Maquila, currency misalignment and export-led growth in Mexico

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The paper argues that the weak effect of exports on GDP growth in Mexico is partly explained by two features of the Mexican economy that arose subsequent to trade liberalization: the peso's continued real appreciation and the large and rising share of the maquila sector in manufacturing exports. The argument is developed through an analytical example for a stationary economy with no investment. As motivation for the example's main assumptions, the paper presents empirical evidence gathered from the country's Annual Industrial Survey and the estimation of cointegration equations for maquila and non-maquila intermediate imports. The empirical evidence shows that (a) exports are highly dependent on imports and thus benefit from trade liberalization, and (b) while real exchange rate changes can induce substitution between local and imported intermediate goods generally, this is not the case in the maquila sector.

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I

Introduction

As part of the debate on the causes underlying the slow growth of the Mexican economy, several analysts have focused on the effects of trade liberalization in that country. While some have expressed their concern about the increased import-intensity of economic activity and the possible tightening of the external constraint on the country's economic growth, others — including in international economic organizations and the Mexican government— argue that trade liberalization should be pursued further.[1] The premise is that, by improving access to imported intermediate goods, further liberalization would make local firms more competitive and thus accelerate export and GDP growth. The ratios of foreign trade to GDP, in this view, are still too low in Mexico.

The present paper argues that focusing on the level of foreign trade ratios in Mexico can be misleading. The country's experience shows that the export ratio can increase sharply —as happened during the two episodes of GDP growth acceleration recorded after the enactment in 1994 of the North American Free Trade Agreement (NAFTA)— and yet have a relatively weak effect on average GDP growth. Rather than looking at export and import ratio levels, which may be too high or too low depending on the analyst, the paper argues that the weakness of export-led growth in Mexico is partly explained by two features of the economy subsequent to trade liberalization: the continued real appreciation of the peso (see Galindo and Ros, 2008; and Ibarra, 2008a

and 2010b) and the large and rising share of maquila goods (an extreme example of vertical specialization of production) in the country's export basket. The two features imply that, while trade flows can respond positively to trade liberalization and increase as a share of GDP, their effect on GDP growth will be weak.

The negative impact on profit margins and investment in the tradables sector has been a core factor whereby the peso's appreciation has held back Mexico's economic growth, as studied elsewhere (see Ibarra, 2008b and 2010a). Investment, however, is not central to the argument of the present paper, which is thus developed through an analytical example for an economy with no investment and constant potential output. The analysis focuses on how trade liberalization and the subsequent rise in the export and import ratios can have different effects on output, depending on the level of the real exchange rate and the share of the maquila sector in exports.

The argument relies on three assumptions: first, that exports use intermediate imports intensively, and thus benefit from trade liberalization; second, that despite the tight link between exports and intermediate imports, the real exchange rate can induce substitution between local and imported intermediate goods; and third, that the maquila sector is qualitatively different, because of the absence of substitution.

The initial sections of the paper provide empirical support for those assumptions. Section II calculates the use of intermediate imports by the top non-maquila exporting classes within Mexico's manufactures, according to data from the country's Annual Industrial Survey. Section III presents separate cointegration equations that measure the response of maquila and non-maquila intermediate imports to variations in exports and the real exchange rate. Section IV develops the paper's main argument, while section V summarizes the results. Two appendices contain details about the calculation of the import share in the Annual Industrial Survey and the sources and definitions of the data used in section III.

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[1] For the first view, see Moreno-Brid (1999); López and Cruz (2000); Ocegueda (2000); Guerrero de Lizardi (2003); Cardero and Galindo (2005); Pacheco-López (2005); Moreno-Brid, Santamaría and Rivas (2005); and Pacheco-López and Thirlwall (2007). For the second view, see OECD (2005); Moissinac (2006); Haugh, Jamin and Rocha (2008); and WTO (2008a and 2008b). While it is generally acknowledged that Mexico has a very open trade regime, in supporting their case for further trade liberalization Haugh, Jamin and Rocha (2008) stress (a) the presence of relatively high most favoured nation tariff barriers, (b) the complexity of trade policy settings arising from the combination of multiple regional trade agreements and (c) relatively high non-tariff barriers.

II

Exports and intermediate imports in manufactures

Following the enactment of NAFTA in 1994, there were two episodes of growth acceleration in Mexico, in the periods 1996-2000 and 2004-2007. The average annual GDP growth rate increased from less than 1% in the preceding three years to 5.5% during the first episode and to 3.8% during the second one. Both episodes were characterized by an initial depreciation of the currency (particularly sharp in the first case) and the expansion of manufactured exports.

Reflecting the leading role of exports in Mexico's growth, the ratio of manufacturing exports to GDP increased from 10.6% in 1993 to 29.9% in 2000 (at the end of the first episode) and to 37.1% in 2007 (at the end of the second one). The ratio of imports to GDP followed a similar trend, increasing from 16.3% before the enactment of NAFTA to 34.8% in 2000 and to 43.6% in 2007. Intermediate goods were the largest component, accounting for at least three quarters of goods imports (see table 1).

The simultaneous increase in export and intermediate import ratios suggests that exports are more intensive in the use of imports than is the rest of production: given the difference in import intensity, the intermediate import ratio would rise as the composition of industrial production shifts towards exports. This section and the next present empirical evidence of import use in export production, beginning here with a set of indicators taken from Mexico's Annual Industrial Survey.

The Survey presents annual data, from 1994 to 2003, for 205 manufacturing classes that comprise about 65% of non-maquila manufacturing employment and 85% of gross production. Among other variables, the Survey contains series for the nominal value of domestic and external sales and of local and imported intermediate goods. The data can be used to calculate the share of imports in the intermediate basket of each manufacturing class as an indicator of the import intensity of production.[2] Ideally, the import share should be calculated separately for domestic-market and export production, but the Survey data do not allow that separation. Instead, the analysis will proceed by identifying the top exporting classes within the Survey in order to contrast their import intensity with that of the rest of the classes.

By types of good, manufacturing exports in Mexico are very concentrated (see Chiquiar, Fragoso and Ramos-Francia, 2007; and Gallagher, Moreno-Brid and Porzecanski, 2008). In 1994, 50.5% of Survey exports came from only three classes: auto and truck production and assembly (33.3%); auto parts and engines (11.2%); and computer production, assembly and repair (6%). By 2003, the percentage was even higher. Comparatively, the share of the top 25 classes in total exports was 79%

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[2] The intermediate basket consists of parts, components and raw materials.

TABLE 1

Mexico: foreign trade, selected ratios and years

	1993	1996-2000	2001-2003	2004-2007	2006
Average GDP growth rate[a]	1.9	5.5	0.7	3.8	4.8
Goods imports/GDP	0.1626	0.2120-0.3477	0.3423-0.3424	0.3678-0.4357	0.4159
Intermediate imports/GDP	0.1196	0.1744-0.2767	0.2679-0.2700	0.2903-0.3271	0.3168
Non-maquila intermediate imports/GDP	0.0787	0.0927-0.1323	0.1311-0.1277	0.1315, n.a.	0.1251
Maquila intermediate imports/GDP	0.0409	0.0818-0.1444	0.1368-0.1423	0.1588, n.a.	0.1917
Maquila imports/maquila exports	0.7539	0.7965-0.8317	0.8317-0.8428	0.8566, n.a.	0.8763
Maquila exports/manufactured exports	0.5105	0.4859-0.5799	0.5666-0.5689	0.5781, n.a.	0.6056
Manufactured exports/GDP	0.1063	0.2113-0.2993	0.2902-0.2968	0.3208-0.3712	0.3611

Source: Author's calculations with national accounts data in real 1993 pesos from the National Institute of Statistics and Geography (INEGI) of Mexico.
Note: All ratios are expressed in proportional terms.
n.a.= not available.

[a]　The GDP growth rate is the average of the period delimited by the initial and final year in the first row.

in 1994. The high contribution of the top exporting classes stems not only from their size (larger than the average) but also from the high share of exports in their sales (see table 2).[3]

The Survey data confirm that the top exporting classes use imports intensively, well above the average for manufactures. In 1994, the aggregate share of imports in the intermediate basket, excluding the top 25 exporting classes, was 26.8%; the import share for the top 25 classes, in contrast, was 47.7%. A more detailed look reveals that it was the top three classes that made the difference, with an import share of 66.2%.

It can be expected that the import intensity of export production, already high when NAFTA came into effect, increased over time, as part of the worldwide trend towards the vertical specialization of industrial production (see Feenstra, 1998; and Hummels, Ishii and Yi, 2001). To explore this possibility, the import shares for 2003 were plotted against those for 1994 (see figure 1).[4] As can be

seen, in the export boom that followed the enactment of NAFTA most of the top exporting classes intensified their use of intermediate imports; notably, import intensification took place despite a sharp depreciation of the peso in 1995.

Figure 1 also shows, however, that the top two exporting classes moved in the opposite direction. As a result, while the average import share for the top exporting classes —not including the top two— increased from 26.2% in 1994 to 37.5% in 2003, the share for the top two fell 10 points, to 56.3%. The net result is that the average import share for the top 25 classes remained at a high but unchanged level of just under 50% (see table 2).

The above-mentioned indicators suggest that, compared with production for the domestic market, export production is particularly dependent on imports. Trade liberalization, by improving the access of local firms to intermediate imports, may boost exports, regardless of the behaviour of other determinants, such as the real exchange rate.

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[3] While the ranking of the top three exporting classes remained constant between 1994 and 2003, there were some shifts within the list of the top 25 classes. For example, in 2003 there were six new classes in the top 25 (ranked 26, 27, 42, 44, 56 and 58 in 1994), which increased their share in total exports from 3.5% in 1994 to 4.7% in 2003. At the same time, the six classes leaving the list (ranked 12, 14, 18, 20, 21 and 24 in 1994) declined from 6.1% to 2.3% of total exports.

[4] The intermediate basket of each class consists of both local and imported goods, whose relative prices (the "intermediate" real

exchange rate) may change over time. The change in relative prices affects the estimated value of the import share, even if no change in real quantities has taken place. For instance, a rise in the relative price of imported goods would spuriously increase the value of the import share. To avoid this measurement error, the import share for the top 25 manufacturing export classes was calculated at purchasing power parity (see the explanation in appendix A).

TABLE 2

Mexico: Annual Industrial Survey, selected indicators and years

	Share in Survey sales			Share in Survey exports			Share of exports in sales (weighted average)			Share of imports in intermediate basket[a] (weighted average)		
	1994	1996	2003	1994	1996	2003	1994	1996	2003	1994	1996	2003
Auto and truck production and assembly	0.1202	0.1429	0.1517	0.3327	0.4034	0.4182	0.4465	0.8276	0.7605	0.6402	0.6792	0.4887
Auto parts and engines	0.0313	0.0349	0.0275	0.1119	0.0752	0.0600	0.5757	0.6317	0.6013	0.6234	0.5671	0.4865
Computer production, assembly and repair	0.0121	0.0263	0.0257	0.0599	0.0803	0.0888	0.7952	0.8949	0.9541	0.9361	0.9486	0.9891
Top 3	0.1636	0.2041	0.2048	0.5045	0.5589	0.5670	0.4971	0.8028	0.7634	0.6622	0.7008	0.5631
Top 25	0.4010	0.4280	0.4039	0.7895	0.7907	0.7859	0.3552	0.5418	0.5366	0.4772	0.4920	0.4827
Top 25 excluding the top 3	0.2373	0.2238	0.1991	0.2851	0.2318	0.2189	0.2360	0.3037	0.3032	0.2623	0.2705	0.3745
Survey excluding the top 25	0.5990	0.5720	0.5961	0.2105	0.2093	0.2141	0.0529	0.1073	0.0991	0.2683	n.a.	n.a.

Source: Author's calculations using data from the Annual Industrial Survey of the National Institute of Statistics and Geography (INEGI) of Mexico.

[a] See appendix A for the calculation of the share of imports in intermediate goods.

FIGURE 1
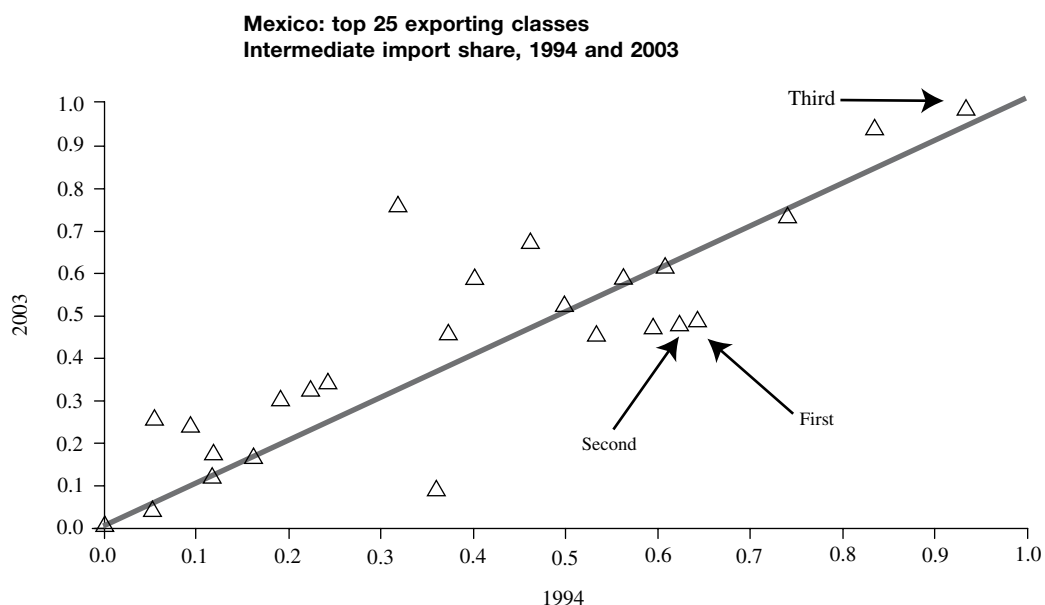
Mexico: top 25 exporting classes
Intermediate import share, 1994 and 2003

Source: Author's calculations using data from the Annual Industrial Survey of the National Institute of Statistics and Geography (INEGI) of Mexico.

III

Cointegration equations for

intermediate imports

To further investigate the link between exports and imports, this section presents several cointegration equations for the determination of intermediate imports in Mexico. The equations include both exports and the industrial production index as regressors. A positive export coefficient implies that a shift in the composition of production towards exports, leaving the production level constant, raises intermediate imports—in other words, that export production is more intensive in imports than is the rest of industrial production. The equations, therefore, complement the evidence gathered from the Annual Industrial Survey.

Exports may affect imports indirectly, by inducing changes in the real exchange rate. An exogenous rise in exports, for example, may appreciate the currency and encourage a heavier use of imports. To control for the latter effect, the equations include the real exchange rate as a regressor. The specification in addition allows for testing whether intermediate imports respond to changes

in the real exchange rate, a key element of the analysis to be carried out in the next section. Also in preparation for that analysis, separate estimation results are presented here for maquila and non-maquila imports.

The presumed cointegration equation takes the form:

$$MINT_{LR} = \delta_0 + \delta_1 NEXP + \delta_2 IPI + \delta_3 REER \qquad (1)$$

where MINT is total imports of intermediate goods, excluding the maquila sector, and NEXP is total exports of goods, excluding oil and the maquila sector. Originally expressed in United States dollars, both variables were deflated with the United States producer price index and transformed to natural logs. IPI is the natural log of Mexico's industrial production index, while REER is the natural log of the Bank of Mexico's real effective exchange rate index, a weighted ratio of foreign to Mexican

consumer prices (see appendix B for data sources and definitions). To capture the "long-run" effects, all the variables are measured in levels.

Following the bounds testing approach of Pesaran, Shin and Smith (2001), equation (1) can be implicitly estimated by an autoregressive distributed lag (ARDL) model in error-correction form:

$$\Delta MINT_t = \sum_{j=1}^{n} a_j \Delta MINT_{t-j} +$$
$$\sum_{i=1}^{3} \sum_{j=0}^{n} b_{i,j} \Delta Z_{i,t-j} + \sigma MINT_{t-1} + \sum_{i=1}^{3} d_i Z_{i,t-1} + d_0 \qquad (2)$$

where Δ indicates the first difference of the variable and Z_i stands for the import determinants.

Equation (2) has two segments. The first two terms on the right side, with the variables measured in first difference, capture the short-run, transitory effects on imports. The remaining terms, consisting of a constant plus the lagged levels of the dependent variable and its determinants, represent the long-run segment of the model. More specifically, once the existence of cointegration has been statistically established, the long-run coefficients can be retrieved as $\delta_i = -d_i/\sigma$.

An attractive feature of ARDL models in general is that they yield unbiased estimates of the long-run coefficients, even if some of the regressors are endogenous (see Pesaran and Shin, 1998). In addition, estimation following the bounds testing approach can combine in the same equation variables that are integrated of order zero $I(0)$ or one $I(1)$, in contrast to other popular approaches, such as Johansen's vector-error correction model, which require the same order of integration. Finally, the error-correction form of the ARDL model estimates in a single stage both the short- and long-run coefficients, including the speed of adjustment coefficient (σ), which in a standard error-correction model would correspond to the coefficient on the (lagged) long-run error, $MINT\text{-}MINT_{LR}$.

The estimation proceeds in two steps. In the first step, the statistical adequacy of the model must be tested. This requires determining the optimal number of lags for the variables in first difference —resorting, for example, to Akaike's information criterion— and confirming that the model passes the standard diagnostics tests. Once the statistical adequacy of the model has been tested, the second step explores the existence of cointegration.

There are two cointegration tests. First, the speed of adjustment coefficient σ must be negative, indicating that the dependent variable moves over time towards its long-run equilibrium level. Pesaran, Shin and Smith (2001) provide critical values for the corresponding t-test, with lower and upper bounds depending on whether the variables in the equation are purely integrated of order one (upper bound) or zero (lower bound). Cointegration is unambiguously accepted when the absolute value of the statistic lies above the upper bound. The second is an F-test for the significance of the level coefficients, under the null that σ and the d's in equation (2) are jointly equal to zero. Again, Pesaran, Shin and Smith (2001) provide lower and upper critical values, with cointegration being accepted when the F-statistic lies above the upper bound.

Equation (2) was estimated using monthly series from January 1988 (after completion of the first stage of trade liberalization in Mexico (see UNCTAD, 2007; and Moreno-Brid, Santamaría and Rivas, 2005) to December 2006 (the latest available official statistics for the non-maquila manufacturing sector), for a total of 228 observations. Table 3 shows that the variables used are integrated of order zero or one but not higher, thus validating the use of the bounds testing approach.

Table 4 presents the estimation results. While significance tests cannot properly be performed on the individual coefficients because of the presence of unit roots, table 4 still reports the coefficients' p-values as a quick indication of statistical significance. The number of lags, detailed in the table, was determined by Akaike and the results of diagnostics tests. The equation in column 1 of table 4 is:

$$MINT_t^{LR} = 4.53 + 0.40NEXP_t + 1.18IPI_t - 0.28REER_t \quad (3)$$

which the two bounds tests amply accept as a cointegration equation.

The estimation results show that exports have a significant effect on intermediate imports. Since the analysis controls for industrial production, the results confirm that export production is more intensive in imports than is the rest of industrial production. The estimation also yields a negative real exchange rate coefficient, indicating that, despite the tight link between exports and intermediate imports, the real exchange rate can induce substitution between local and imported intermediate goods.[5]

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[5] Ibarra (2010c) estimates cointegration equations for intermediate imports in Mexico using Johansen's vector error-correction model. The estimated elasticities —0.42 for exports, 1.08 for industrial production and -0.20 for the real exchange rate— are very similar to those presented in equation (3).

TABLE 3

Mexico: unit root tests

(Estimation period: January 1988 to December 2006, 228 observations)

	Augmented Dickey-Fuller test[a]			Phillips-Perron test[b]		
	Level	Level with trend	First difference	Level	Level with trend	First difference
IMAQ	-2.7663 *	-0.8910	-4.1442 ***	-1.9884	-4.8803 ***	34.1115 ***
IPI	-1.0422	-2.0306	-9.5999 ***	-1.0545	-2.2630	-17.4655 ***
MAQ	-2.7754 *	-0.9390	-3.8992 ***	-1.9007	-4.8266 ***	33.0994 ***
MINT	-2.4646	-3.3888 *	-16.3921 ***	-2.2449	-4.8167 ***	-28.4717 ***
NEXP	-1.2307	-0.8688	-4.7172 ***	-1.0564	-3.7786 **	31.2868 ***
REER	-2.8356 *	-2.9708	-11.7618 ***	-2.5983 *	-2.6175	-11.6694 ***

Source: Author's calculations.
Note: See appendix B for definitions and sources.
***, **, *: Unit root hypothesis is rejected at 1%, 5%, 10%.

[a]   Augmented Dickey-Fuller test with intercept and lag length determined by the Schwarz information criterion, with maximum lag set at 12; the test uses MacKinnon one-sided *p*-values.
[b]   Phillips-Perron test with intercept, Bartlett kernel and Newey-West bandwidth; the test uses MacKinnon one-sided *p*-values.

TABLE 4

Mexico: intermediate-import equations, long-run coefficients from error-correction ARDL models

(Estimation period: January 1988 to December 2006, 228 observations)

	Non-maquila trade flows	Maquila trade flows		
			(Jan. 1988 to Dec. 2006, 132 observations)	
	(1)	(2)	(3)	(4)
Speed of adjustment	-0.235	-0.284	-0.425	-0.378
Constant	4.527 (0.001)	-1.007 (0.005)	-0.879 (0.002)	-0.820 (0.007)
Exports (NEXP or MAQ)	0.401 (0.000)	1.185 (0.000)	1.061 (0.000)	1.001 (0.000)
Real exchange rate, REER	-0.278 (0.056)	0.131 (0.001)	0.113 (0.002)	0.128 (0.001)
Industrial production index, IPI	1.185 (0.011)	-0.541 (0.000)	-0.165 (0.134)	
Adjusted R-sq	0.668	0.984	0.997	0.997
Jarque-Bera	0.579 [0.749]	3.356 [0.187]	3.395 [0.183]	1.301 [0.522]
Breusch-Godfrey (1)	1.046 [0.308]	0.326 [0.569]	0.000 [0.999]	0.339 [0.561]
Breusch-Godfrey (3)	0.348 [0.791]	1.638 [0.182]	1.131 [0.340]	0.809 [0.492]
Breusch-Godfrey (6)	0.413 [0.870]	1.003 [0.425]	2.841 [0.014]	2.840 [0.013]
ARCH	1.773 [0.184]	0.779 [0.378]	0.017 [0.897]	0.119 [0.731]
RESET	0.137 [0.712]	0.050 [0.824]	0.334 [0.564]	0.034 [0.853]
Bounds *t*-stat	-5.01 ***	-5.20 ***	-4.64 ***	-4.72 ***
Bounds *F*-stat	5.44 **	7.78 ***	5.90 ***	9.49 ***

Source: Author's estimations.
Notes:
(a) For illustrative purposes, *p*-values for the d_i coefficients from equation (2) (see main text) are shown in brackets.
(b) Diagnostics: The null hypotheses are that residuals are normally distributed (Jarque-Bera) and that there is no serial correlation of up to nth order (Breusch-Godfrey), no autoregressive conditional heteroskedasticity (ARCH) and no misspecification error (the Ramsey regression equation specification error test (RESET)). *F*-statistics (χ^2 for Jarque-Bera) are presented with *p*-values in brackets.
(c) In column 2, trade data were seasonally adjusted with the X12 procedure, using the multiplicative method, and default seasonal and trend filters.
(d) The number of lags in first-differenced variables is two in column 1, five in column 2 and six in columns 3 and 4.
(e) Column 2 includes separate 0-1 dummies for the months of January from 1990 to 1996, December from 1990 to 1994, plus March 1990, June 1994 and April 1997 and 1998.
(f) Bounds testing: *** (**) Test statistic lies above the upper bound at the 1% (5%) significance level. The 1% upper critical value is -4.37 for the *t*-test and 5.61 for the *F*-test. The 5% upper critical value is 4.35 for the *F*-test [from Pesaran, Shin and Smith (2001), table CI(iii), case III, k=3 regressors].

Although excluded from the previous estimations, the maquila sector plays a large and increasing role in Mexico's trade. The country's ratio of imports to GDP rose from 16.3% in 1993 to 41.6% in 2006, that is, 25.3 points of GDP. Intermediate imports accounted for 19.7 of those 25.3 points, the greatest part of which —15.1 points— were destined for the maquila sector. In other words, the maquila sector accounted for 76.6% of the increase in intermediate imports and 60% of the increase in the import ratio from 1993 to 2006 (see table 1).

The high impact of the maquila sector on the evolution of the import ratio has two sources. First, the use of intermediate imports intensified: although by definition the maquila sector is characterized by a high ratio of imports to gross production (see Buitelaar and Padilla, 2000; and UNCTAD, 2002), the import intensity increased over time, with a rise in the import-export ratio from 0.754 in 1993 to 0.876 in 2006.

And second, manufacturing export growth was biased towards the maquila sector: while the ratio of manufactured exports to GDP increased from 0.106 in 1993 to 0.361 in 2006, the share of the sector in manufactured exports rose from 0.511 to 0.606; as a result, maquila exports increased from 5.4% to 21.9% of GDP. The bias towards the maquila sector originated in the sluggishness of non-maquila manufactured exports, which recorded an average annual growth rate of only 6.2% from 1997 to 2006 (after growing at 29.7% during the period 1994-1996).[6]

The series for maquila exports and imports show very strong —but transitory— seasonal patterns in the early 1990s, making it difficult to obtain a statistically acceptable model. To deal with this problem, the original data were seasonally adjusted and the estimation of cointegration equations included separate 0–1 dummies mainly for the months of January and December in the first half of the 1990s (see notes at table 4). The dependent variable in the equations is maquila imports (*IMAQ*), while the right side variables consist of maquila exports (*MAQ*) —both variables in real dollar terms and expressed as natural logs— and the industrial production and real exchange rate indices.

The estimated equation (see column 2 in table 4) is:

$$IMAQ_t^{LR} = -1.01 + 1.19 MAQ_t - 0.54 IPI + 0.13 REER \quad (4)$$

which, again, is amply accepted as a cointegration equation by the bounds tests.

The equation shows a positive real exchange rate coefficient, indicating that a real currency depreciation raises the real dollar value of maquila imports. The result indicates that, once maquila exports are controlled for, changes in the real exchange rate have no negative effect on import volumes. To the contrary, a depreciation may create expectations of further export expansion, leading firms to demand intermediate imports beyond the requirements of current production (see Cerra and Dayal-Gulati (1999) for a similar finding in the Chinese case).

The erratic behaviour of the maquila series in the early 1990s forced the introduction of a large number of dummies in the import equation, as otherwise diagnostic tests failed. To check for the robustness of results, the import equation was re-estimated, but without dummies, for a shorter sample beginning in January 1996 (see column 4 in table 4). The estimated equation is:

$$IMAQ_t^{LR} = -0.82 + 1.0 MAQ_t + 0.13 REER_t \quad (5)$$

There are two results. First, the equation for the original sample showed a negative effect of industrial production on maquila imports —which was unexpected and hard to explain. In the reduced sample, in contrast, dropping the industrial production index from the import equation improves the results of the cointegration tests (compare the *F*-test in columns 3 and 4 of table 4). Dropping industrial production is intuitive: since the equation controls for the level of maquila exports, an increase in industrial production specifically means an increase in non-maquila production —which by definition should have no effect on imports in the maquila sector, since the maquila and non-maquila industrial sectors are delinked. Second, and more importantly for our present purposes, estimation with the reduced sample yields again a positive coefficient on the real exchange rate, confirming that real currency depreciation fails to reduce the use of intermediate imports in the maquila sector.

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[6] Likely factors retarding the growth of non-maquila exports are the currency appreciation and low dynamism of investment that have characterized the economy in the past decades. Indeed, recent studies conclude that episodes of growth acceleration typically feature a competitive real exchange rate level and a simultaneous boom in export and investment (see Rodrik, 2005; Hausmann, Pritchett and Rodrik, 2005; Freund and Pierola, 2008; and Ros, 2009).

IV

Maquila, currency misalignment and trade liberalization

As part of the debate on the causes underlying the slow growth of the Mexican economy, several analysts have argued that trade liberalization in Mexico has not gone far enough: further liberalization would improve the access of local firms to imported intermediate goods, and thus accelerate export and GDP growth. In this view, the ratios of foreign trade to GDP are still too low in Mexico (see references in the introduction).

But focusing on the level of foreign trade ratios in Mexico may mislead. The country's experience, particularly after the enactment of NAFTA in 1994, shows that the export ratio can increase sharply and yet have a weak effect on GDP growth. In the present section, it is argued that the weak response of GDP is related to two features of the Mexican economy subsequent to trade liberalization: the continued real appreciation of the peso and the high and rising share of the maquila sector in manufacturing exports.

The negative impact of the peso's appreciation on profit margins and investment in the tradables sector is arguably a core factor in explaining the slow growth of the Mexican economy (see Ibarra, 2008b and 2010a). Investment, however, is not central to the argument presented here, which thus is developed through an analytical example for an economy with no investment and constant potential output.

The analysis relies on three assumptions motivated by the empirical results of the preceding sections: first, since exports are intensive in the use of imports, they are expected to respond positively to trade liberalization —which improves the access by local firms to a wider variety of foreign-produced goods and thus makes their exports more competitive (see Goldberg and others, 2009); second, despite the tight link between exports and intermediate imports, variations in the real exchange rate can induce substitution between local and imported intermediate goods; and third, not only does maquila production display a particularly tight link between imports and exports, but that link does not respond to variations in the real exchange rate.

Consider, then, an economy with three sectors: a manufacturing export sector that uses both local and imported intermediate goods; an intermediate sector that sells its production to the export sector; and a consumption sector that produces non-tradable services without intermediate goods. The export sector demands $a<1$ units of intermediate goods per unit of gross production X, with an import share σ. The demand for local intermediate goods, equal to the intermediate sector's gross production, is therefore $a(1-\sigma)X$. The intermediate sector demands $m<1$ imports per unit of gross production. Finally, consumption demand consists of an exogenous component C_o of non-tradable services and a component c_1Y, $c_1<1$, which depends on income. A fraction $f<1$ of the latter is imported.

Total output can be calculated either as value added across the three sectors or as consumption demand plus net exports. Thus, with imports $a\left[\sigma+m\left(1-\sigma\right)\right]X+C_1fY$, total output is:

$$Y^{GG}=\frac{C_0+\left\{1-a\left[m+\left(1-m\right)\sigma\right]\right\}X}{1-C_1(1-f)} \qquad (6)$$

Exports are assumed to depend positively on the real exchange rate q (the ratio of foreign to local prices) and the import ratio σ, where, as mentioned, the intuition for the latter effect is that greater access to foreign goods makes local producers more competitive in the export market. On the other hand, the import ratios m and σ are assumed to depend negatively on both q and the level of trade barriers. An implication is that trade liberalization, by reducing those barriers, will increase exports for a given level of the real exchange rate.

In the setting of a stationary economy, external equilibrium requires net exports to be equal to zero. By equating imports to exports and solving for Y, the output level satisfying that condition is found to be:

$$Y^{EE}=\frac{\left\{1-a\left[m+\left(1-m\right)\sigma\right]\right\}X}{C_1f} \qquad (7)$$

The goods market and external equilibrium conditions expressed above in equations (6) and (7)

can jointly be solved for the economy's potential output level: $Y^{PP} = \dfrac{C_0}{1-C_1}$, which is constant; alternatively, they can be solved for the export ratio consistent with potential output:

$$\frac{X}{Y^{PP}} = \frac{C_1 f}{1 - a\left[m + (1-m)\sigma\right]} \qquad (8)$$

Equation (8) is shown in figure 2. The *XX* curve represents the left side of the equation; it is upward sloping under the assumption that the direct effect of the real exchange rate on exports dominates the indirect effect via σ. For a given level of the real exchange rate, the position of the *XX* curve determines the actual export level. The figure also shows a *MM* curve representing the right side of equation (8), which is downward sloping under the assumption that the import ratios fall when the currency depreciates.

Equation (8) shows that the economy can reach potential output through different levels of the export ratio, depending on the import intensity of production: the higher the m and σ ratios, the higher the export ratio. Thus, the level of an economy's export ratio by itself does not say much about the effect of exports on

GDP. Neither does looking at net exports, since in the final equilibrium net exports will be equal to zero (see Prasad (2009) for a recent discussion on measuring the contribution of exports, from the demand side, to output growth).

Figure 2 brings out the real exchange rate's macroeconomic role. For the export ratio to reach the level consistent with potential output, the real exchange rate must be at the equilibrium level q^E. With a misaligned currency, actual output will differ from its potential level. For example, with an overvalued currency q^1 the export ratio needed to reach potential output would be given by point 1, but the actual export ratio would be at point 2. Thus, because of the misaligned currency, the economy will remain below potential output no matter how high the actual export ratio is.

The previous results can be used to analyse the effects of trade liberalization and the role played by the real exchange rate. Consider an economy with depressed output, for example at point 2 in figure 3. The effects of trade liberalization will depend on the behaviour of the real exchange rate. Trade liberalization, by raising the import ratios m and σ, will shift both *XX* and *MM* to the right, thus increasing the level of the foreign trade ratios for any given level of the real exchange rate. If liberalization is accompanied by real currency

FIGURE 2

Export ratio and real exchange rate
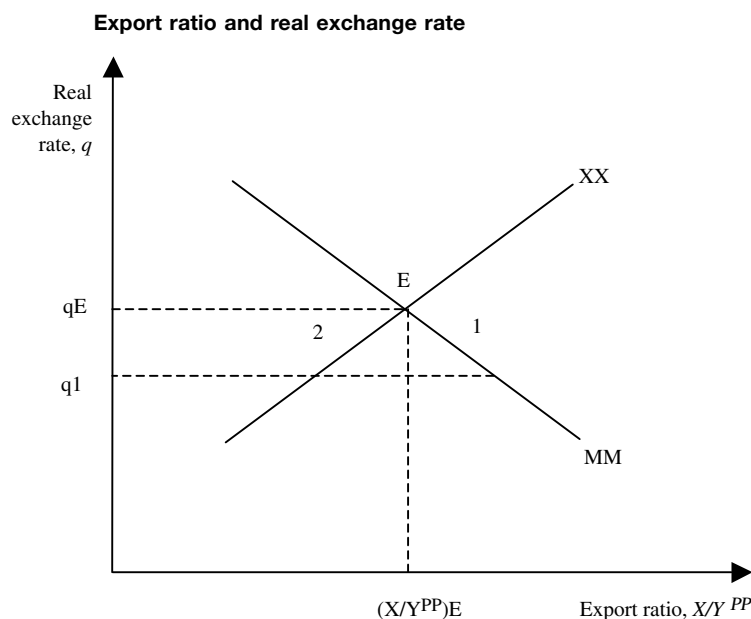
Source: prepared by the author.

FIGURE 3

Effects of trade liberalization
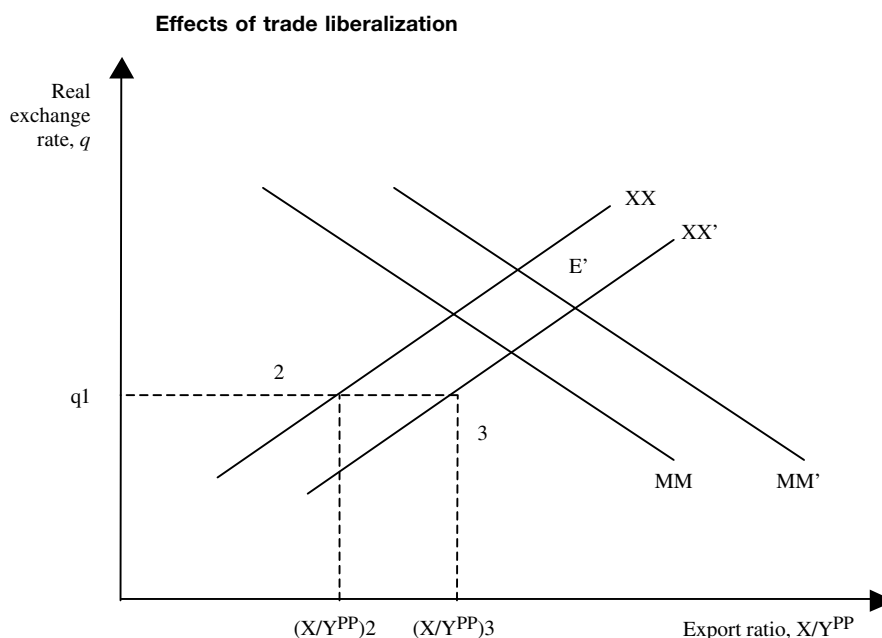
Source: prepared by the author.

depreciation, the economy will move to point E', reaching potential output with a higher export ratio.[7]

 With a misaligned (overvalued) currency, in contrast, the transmission of a higher export ratio to output may fail, as shown by the move from point 2 to point 3 in figure 3. The export ratio at points 2 and 3, from the goods market equilibrium condition expressed in equation (6) and the definition of potential output, is:

$$\frac{X}{Y} = \frac{C_1 f - \left(1 - C_1\right)\left(\dfrac{Y^{PP}}{Y} - 1\right)}{1 - a\left[m + \left(1 - m\right)\sigma\right]} \qquad (9)$$

which simplifies to equation (8) when output is at its potential level. Equation (9) shows that a deepening of trade liberalization (leading to further increments in the import ratios) will keep pushing the actual export ratio up, and yet there may be no effect on the gap between potential and actual output. The reason is not that the export ratio is too low, or that the import ratio is too high, but that the currency is misaligned.

 Consider now the influence of the other key stylized fact of the Mexican economy, the high and rising share of the maquila sector in manufacturing exports. To assess the effect of the increasing role of the maquila sector, recall equation (8), which shows the export ratio needed to reach potential output. Maquila production is defined by very high values of the a and σ coefficients, which combined imply a high ratio of intermediate imports to gross production—0.876 in 2006 (see table 1). As equation (8) shows, with those parameter values the export ratio that is necessary to reach potential output may be extremely high; in fact, the necessary export ratio tends to infinity as a and σ tend to one. In terms of figure 2, there would be no intersection between the *XX* and *MM* curves.

 To the extent that export growth is biased towards maquila goods, the growth of exports will keep pushing the export ratio up, with little effect on GDP. While non-maquila exports also may be intensive in imports, a key difference is that non-maquila intermediate imports appear to respond significantly to variations in the real exchange rate, while maquila imports do not. Thus, the shortcomings of maquila exports as an engine of GDP growth cannot be removed by adjustments in the real exchange rate.

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[7] Figure 3 shows a case in which the equilibrium real exchange rate remains practically unchanged after trade liberalization, which is not necessarily so in practice. See Li (2003) for a theoretical survey and panel econometric evidence regarding the effects of trade liberalization on the real exchange rate.

V

Conclusions

Mexico presents the puzzling picture of an economy that liberalized its trade regime and sharply raised its ratio of manufacturing exports to GDP, and yet failed to sustain fast rates of GDP growth. While some analysts argue that the puzzle is explained by the simultaneous rise of the import ratio, others claim that trade liberalization has not gone far enough: further liberalization would improve the access of local firms to foreign goods, increasing their competitiveness and therefore the growth rates of exports and GDP. In this view, Mexico's foreign trade ratios are still too low.

The paper argued that focusing on import and export ratio levels can be misleading, and that Mexico's puzzle is better explained by two of the economy's stylized facts subsequent to trade liberalization: the tendency of the peso to appreciate in real terms and the large and increasing share of the maquila sector in the country's export basket. The argument, which was developed through the simple example of an economy with no investment and constant potential output, was motivated by two pieces of empirical evidence.

First, export production uses imports intensively. According to data from Mexico's Annual Industrial Survey, which covers the non-maquila manufacturing sector, the share of imports in the intermediate basket is particularly high among the top exporting classes, and in some cases tended to further increase after the enactment of NAFTA. The high import-intensity of exports was confirmed by the estimation of several cointegration equations for the determination of intermediate imports. The equations showed that a rise in exports increases imports for given levels of industrial production and the real exchange rate. The implication is that exports are more intensive in imports than is the rest of industrial production.

A second piece of evidence from the cointegration equations underscores a critical difference between maquila and non-maquila production. In the latter case, there can be substitution between local and imported intermediate goods, with a real currency depreciation reducing intermediate imports for given levels of exports and industrial production. In contrast, there is

no substitution in maquila production. The contrast is important because of the maquila sector's large share in Mexico's trade, accounting for 60% of manufacturing exports and total intermediate imports in 2006.

Since exports are intensive in imports, trade liberalization —by improving the access of local firms to imports— tends to increase the export ratio irrespective of the real exchange rate situation. Further trade liberalization, as recommended by different analysts, may indeed keep pushing the export ratio up, but with an uncertain effect on output. It was shown in particular that with a misaligned (overvalued) currency, the rise in the export ratio will necessarily have a weak effect on output, which in the analytical example appears as a failure to reach the economy's potential output level.

A similar result obtains under a pattern of export growth biased towards the maquila sector. The maquila sector features a particularly high ratio of imports to gross production —a shortcoming that cannot be removed by an adjustment in the real exchange rate. The high import ratio implies a weak (direct and indirect) effect on GDP, irrespective of how high the export ratio may be. The bias of manufacturing exports towards the maquila sector is thus a second factor in the puzzling mix of sharply rising export ratios and slow GDP growth in Mexico.

Finally, regarding policy implications, the paper points to the importance of trying to keep a competitive level for the real exchange rate. A competitive rate not only stimulates faster growth of non-maquila manufactured exports, but also amplifies the positive effect of exports on GDP.

The real exchange rate may be affected by different variables. In the specific case of Mexico during the period under analysis, there is already evidence that the real exchange rate can be significantly influenced by sustained changes in the stance of monetary policy. In particular, a reduction in the difference between peso and dollar short-term interest rates tends to depreciate the peso (see Ibarra, 2010b). This implies that adjustments in the monetary policy stance may affect the rate of economic growth through the real exchange rate channel.

The import share in the Annual Industrial Survey

The data in Mexico's Annual Industrial Survey are reported in nominal terms. Since the intermediate basket consists of both local and imported goods, tracking over time the share of imports requires controlling for possible changes in the "intermediate" real exchange rate of each class. Each manufacturing class i uses both local and imported intermediate goods, identified by the sub-indices j and $j*$, respectively. By definition, the nominal value of the intermediate imports must be $Q_{i,j}^{*n} = SP_{i,j}^* Q_{i,j}^*$, where $Q_{i,j}^*$ is the real amount of intermediate imports, $P_{i,j}^*$ the corresponding price index (in dollars, the foreign currency) and S the nominal exchange rate (in pesos per dollar). The nominal value of the local intermediate goods must be $Q_{i,j}^n = P_{i,j}Q_{i,j}$. Using the Survey data, the import share that can be readily calculated for each year is:

$$share_i = \frac{Q_{i,j}^{*n}}{Q_{i,j}^{*n} + Q_{i,j}^n} =$$

$$\frac{SP_{i,j}^* Q_{i,j}^*}{SP_{i,j}^* Q_{i,j}^* + P_{i,j}Q_{i,j}} = \frac{1}{1 + \dfrac{Q_{i,j}^*}{q_i Q_{i,j}}} \qquad (A.1)$$

where $q_i = SP_{i,j}^*/P_{i,j}$ is the "intermediate" real exchange rate based on the prices of the intermediate goods used by class i.

Equation (A.1) shows that the import share calculated directly from the Survey can be spuriously affected by variations in each class's intermediate real exchange rate. To avoid that effect, the following adjustment was made. First, for each year and class, an "intermediate" purchasing-power-parity (PPP) nominal exchange rate (S_i^p) was calculated. Setting arbitrarily the initial value of q_i equal to one, the PPP rate is $S_i^p = P_{i,j}/P_{i,j}^*$.

Second, for each year and class the PPP rate was used to obtain a "misalignment" ratio $\mu = S_i^p/S$, also equal to one in

1994. Finally, using the value of μ_i for each year and class, an adjusted import share was calculated that reflects only changes in volumes (because each class's intermediate real exchange rate is kept constant):

$$share_i^a = \frac{\mu Q_{i,j}^{*n}}{\mu Q_{i,j}^{*n} + Q_{i,j}^n} = \frac{1}{1 + \dfrac{Q_{i,j}^*}{Q_{i,j}}} \qquad (A.2)$$

Note: The superscript ^{a} is used to indicate the calculation of the "adjusted" share, to differentiate it from the non-adjusted share as calculated in equation (A.1).

Since series for each sector's specific price index of intermediate imports $P_{i,j}^*$ are not available, the calculation of q_i had to rely on one of two aggregate indices: the Bank of Mexico's dollar index of import prices (a valid proxy since most of Mexico's imports consist of intermediate goods) or the United States producer price index for intermediate goods (valid because most of Mexico's imports originate in the United States). While some exploration showed that the two indices behave in a similar way, the results reported in the present paper are based on the Bank of Mexico's index of import prices.

The prices of the local intermediate goods $P_{i,j}$ were obtained from a series of producer price indices calculated by the Bank of Mexico and based on the basket of intermediates consumed by different sectors of activity. However, while the Survey identifies 205 manufacturing classes, the Bank of Mexico's price index is calculated at the more aggregate level of 49 manufacturing subsectors. Thus, each of the top 25 exporting classes from the Survey was assigned to one of the 49 manufacturing sectors identified by the Bank of Mexico, matching as closely as possible the definition of the production activity presented by each source.

APPENDIX B

Data sources and definitions for section III[8]

IMAQ: Natural logarithm of maquila imports.
Source: Bank of Mexico.

IPI: Natural logarithm of the industrial production index, seasonally adjusted.
Source: National Institute of Statistics and Geography (inegi) of Mexico.

MAQ: Natural logarithm of maquila exports.
Source: Bank of Mexico.

MINT: Natural logarithm of imports of intermediate goods, excluding the maquila sector.
Source: Bank of Mexico.

NEXP: Natural logarithm of exports of goods, excluding oil and the maquila sector.
Source: Bank of Mexico.

REER: Natural logarithm of the consumer price index-based, real effective exchange rate index calculated by the Bank of Mexico. A higher index indicates a peso depreciation.
Source: Bank of Mexico.

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[8] The original balance-of-payments data, in dollars, were deflated using the United States producer price index.

(Original: English)

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