies.

negative and not statistically significant, suggesting that the Balassa-Samuelson effect has no relevant impact on the RER in the Mexican case. The same happens with the coefficient of the EMBI; it is positive, as expected, but not statistically significant.

Results from Impulse-Response (IRs) analysis – calculated over twenty quarters – see Annex – are consistent with the signs of the estimated coefficients for equation (3), that is:

- Current account is positively associated with RER; and it takes five quarters for a RER depreciation to improve net trade.
- Increases in TOT and IDIF appreciate RER and the response suggests that shocks in any of these two variables may have a long-lasting effect (hysteresis) on the RER.
- Higher EMBI is associated with a depreciation of the exchange rate
- IRs for the Balassa-Samuelson Index are inconclusive; a result totally compatible with the statistical non-significance of the estimated parameter.

As argued in Bresser-Pereira et al. (2021), the current account equilibrium real exchange rate is the one in which the current account is in equilibrium (neither surplus nor deficit). To estimate such equilibrium, *REER_CA*, the parameters estimated in (3) need to be multiplied by the long-run component of the observed data. In this regard, we follow Bresser-Pereira et al. (2020) and apply the Hodrick-Prescott filter to identify the transitory and the permanent components. Multiplying the permanent component of the explanatory variables by the vector of estimated parameters obtained in equation 3 leads to the REER_CA estimations.

THE TENDENCY TOWARDS OVERVALUATION

As Figure 1 reports, the estimated current account exchange rate equilibrium, REER_CA, follows an overall upward trend throughout the period of analysis. This result suggests that, in order to balance its current account, Mexico has needed a persistent exchange rate depreciation. Note, however, that this upward trend is interrupted by periods of, say, stabilization. Indeed, the upward shift from 2000 to 2006 was followed by six years of stabilization, 2006-2012. After 2012, there is another sharp upward adjustment followed again by a phase of rather constant behavior from 2015 onwards.

The observed REER series does not show such clear upward trend. On the contrary, its trajectory reveals sharp depreciations –associated with macro-financial turmoil – followed by phases of sustained appreciation. The magnitude of misalignment becomes important.

Figure 1: Mexico: observed and current account equilibrium exchange rate: 2000 - 2019

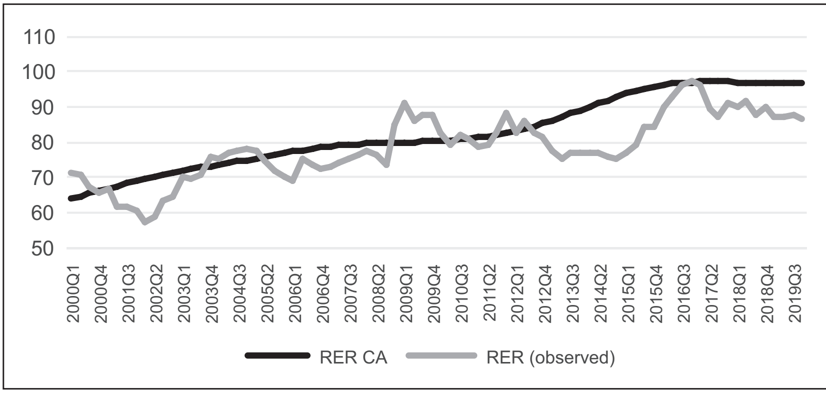
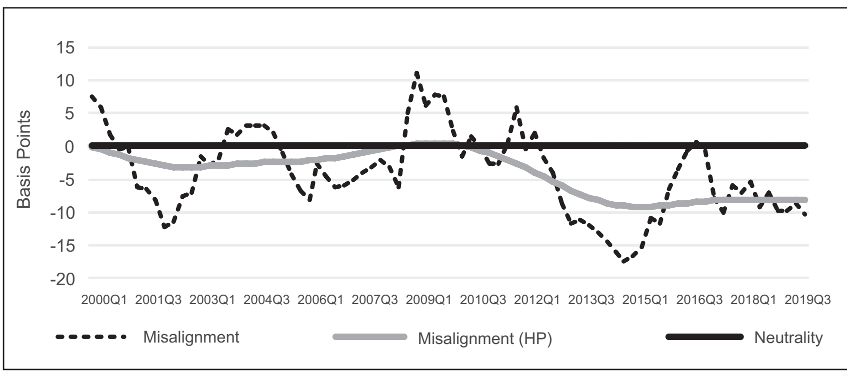


Figure 2: Mexico: Real exchange rate misalignments, 2000 -2019 (basis points relative to the RER equilibrium level)



Source: Authors'own elaboration.

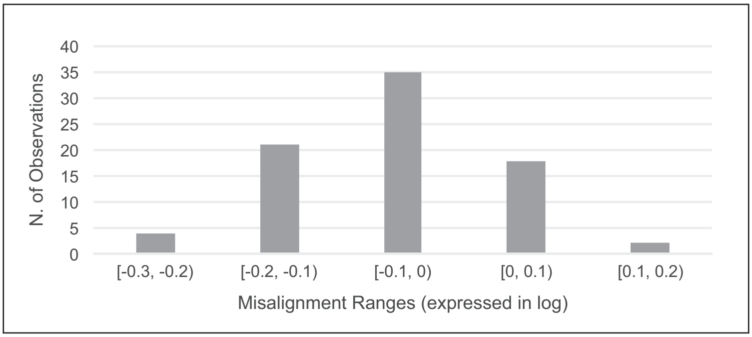
Misalignments are defined as the difference between the actual value of the real exchange rate and its current account equilibrium value. Negative misalignments correspond to periods of overvaluation; positive ones to periods of undervaluation. Figure 2 shows that the Mexican Peso remained overvalued for: 2000q4-2003q3, 2005q2-2008q3, and 2012q3-2019q4. On the contrary, periods of overvaluation are less frequent and rather shorter: 2003q4-2005q1 and 2008q4-2010q4.

Overall, for the 80 quarters analyzed, only 20 can be classified as periods of undervaluation. The misalignment frequency distribution is reported in Figure 3 and confirms the tendency or pattern in Mexico of the real exchange rate towards overvaluation. Indeed, data distributes normally around the interval 0-0.1.[5] The cumula-

[5] According to Jarque Bera test whose p-value is 0.53 and thus rejects the null hypothesis of non-normal distribution for misalignments.

tive distribution reveals that in 75% of time period here analyzed, the misalignment was in the interval (-0.2, 0), i.e., in a range of overvaluation. This conclusion is supported too by the long-run misalignment trajectory (obtained applying an HP filter).

Figure 3: Mexico: Real Exchange Rate Misalignment
Frequency Distribution 2000 - 2019



Source: Authors own elaboration.

Historical evidence reveals a tendency of the RER to an overvaluation in Mexico. After the banking crisis experienced in 1994, Mexico adopted a floating exchange rate regime; this shift coincided with the sign of the NAFTA agreement (now USMXCA) that favored trade and financial openness. As a result, capital inflows to Mexico increased exponentially. In 2001, Banco de Mexico adopted an inflation-targeting regime that until very recently still prevailed. The combination of sticky prices, a floating exchange rate, increased trade and a massive, much more conspicuous short term financial inflows led to a nominal – and real – exchange rate appreciation.

The RER appreciated around 60% from March 1995 to March 2001. Linked to the turmoil of the 9-11 events in 2001 in the oil markets and in world trade, Mexico entered into a recession from 2001 to 2003. The Mexican Peso remained overvalued until the Great Financial Crisis (GFC). Internationally very ample liquidity conditions were behind the further overvaluation of the peso in the aftermath of the GFC. With the first signs of the Great Moderation, the Fed began an expansionary monetary policy cycle. It lowered the interest rate from 5% to 0.25% in less than two years, from mid-2007 to the end of 2008. The near-zero interest level remained unchanged for eight years until December 2016. As the Bank for International Settlements has argued, the low-interest rate environment created the incentive for non-financial firms in developing countries to finance their activities through international debt; among them Mexico who experienced a spectacular rise in capital inflow that appreciated its currency.[6]

The world economy suffered two major shocks in 2014-16. On the one hand, the price of oil collapsed from US$112 a barrel in September 2014 to US$31 in

[6] See BIS (2016 and 2020).

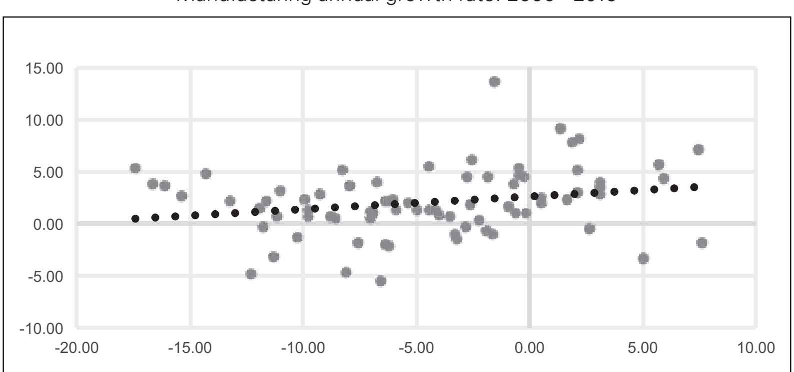
January 2016 due to lower global demand (Gruss, 2014). On the other, we have the impressive technological advances of the "Shell revolution" in the United States (Raimi, 2017). In 2016, the Fed started an interest rate hike cycle that lasted until 2019 that brought the one-year nominal rate from 0.25% to 2.3%. In this context, Mexico's TOT fell by 32% by January 2016, and short-term capital outflows adversely marked Mexico's, and other emerging markets, balance of payments. Mexico's RER depreciated 25% from 2014 to 2016; by the end of the year, it was close to its current account equilibrium level. From January 2017, the nominal depreciation and its pass-through started to push up domestic prices. By December, annual inflation as measured by the consumer price index reached 6.6%; two percentage points above the central bank's upper bound target. In this process, the RER appreciated, shifting away, once again, from its current account equilibrium level.

MISALIGNMENT AND MANUFACTURING ACTIVITY

In this section we analyze the effects of currency misalignment on Mexico's manufacturing activity, based on the notion that the evolution of the relative prices of tradeable /non-tradeable goods and services has an impact on manufacturing. In particular, it may be a factor stimulating or discouraging exports, import substitution and, most important in a long-term perspective, investment. This latter impact, thus, may promote or hinder a structural change conducive to an alleviation of the balance of payments constraint.

Figure 4's scatter plot illustrates, for the Mexican case, the correlation between RER misalignment and manufacturing output. It suggests the existence of a positive correlation between them, in other words it suggests that a undervalued exchange rate is positively associated with more dynamic manufacturing activity.

Figure 4: Mexico: Exchange Rate Misalignment and Manufacturing annual growth rate: 2000 - 2019



Note: Shifts to the right in the X" axis reflect a movement towards an overvaluation; and vice versa; Source: own elaboration based on our econometric calculations of RER and on data from INEGI Manufacturing Statistics (2021).

Table 1 presents statistical indicators of the evolution of the index of manufacturing activity disaggregated, following Araujo and Peres (2018), in three broad sectors: tech and large-scale intensive, dependent on natural resources, and labor-intensive. Different from Araujo and Peres (2018), our classification for tech-intensive also includes sectors classified as having significant economies of scale – for example, the automotive industry.

Table 1: Mexico: RER Misalignment and Manufacturing Output: 2000q1-2019q4

		Tech intensive & Economy of Scale		Natural resources		Labor Intensive	
Misalignment	#Obs.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
[-15, – 5)	33	-0.64	4.29	0.24	2.08	-2.02	4.02
[-5, 0)	23	3.24	5.34	1.12	2.02	-1.16	4
[0, 5)	13	3.98	5.34	1.95	2.79	1.41	4.45
[5, 10)	6	2.55	7.97	-0.68	5.44	-1.08	5.81
All	75	1.58	5.51	0.63	2.86	-0.96	4.46

Note: we define overvaluation as exchange rate misalignment that falls within the range [-15, – 5); Close to equilibrium where it lies within [-5, 5); and undervalued when the misalignment is equal or greater than 5. Source: Authors' own elaboration with data from INEGI Manufacturing Survey (2021).

For each of the three groups of manufacturing in Mexico, Table 1 reports the mean and standard deviations of the annual growth rate of output (as measured by INEGI's index) for different misalignment ranges. Recall that ranges with negative (positive) values are associated with period of overvaluation (undervaluation). The [-5, 0) and [0, 5) are identified as periods when the real exchange rate was close to its current account equilibrium level.

The dynamism of each sector when the currency is overvalued is far from homogenous. Industries linked to natural resources report positive growth of output. The weighted average for the two ranges is 0.28%, supporting the ND view that overvaluation tends to favor agricultural and mining activities. However, for technological intensive sectors, the association with overvaluation reports a negative sign – the weighted average of annual growth drops to – 1.62%, thus suggesting that an appreciated real exchange rate undermines high-tech capital-intensive sectors as documented in the literature on premature industrialization (Bresser-Pereira 2008; Rodrik, 2016; Botta et al., 2021, Cruz, 2015). An appreciated exchange rate favors imports of capital goods as well as investment in non-tradable sectors but makes exports more expensive. As a result, when currency appreciation persists over time activity in technological sectors relatively slows down.

The weighted average of the annual growth rate of labor-intensive activities is also negative (-1.90%) in periods when the RER is overvalued. Such appreciation tends to increase real wages and reduce the profit margin for labor-intensive industries (Ros, 2015). Therefore, in such cases, their activity may tend to decline and investing in them becomes less attractive.

Dynamism of manufacturing is higher in periods when the RER is close to its current account equilibrium level. Indeed, ranges [-5, 0) and [0, 5) report higher growth rates in each of the three sectors. Moreover, in the "undervalued" portion of this range [0, 5), manufacturing has an even better performance in the three sectors. Indeed, for tech-intensive sectors it raises from 3.24 to 3.98%. For natural resource intensive ones it increases from 1.12 to 1.95%.

When the misalignment is over and above 5, i.e., when the currency is highly undervalued, way beyond its historical standards, the activity in industries intensive in natural resource or in and labor falls even faster. We try to explain these results in two ways. First, sectors with a key dependence on natural resources, say oil extraction, tend to be highly indebted in foreign currency.[7] For them, small depreciations are not a source of concern as hedging practices generally cover their foreign FX position. But large ones, above a certain threshold, forces leveraged firms to pay margin calls, usually expensive. Second, acute depreciations constrain the import of capital goods and thus may block expansion plans (Nalin and Yajima, 2021). In other words, financial and, say, structural constraints affect the relationship between undervaluation and manufacturing activity and may make it far from linear. A similar explanation may also apply to understand the performance of tech-intensive sectors, as they register lower – bit still positive – growth rates in the overvalued range [-15, – 5).

All in all, we conclude that misalignment ranges not too far away from the equilibrium level, that is within either [-5, 0) or [0, 5) show more dynamic manufacturing activity than periods with highly overvalued or highly undervalued RERs. Even so, the performance is more dynamic in the slightly depreciated range, [0, 5).

Figure 5 illustrates the evolution of Mexico's RER misalignment in 2000-2019, emphasizing the overvaluation ranges associated with lower manufacturing growth. For the sake of simplicity, we subdivide the period of analysis in three long phases that we nominate according to the variable or policy tools whose evolution we find most important in each period.

Inflation 2000-2009. When domestic tradable prices rise, the real exchange rate appreciates and the loss of international competitiveness hurts manufacturing activity. While the average inflation for the period 2000-2019 is 4.6%, from 2000q1 to 2001q4 it was 7.95%. As a result, the average RER misalignment was – 8.44, falling in the highly overvalued range. In the second half of 2017, the overshoot of the exchange rate associated with the turmoil of the tortuous beginning of NAFTA renegotiations helped inflation to rise to an annual average of 6.45%, and the misalignment of RER from the current account equilibrium averaged – 7.99%.

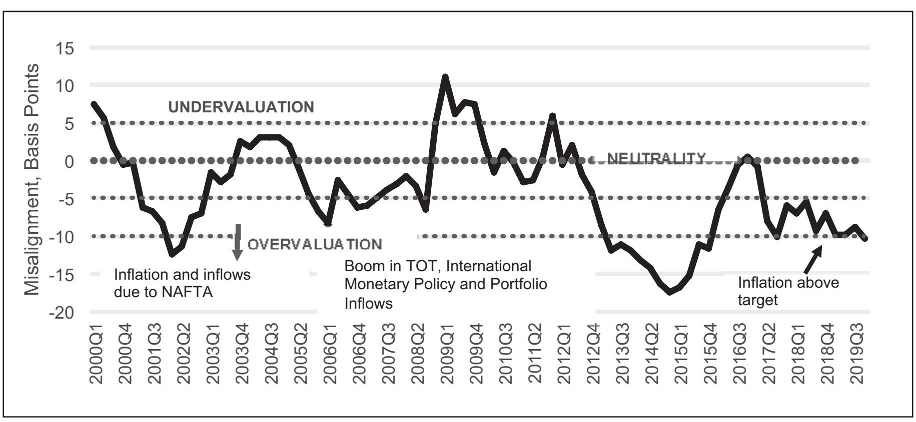
Trade Policy and Foreign Direct Investment. Let us first recall that in the end of 1994 just after the launch of NAFTA, Mexico suffered a huge balance of payments crisis – a.k.a. the Tequila Crisis. Among the macro policies applied to face it

[7] For Mexico, the case of Pemex, the state-owned oil company, is well known for the rapid increase in leverage in foreign currency that has marked its evolution for quite a long time.

was a huge depreciation of the Mexican peso vis a vis the US dollar. Helped by a massive rescue package from the US, stabilization soon ensued. This episode was followed, as in previous crisis, by a tendency towards an appreciation of the RER. Indeed, from 1996 to 2002, the Mexican Peso appreciated in nominal and real terms, which ultimately brough about a misalignment. Indeed, from 2001q2 to 2002q4, the RER misalignment averaged – 12.06 basis points relative to its equilibrium level. As argued by Ibarra (2011) and Cruz (2015), Mexico's persistent tendency towards RER appreciation is an element behind the economy's premature deindustrialization.

Monetary Policy and capital flows: As is well argued in the theoretical and documented in the empirical literature, booms in FDI or in short term capital inflows may trigger – à la Dutch disease – acute and long-standing episodes of currency overvaluation. In the Mexican case, these events marked the period from 2012q4 to 2014q4. In the aftermath of the great financial crisis, the ultra-expansionary monetary policies pursued by central banks worldwide created a macro-financial environment with abundant liquidity; Part of this inevitably "flew" to emerging economies, such as Mexico. The massive foreign capital inflows, in search of higher yields in domestic securities, tended to appreciate the peso in nominal terms and cause a misalignment of the RER of – 12.06 basis points from its equilibrium level. However, Hawkish monetary in developed countries in 2013 and Mexico's Central Bank's response concurred to generate an adjustment in RER, which depreciated 27 percent from September 2014 to January 2016 and reduced the misalignment practically to zero.

Figure 5: Mexico, Degree of Real Exchange Rate Misalignment: 2000-2019



Note: Upward (downward) movements represent depreciation (appreciation).
Source: Authors' own calculation.

The analysis so far reported underlines the challenge for Mexico's policymakers to maintain a stable, equilibrated RER. Clearly, if Mexico wants to boost its manufacturing activity, exchange rate policy becomes crucial. Certainly, any such attempts would need to be supported by policy tools to manage foreign capital flows and limit systemic financial vulnerabilities.

ECONOMETRIC ANALYSIS

We test econometrically the long-term relationship between RER misalignment – in particular overvaluation – and economic growth of the three manufacturing sectors identified above. We adopted the dynamic ordinary least square (DOLS) cointegration methodology put forward by Durbin and Watson (1993).[8] The model specification chosen includes the manufacturing activity index, the RER misalignment from its current account equilibrium level, and a general economic activity indicator (IGAE) used as a proxy for the overall dynamism of the Mexican economy. Additionally, we include the interaction between the RER misalignment and a dummy variable that takes the value of 1 when MIS<0 and 0 otherwise; thus, it captures the effect of currency overvaluation, and we expect a negative coefficient for it.

Before testing the long-run relationship, we confirmed the presence of a unit root process in all variables under scrutiny (see Annex). Results from unit root tests indicate that all the series under study are unit root non-stationary. We then proceeded to estimate the following dynamic OLS system:

$$\boldsymbol{lnMANUF_i = \beta_0 + t + t^2 + \beta_1 lnIGAE + \beta_2 lnMIS + \beta_3 lnMIS * OVERVAL + \sum_{j=-q}^{p} dlnIGAE_{t-j} + \sum_{j=-q}^{p} dlnMIS_{t-j} + u_t} \quad (4)$$

Leads and lags of the differences of the independent variables do not have a direct interpretation. The importance of including them lies in the fact that they eliminate the effects of the short-run dynamics of the errors on the long-run estimators.

According to Ros and Frenkel (2006), positive spillovers effects of the real exchange rate on economic activity are not immediate and can take up to two years to manifest. Thus, following their insight and empirical findings for Mexico, we arbitrarily include eight quarters of lags in our estimation, while we consider only a one-period lead (but we test up to four leads, and results do not change). We include two stochastic trends (linear and nonlinear) and a dummy for each estimation to address correct specification issues.[9] Table 2 shows DOLS estimation results:

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[8] It addresses the problem of endogeneity of the regressors and of autocorrelation of the residuals, through the inclusion of differences of the regressors to correct the former, and of advances and lags of the differences to correct the latter.

[9] Dummy TI: 2004q2, 2005q4, 2006q2, 2017q1; Dummy RI: 2011q4, 2015q3, 2017q3, 2019q2 2015q4; Dummy LI 2002q2, 2012q3, 2014q3, 2016q1.

Table 2: Mexico: Growth of Manufacturing, Cointegration Results
Determinants of $lnMANUF_i$, 2001.01-2019.12

Variable	Tech-Intensive	Natural Resources	Labor Intensive
β_0	-3.496 ***	-1.950 ***	-1.685
t	-0.014 ***	-0.005 ***	-0.012 ***
t^2	0.00006 ***	-0.00001***	0.00002 ***
$lnIGAE$	1.915 ***	1.513 ***	1.524 ***
$lnMIS$	0.399 ***	0.214 ***	0.554 ***
$lnMIS * OVERVAL$	-0.284 ***	-0.267 ***	-0.658 ***
$Dummy$	0.027 ***	0.022 ***	0.045 ***
	Cointegration Test		
$Engel - Granger$	-4.804 (0.04)	-4.941 (0.03)	-3.973 (0.20)
$Phillips - Ouliaris$	-4.875 (0.03)	-4.924 (0.03)	-4.120 (0.16)
$Hansen$	0.005 (p > 0.2)	0.037 (p > 0.2)	0.029 (p > 0.2)
	Correct Specification Tests		
R^2	0.985	0.995	0.906
F	109.76(0.00)	215.6 (0.00)	15.5 (0.00)
Jarque-Bera	1.64 (0.44)	0.37 (0.83)	0.31 (0.87)
LM(4)	0.52 (0.72)	0.74 (0.57)	1.93 (0.12)
Breusch-Pagan-Godfrey	0.739	0.328	0.817
Reset(1)	0.58 (0.57)	1.27 (0.21)	1.72 (0.09)

Note: *** 1% level of significance; ** 5% level of significance; * 10% level of significance.

For Engel-Granger (EG) and Phillips-Ouliars (PO) test we report the Tau Statistic and its associated p-value in parentheses. For Hansen Instability (HI) test we report the Lc statistic. For the Breusch-Pagan-Godfrey heteroskedasticity test we report the F-Statistic. For the Breusch-Godfrey Serial Correlation LM Test we report the F-Statistic and its associated p-value in parentheses. For the Ramsey RESET Test we report the t-statistics and its associated p-value.

The tests to validate the existence of a cointegration relationship among our set of variables gave the following results. For TI and NR sectors, the three tests (EG, PO, and HI) confirm that residuals are stationary, thus confirming the existence of a cointegration vector between the variables. For LI sectors, the HI test confirms the existence of cointegration, while EG and PO reject the hypothesis. In this case, we further explored the hypothesis by testing the stationarity of the residuals through PP and ADF tests, These two additional tests indicated the residuals to be I(0), thus giving support to the results from the HI test for the existence of cointegration. We investigated the correct specification of the three models and conclude that residuals are normally distributed, do not present autocorrelation, and are homoscedastic. Also, the RESET test confirms that a nonlinear combination of the explanatory variables does not improve the explanatory power of the models.

Estimation results show that the overall dynamism of the economy, proxied by the IGAE index, is statistically significant in each regression. TI sectors present the highest elasticity to IGAE; a 1.915% increase in technological intensive activity follows a one percent increase in the IGAE index. The elasticity to IGAE for NR and LI sectors is lower in both cases.

The coefficient for MIS is positive and statistically significant in each regression, showing that undervaluation has a positive effect *per se* on manufacturing activity. However, its impact varies according from sector to sector, as expected. NR sector shows the lowest impact of MIS, with an elasticity of 0.214%. Nevertheless, its effect almost doubled for TI sectors with a coefficient of 0.399%, showing the critical role of RER misalignment in promoting investment in technological activities. In labor-intensive sectors, the coefficient raises further to 0.554%; linked to the central role of real wages in Mexican manufacturing activity.

The effect of MIS on manufacturing activity is not linear, however. When focusing on the effect of overvaluation, the elasticity of manufacturing activity to MIS turns negative. The overvaluation coefficient – captured by the interaction of MIS with a dummy variable that accounts for periods of negative misalignment – is indeed negative and statistically significant in each regression reported in Table 2. An excessive appreciated currency contracts manufacturing activity in each sector. Once again, the magnitude of the effect depends upon the sector under investigation. When overvaluation takes place, real wages are higher, and, as a result, labor-intensive activity shows the highest elasticity to overvaluation. The effect drops acutely when focusing on the other two sectors, which indeed shows similar coefficients. For NR activities, the elasticity is 0.27%, and in TI industries 0.28%.

CONCLUSION

In the present work, we tested the Neo Developmentalist hypothesis that real exchange rate misalignments from their current-account equilibrium level do matter for manufacturing activity. On the one hand, we constructed a series of the RER rate current account equilibrium level; that is, the real exchange rate level that balances the CA intertemporally. To do so, we followed the methodology put forward by Bresser-Pereira et al. (2021). For the Mexican case we did so relying on a set of five indicators that we identified as best capturing the economy's key structural, macro, and financial determinants of RER.

The construction of RER_CA defines the existence of mainly two currency regimes: overvaluation and undervaluation.[10] The first occurs when the observed RER is above (more appreciated) than the level required to balance the current account; the second when the currency is depreciated in real terms relative to its current account equilibrium level. Theoretical and empirical contributions appoint

[10] Actually three, as the prevalence of equilibrium is a possibility too.

to, a priori, different outcomes of the two regimes regarding their impact on manufacturing output's dynamism. Overvaluation does seem to hurt manufacturing activity through the so-called Dutch disease and the premature deindustrialization it brings about. On the other hand, undervaluation should promote investment in manufacturing activity through price competitiveness, lower real wages, and higher mark-ups.

We can draw some general conclusions of the empirical investigation of the role of RER misalignment on Mexico's manufacturing sectors. Despite some sectorial differences, aggregate demand (IGAE) and exchange rate undervaluation are push factors for manufacturing activity, while overvaluation works as a pull factor – i.e., contracts manufacturing activity. Results on intensive technology activity confirm previous findings presented in the literature review.

The empirical study of the Mexican case shows higher growth rates in the manufacturing activity when the currency is slightly above its equilibrium, that is, when RER is slightly undervalued. On the contrary, overvaluation appears associated with negative growth rates in the manufacturing sectors. Dynamic Ordinary Least Squares estimations confirm the existence of a long-run relationship among misalignment, overvaluation, and manufacturing performance – also with the overall economic activity of the country, measured by the IGAE index. Results show that the output elasticity to exchange rate misalignment is positive and statistically significant in each sector. The elasticity is higher for labor-intensive manufacturing activity, which underlines the role of real wages for the Mexican manufacturing sector. Also, labor-intensive industries are those that suffer the most from currency overvaluation. While a negative and statistically significant sign appears in all models, the estimated coefficient is three times higher for the labor-intensive industry, reflecting its particularly sensitivity to such relative prices. Technological intensive sectors are sensitive to RER misalignment, overvaluation, and economic activity. Yet the latter reports the highest coefficient indicating that dynamism of the economy generates a positive spiral cycle for technology, while misalignment works as a complementary policy that boosts innovation and large-scale industries likely by boosting exports.

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