The Role of Intermediate Inputs in a Multisectoral Balance-of-Payments-Constrained Growth Model: The case of Mexico

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Abstract

In this paper we focus on the effects of the imports of intermediate inputs in the growth performance. Such analysis is important insofar as some countries import large amounts of intermediate inputs to be used in the production of final goods to export. Then it arises the question whether such strategy would not damage the growth performance in a balance-of-payments-constrained growth set up. To answer this question, departing from Blecker and Ibarra (2013), in the present paper we advance a disaggregated version of the balance-of-payments-constrained growth hypothesis that explicitly takes into account the influence of the intermediate inputs. In order to test the predictive power of this new version, we test it econometrically for the Mexican economy from 1962 to 2014. Besides, we perform numeric simulations that aim to compare the dynamic path of the Mexican economy in two distinct scenarios, namely with and without intermediate inputs. The results show that a strategy based on the imports of intermediate inputs with high elasticity with respect to exports may dampen the growth performance, and it is relevant to understand the Mexican growth experience in the last decades.

1 Introduction

The role of imports of intermediate inputs as one of the elements of a sound growth strategy is a contentious issue. For some authors such as Blecker and Ibarra (2015), such strategy allows a country to increase its share in the world economy since it spurs manufactured exports whose production depend on such intermediate inputs. But for others authors such as Moreno-Brid (1999, 2002) and Pacheco-López and Thirlwall (2004) such strategy may result in an increase in the income elasticity of demand for imports without a compensating effect on the income elasticity of exports. If this is the case, then a country that relies on massively imports of intermediate input may experience lower growth rates consistent with intertemporal equilibrium in the balance-of-payments. This kind of reasoning follows from the balance-of-payments constrained growth hypothesis, which considers that a country's long run growth rate can be approximated by the ratio of the export and import income elasticities multiplied by the growth rate of international income [see Thirlwall (1979) and Perraton (2003)].

The Thirlwall law [Thirlwall (1979)], as this hypothesis is known, is an empirical regularity that has been confirmed for a number of countries [see e.g. Thirlwall (2012), Razmi (2005), Jeon (2009), McGregor and Swales (1985), Atesoglu (1993) and Halicioglu (2012)]. In a first phase of extensions, Thirlwall's law was extended to consider more inclusive versions of the balance of payments, thus considering capital flows [Thirlwall and Hussain (1982)], external debt [McCombie and Thirlwall (1997) and Moreno-Brid (1998-99)], interest payments on debt [Elliot and Rhodd (1999)] etc. More recently a second wave of extensions has been focused on more disaggregated versions of this empirical regularity. While the original version assumed just two countries, Nell (2003), for instance, has considered an arbitrary number of commercial partners. This contribution becomes relevant insofar as it focus on the identification of trading partners that contribute most to the long-term growth, as well as it allow us to consider economic and industrial policies to improve trade relations with such partners.

Meanwhile, Araujo and Lima (2007) focusing on a sectoral disaggregation, have derived a multi-sectoral version of such hypothesis by showing that the export and import elasticities may be viewed as averaged means of sectoral export and import elasticities respectively, being the weight of each sectoral elasticity the share of each sector in trade. With such derivation, the authors have shown that even if sectoral elasticities and world income growth are constant, a country can grow faster by either increasing the share in exports of sectors with a high-income elasticity for exports or decreasing the share of import of sectors with a high-income elasticity for imports. Such range of view, which points to the connections between economic growth and structural change, has been confirmed by studies showing that countries that relied upon strategies based on export-led structural changes such as the east Asian countries succeeded in terms of growth performance [see e.g. McMillan and Rodrik (2011)].

Following the derivation of the multi-sector Thirlwall's law - MSTL hereafter - a number of empirical studies aiming at testing it have found support to the disaggregated version [see e.g. Gouvea and Lima (2009), Gouvea and Lima (2013), Tharnpanich and McCombie (2013) and Romero and McCombie (2016)]. These papers highlight the fact that higher levels of disaggregation allow us to better understand the factors that can spur growth mainly in underdeveloped and in emerging countries. In all cases the authors have found that export and import composition play an important role in explaining growth experiences, with high and sustained growth rates being related to a larger share of high-tech products in exports. Countries that increase the share of high tech goods in their exports benefit more from international trade than those that specialize in the production and exports of commodities, which are characterized by low income elasticity.

The present article aims to give more realism to the balance-of-payments growth rate hypothesis by considering explicitly the imports of intermediate goods that are used in the production of final goods for exports. Such an analysis was firstly advanced by Blecker and Ibarra (2013) in a balance-of-payments constrained growth set up and is related to the fact that a strategy based on the imports of intermediate inputs would allow the country to export manufactured goods with higher income elasticity of demand. But if on one hand, such strategy enhaces the average income elasticity of exports, on the ohter hand, it also increases the aversage income elasticity of imports, mainly if the intermediate inputs present high elasticity with respect to exports. The final outcome, namely if such strategy is beneficial or harmful to growth, is an empirical question addressed in this paper with respect to the Mexican economy. In such a context it arises the question if massive imports of intermediate goods would not decrease the growth rate predicted by the disaggregated version of the balance-of-payments constrained growth rate hypothesis.

According to the initial insight, we believe that this derivation is important for understanding the growth experience of some countries such as Mexico and China, whose trade experience is characterized by the imports of large quantities of intermediate goods. In order to address this issue, we depart from Blecker and Ibarra (2013) by assuming that the growth rate of intermediate inputs is a function of the growth rate of exports. But here we intend to proceed to a higher level of disaggregation. While Blecker and Ibarra (2013) have considered just four sectors, namely two exporters and two importers, the version presented here is advanced in a fully multi-sectoral scheme, which takes into account an arbitrary number of sectors. Such development is in accordance with the structural economic dynamic approach advanced by Pasinetti (1993) and used by Araujo and Lima (2007) in deriving the MSTL. Thus, this article presents a genuinely multi-sectoral version of the balance-of-payments growth rate hypothesis in the presence of intermediate goods, thus allowing us to verify the validity of the Blecker and Ibarra's insight that the imports of intermediate inputs negatively affects the long-run growth rate in a disaggregated set up. This effect occurs via a reduction of the income elasticity of exports proportional to the elasticity of intermediate inputs.

Such derivation becomes important insofar as it allows to compare the growth performance in two distinct scenarios, namely with and without intermediate goods. In order to illustrate the working of this extended version, we test it to the case of the Mexican economy in the last decades by using data from COMTRADE. In order to estimate sectoral elasticities we have adopted two estimation approaches. The first one considers the series in growth rates. Such strategy is useful since most of the series in level were found to be integrated of order 1 and, by considering, first differences to reckon the growth rates, allowed us to obtain stationary series. But since most of previous studies [see e.g Gouvea and Lima (2013)] have performed the estimates by using log versions of the series in level, we have also decided to estimate sectoral import and export functions by following this approach. But in that case, we needed to employ the Johansen methodology that allows us to consider cointegration of I(1) series. It is important to stress that although using these two different estimation strategies, the estimated elasticity did not present significant differences, which points to the robustnesses of the results. We have found that the performance of the Mexican economy is affected by the imports of intemediate inputs.

But in order to precisely determine if such strategy is harmful to growth, we have decided to run numerical simulations by suing the estimated elasticities to compare the performance of the economy. The results show that, by considering two categories of imports, namely final and intermediate. the economic performance is worst than if all imports are considered as final imports. With this result we show that a growth strategy based on massive imports of intermediate goods may be misleading. But it is important to bear in mind that we are against such strategy since it may allow a country to increase the income elasticity of exports. What we are advocating is that countries that adopt such strategy should try to diminish their dependence on intermedia te imports, mainly if they present a high elasticity with respect to exports.

Besides this introductory section, this article comprises three more sections. The next one advances a derivation of a MSTL with intermediate inputs and section 3 presents the econometric and numerical simulation exercises comparing the original MSTL [Araujo e Lima (2007)] and the one derived here. Section 4 concludes.

2 Derivation of the Multi-sectoral Thirwall's Law with Intermediate Inputs

The fact that Mexican exports are highly dependent on imports of intermediate goods has been highlighted by some authors as Moreno-Brid et al. (2005) and Ibarra and Blecker (2016). One of the striking aspects of this arrangement is that the exports of final goods require massive imports of intermediate goods, giving rise to the question of whether such a strategy is harmful to growth under a balance-of-payments constraint. In order to address this question, we believe that the most appropriate analytical framework is a disaggregated version of the Thirwall law such as the one advanced by Araujo and Lima (2007). But although such framework is carried out under some level of disaggregation, it was not originally designed for analyzing the impacts of a strategy based on imports of intermediate goods since it takes into account only the exports and imports of final goods. Hence, such as the original Thirlwall's law, the MSTL cannot take into fully account the imports of intermediate goods in the growth performance.

Conscious of such limitation, Blecker and Ibarra (2013) have explicitly introduced the possibility of importing intermediate goods in a balance of payment framework with four sectors, two exporters, namely manufactured exports and primary commodities, and two importers, namely intermediate and final goods. By considering that the growth rate of imports of intermediate goods is a function of the growth rate of exports of manufactures, the authors have concluded analytically that there is a reduction in the balance of payments equilibrium growth rate. More specifically, they have found that the income elasticity of exports of final goods undergoes a proportional decrease in the income elasticity of imports of intermediate goods. Such result was obtained under the hypothesis that "all imports have the same prices and all import-competing domestic goods have the same prices, regardless of whether they are intermediate or final goods" and that both physical quantities and prices of primary commodities grow at an exogenously given rate.

In what follows we intend to derive a multi-sectoral version of the MSTL in the same spirit of the one advanced by Blecker and Ibarra (2013) but now with an arbitrary number of sectors. In order to accomplish that, we consider the existence of two countries namely D (domestic) and F (foreign) [see Nishi (2014)] and carry out the analysis from the viewpoint of domestic country. We specify sectoral export functions that depend on the imports of intermediate inputs [see Blecker and Ibarra (2013)] according to:

$$m_{k_i} = \bar{m}_{k_i} \left(\frac{ep_{Fk_i}}{p_{k_i}} \right)^{-\varepsilon_{Dk_i}} Y_D^{\eta_{Dk_i}} x_i^{\gamma_{Dk_i}} \tag{1}$$

where e stands for the nominal exchange rate, p_{Fk_i} is the foreign price of the i-th intermediate input, k_i, used to produce the final i-th consumption good, p_{k_i} is the domestic price of the i-th intermediate output and $\varepsilon_{Dk_i} \in (0,1)$ it the price elasticity of the intermediate output. According to this specification, the production of the i-th consumption good requires only one kind of intermediate output, let us say k_i. The demand for intermediate inputs in terms of one unit of final output of the i-th good for exports, namely m_{k_i}, is a function of the income of the domestic country Y_D, weighted by the income elasticity of demand $\eta_{Dk_i} \geq 0$, and export demand for good i, x_i, weighted by the export demand income elasticity of good i, $\gamma_{Dk_i} \geq 0$. We also consider usual export and import functions for the final goods respectively as:

$$x_i = \bar{x}_i \left(\frac{p_i}{ep_{Fi}} \right)^{-\varepsilon_{Fi}} Y_F^{\eta_{Fi}} \tag{2}$$

$$m_i = \bar{m}_i \left(\frac{ep_{Fi}}{p_i} \right)^{-\varepsilon_{Di}} Y_D^{\eta_{Di}} \tag{3}$$

where $\bar{x}_i$ and $\bar{m}_i$ are a constant terms, x_i is the export demand function for consumption good i, m_i is the import demand function for consumption good i, Y_F is the income of foreign country F, p_i is the domestic price of the i-th good, p_{Fi} is the foreign price of the i-th good, $\eta_{Fi} \geq 0$ and $\eta_{Di} \geq 0$ are the income elasticities of demand for the i-th good exports and imports respectively and $\varepsilon_{Fi} \in (0,1)$ and $\varepsilon_{Di} \in (0,1)$ are the price elasticities of demand for the i-th good exports and imports respectively. By differentiating expressions (1), (2) and (3) we obtain:

$$\hat{m}_{k_i} = \varepsilon_{Dk_i} \left(\hat{p}_{k_i} - \hat{e} - \hat{p}_{Fk_i} \right) + \eta_{Dk_i} \hat{Y}_D + \gamma_{Dk_i} \hat{x}_i \tag{4}$$

$$\hat{x}_i = -\varepsilon_{Fi} \left(\hat{p}_i - \hat{e} - \hat{p}_{Fi} \right) + \eta_{Fi} \hat{Y}_F \tag{5}$$

$$\hat{m}_i = \varepsilon_{Di} \left(\hat{p}_i - \hat{e} - \hat{p}_{Fi} \right) + \eta_{Di} \hat{Y}_D \tag{6}$$

where $\hat{Y}_D$ is the domestic growth rate, $\hat{Y}_F$ is the foreign country growth rate, $\hat{p}_{Fi}$ is the growth rate of price of the i-th good in foreign country, $\hat{p}_i$ is the domestic growth rate of price of the i-th good, $\hat{p}_{Fk_i}$ is the growth rate of price of the k_i-th intermediate good in foreign country, $\hat{p}_{k_i}$ is the domestic growth rate of price of the k_i-th intermedia–te good and $\hat{e}$ is the growth rate of the nominal exchange rate. As in Araujo and Lima (2007), due to inexistence of technical change, let us assume that $\hat{p}_{k_i} = \hat{p}_{Fk_i} = \hat{p}_i = \hat{p}_{Fi} = 0$, $\forall i = 1, .., n-1$ which also means zero inflation rate in both countries for all goods. Besides, let us consider that $\hat{e} = 0$, meaning that neither continuous devaluations nor continuos overvaluations are allowed. By substituting (5) in (4), allows us to obtain:

$$\hat{m}_{k_i} = \eta_{Dk_i} \hat{Y}_D + \gamma_{Dk_i} \eta_{Fi} \hat{Y}_F \tag{7}$$

$$\hat{x}_i = \eta_{Fi} \hat{Y}_F \tag{8}$$

$$\hat{m}_i = \eta_{Di} \hat{Y}_D \tag{9}$$

From Araujo and Teixeira (2003) and Nishi (2014) the balance-of-payments equilibrium should be written as:

$$\sum_{i=1}^{n-1} p_i x_i = \sum_{i=1}^{n-1} \left(e p_{Fi} m_i + e p_{Fk_i} m_{k_i} \right) \tag{10}$$

Expression (10) considers that in equilibrium the imports of final and intermediate has to be totally financed by exports since we do not take into account the possbility of capital inflows, external debt etc. Then the main change in relation to Araujo and Lima (2007) is that now the domestic country imports two different kind of goods, namely final goods and intermediate goods. But, unlike to Blecker and Ibarra (2013) we do not assume that the prices of such goods are the same. By differentiating expression (10) with respect to time and disregarding technical change it yields after some algebraic manipulation the following expression:

$$\sum_{i=1}^{n-1} \left[\frac{p_i x_i \left(\hat{p}_i + \hat{x}_i \right)}{\sum_{i=1}^{n-1} p_i x_i} - \frac{e p_{Fi} m_i \left(\hat{e} + \hat{p}_{Fi} + \hat{m}_i \right) + e p_{Fk_i} m_{k_i} \left(\hat{e} + \hat{p}_{Fk_i} + \hat{m}_{k_i} \right)}{\sum_{i=1}^{n-1} e \left(p_{Fi} m_i + p_{Fk_i} m_{k_i} \right)} \right] = 0 \tag{11}$$

Following Nishi (2014), we define $v_i \equiv \frac{p_i x_i}{\sum_{i=1}^{n-1} p_i x_i}$ as denoting the market share of the i-th industry in a domestic country's total exports, $\mu_i \equiv \frac{e p_{Fi} m_i}{\sum_{i=1}^{n-1} e \left(p_{Fi} m_i + p_{Fk_i} m_{k_i} \right)}$ as denoting the market share of the i-th industry in the domestic country's total imports and $\omega_{k_i} \equiv \frac{e p_{Fk_i} m_{k_i}}{\sum_{i=1}^{n-1} e \left(p_{Fi} m_i + p_{Fk_i} m_{k_i} \right)}$ as denoting the market share of the intermediate k_i-th industry in the domestic country's total imports, with $v_i, \mu_i, \omega_{k_i} \in [0, 1]$. It should also be noted that $\sum_{i=1}^{n-1} v_i = 1$ and $\sum_{i=1}^{n-1} \mu_i + \sum_{i=1}^{n-1} \omega_{k_i} = 1$. We assume that these terms are exogenous and constant. Taking into account that $\hat{p}_{k_i} - \hat{e} - \hat{p}_{Fk_i} = 0$ and $\hat{p}_i - \hat{e} - \hat{p}_{Fi} = 0$ and replacing these expressions in (11) we obtain:

$$\sum_{i=1}^{n-1} v_i \hat{x}_i = \sum_{i=1}^{n-1} \mu_i \hat{m}_i + \sum_{i=1}^{n-1} \omega_{k_i} \hat{m}_{k_i} \tag{12}$$

By substituting (7), (8) and (9) in (12) it yields after some algebraic manipulation, the growth rate consistent with the balance of payments equilibrium:

$$\hat{Y}_D = \frac{\sum_{i=1}^{n-1} \left(v_i - \omega_{k_i} \gamma_{Dk_i}\right) \eta_{Fi}}{\sum_{i=1}^{n-1} \left(\mu_i \eta_{Di} + \omega_{k_i} \eta_{Dk_i}\right)} \hat{Y}_F \tag{13}$$

Expression (13) is a generalization of the MSTL law since if $\omega_{k_i} = 0 \ \forall i = 1, ..., n-1$ we obtain the result derived by Araujo and Lima (2007) without intermediate inputs. Note that both the numerator and denominator now incorporates the presence of intermediate goods to the imports. In the denominator, it is just a matter of decomposition of the imports between final and intermediate goods that were not taken into consideration in the original MSTL. However, the most important difference is in the numerator, where the income elasticity of exports are decreasing in those sectors where intermediate inputs are imported. The additional message that accrue from expression (13) is that the growth rate consistent with intertemporal equilibrium in the balance-of-payments is lower in the presence of intermediate goods being imported to master final goods to export.

Although this result is akin to the one obtained by Blecker and Ibarra (2013) it is worthy to highlight an important difference. These authors have considered a particular structure for the economy assuming that the export sectors, for instance, are manufactured and other goods, the latter comprising primary commodities, chiefly oil and agricultural products. The authors then reasonably assume that both the growth rate of exports of the primary goods and their price grow at an exogenously given rate, presuming that their quantities and prices are determined by conditions in global commodity markets. Here we do not make these assumptions since our first aim was just to obtain a generalization of the MSTL. Although we do not assume a particular structure *ex-ante* for the economy, the model can accommodate such sectoral arrangements with minor changes in the final outcome.

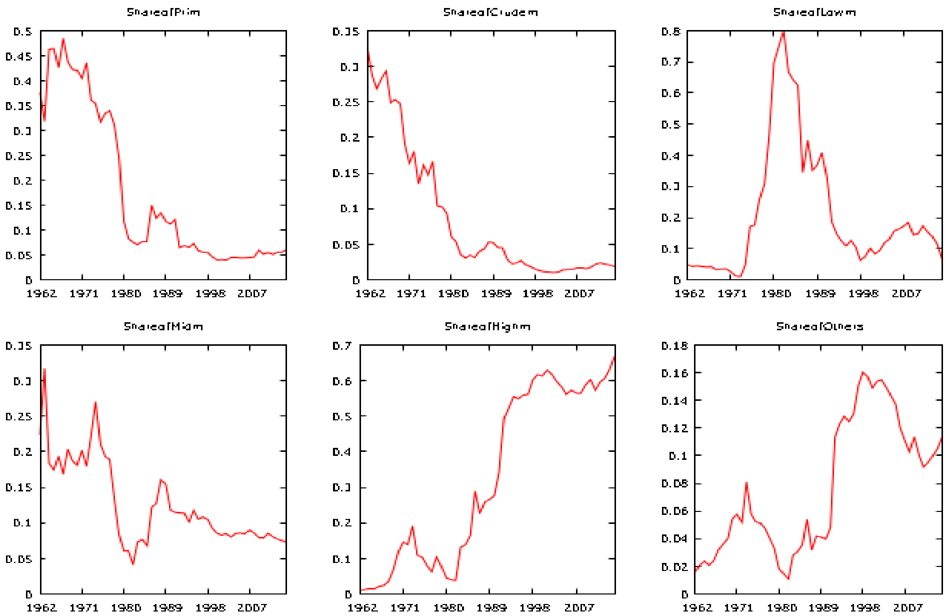
3 Econometric Analysis and Numerical Simulations

As previously stated, one of the aims of this paper consists in comparing the predictive power of the original MSTL and the version presented here with intermediate inputs. In order to reckon the balance-of-payments-constrained growth rate, we have estimated two different versions of the multisectoral Thirlwall's law. The first one being that derived by Araujo and Lima (2007) and the second one that derived here in the presence of intermediate goods. In the first case, according to the methodology adopted by Araujo and Lima (2007), we consider that all imported goods are just final goods not taking into account the existence of intermediate goods. For the second estimate, we have split imports into two categories, namely final goods and intermediate goods. In this regard, we intend to evaluate which of these approaches is best suited to explain the economic growth in Mexico from 1962 to 2014.

In order to proceed to this empirical exercise, due to the high complexity of the economic structure of Mexico, we have focused only on the six major sectors in the Mexican trade in 2014 according to the United Nations Commodity Trade Statistics Database (COMTRADE). The nomenclature of these sectors and their abbreviations are: i) food and live animals (prim), (ii) crude materials, inedible, except fuels (crudem), (iii) mineral fuels, lubricants and related materials (lowm), iv) manufactured goods classified chiefly by material (midm), v) machinery and transport equipment (highm), and vi) miscellaneous manufactured articles (others). All these sectors are organized according to the catalog of the Standard International Trade Classification Revision 1 (SITC-Rev. 1). From this information, we have reckoned the sectoral trade as well as the relative share of exports and imports in the trade sector. The other variables used, namely the economic growth rate of Mexico (gdpmex), the growth rate of the world economy (gdpwld) and the growth rate of the bilateral real exchange rate (exch) were drawn from the World Development Indicators (WDI). Although the relevant equations of the theoretical model were derived in terms of growth rates, we have decided to follow Gouvea and Lima (2010) and Blecker and Ibarra (2013) who estimated the model by using data in logarithm by using the Johansen (1991) and the ordinary least squares (OLS) methods.

Graph 1 shows the evolution of the relative share of sectors in the export of Mexico over the past decades. As can be seen, the more technology-intensive products, namely, the machinery and transport products hold a stake of approximately 65% in the exports against 2% which they had in 1962. On the other hand, primary products, that once held 37.5% share in the exports, now have only 5.5%. This shows that there has been, to some extent, a structural shift in favor of higher income elasticity of demand sectors as pointed out by Gouvea and Lima (2009), implying a better growth performance. This range of view is supported by Blecker and Ibarra (2012, p. 2): "Mexico's exports shifted toward more technologically advanced products with higher income elasticities in a way that more resembles the East Asian countries rather than other Latin American nations in their sample". However, such changes in the composition of exports were not sustained across years and do not reflect their heavy dependency on imported intermediate goods.

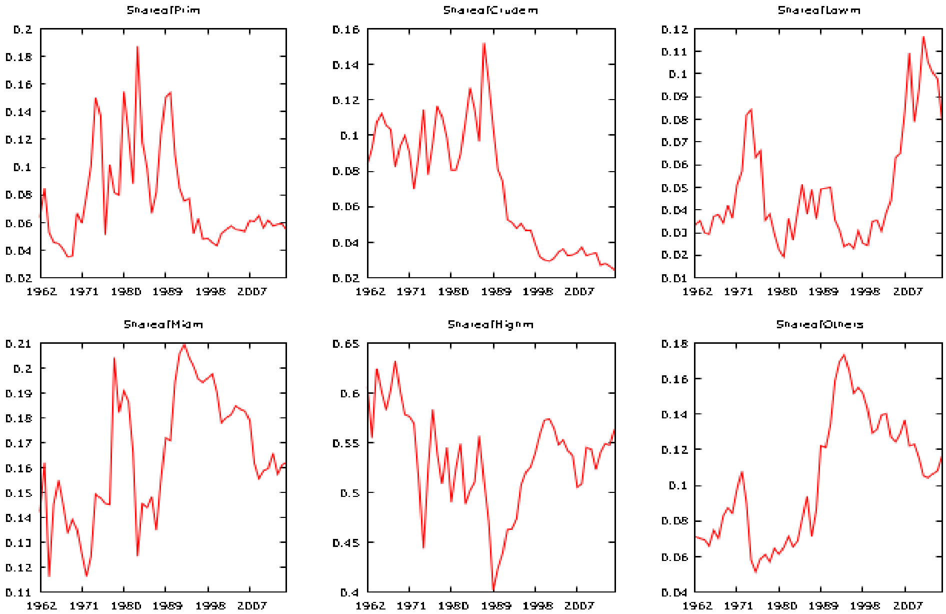
Graph 1: Evolution of Relative Participation of Exports of Mexico Between 1962 and 2015.



Source: COMTRADE.

Graph 2 illustrates the evolution of the relative share of each sector in imports from 1962 to 2015. Imports of hi-tech products (highm) decreased by 4 percentage points or so. In addition, Mexico has also increased the share of intermediate goods (midm) in the imports by approximately 4 percentage points between 1964 and 2015. Insofar as these products have a high-income elasticity of demand, this contributed to the fact that the income elasticity of imports has raised after Nafta as reported by Moreno-Brid (1999, 2002) and Pacheco-López and Thirlwall (2004). In this sense, in the light of the structural change theory [see Blecker (2009) and Thirlwall (2013)], it can be said that structural changes implemented on the exports front was somewhat offset by the deterioration in the imports, slowing the pace of economic growth in Mexico after deepening of trade liberalization.

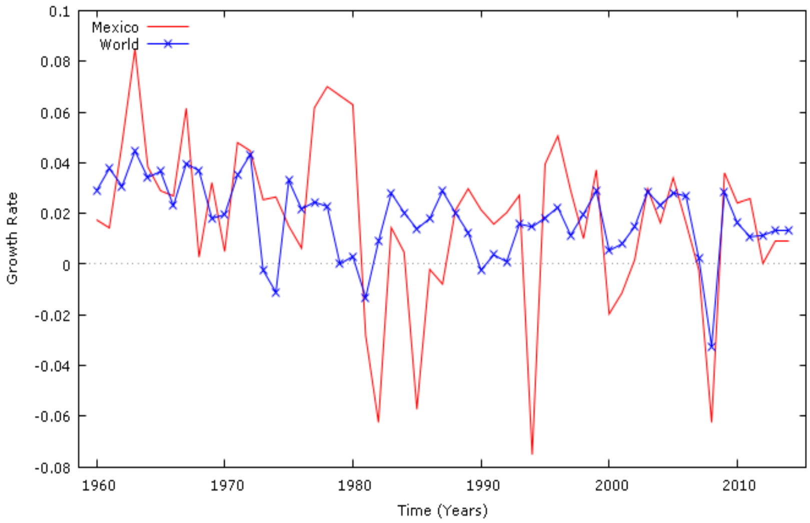
Graph 2: Evolution of Relative Participation of Imports of Mexico Between 1962 and 2015.



Source: COMTRADE.

The reflection of that on the dynamics of trade of the Mexican economy can be seen in Figure 3, which shows the trend observed in the growth rate of GDP of Mexico and of the world growth rate since 1962. Note that the Mexico average per capita economic growth in the first 25 years (2.86% a.p.) was very higher than the average of the last 30 years (0.88% a.p.). Moreover, the annual Mexico average per capita economic growth (1.78% a.p.) was close to the growth rate of the world per capita income (1.79%). Other factors such as the fierce competition of the Chinese producers in the U.S. market after China entry in the WTO in 2001 and repeated economic crisis may help to explain such performance, leading Blecker and Ibarra (2013) to conclude that the external constraint was not binding through the whole period. This shows evidence that had Mexico succeeded in performing a complete structural change, then it would keep growth rates consistent with those in the first years.

Graph 3: Mexico and World GDP Economic Growth Between 1960-2014.



Source: WDI.

Table 1 shows the result of the unit root tests. Among the available tests we used are the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS), whose results are shown below. Although all series but the real exchange rate one were found to be integrated of the first order, all of the series in first difference are stationary at 1% regardless of the test adopted. Hence, the Johansen (1991) test was used to determine if the I(1) series are cointegrated. Then, whenever it is not possible to reject the null hypothesis of the existence of at least one cointegration vector, we estimate the equations by the Johansen method. The advantage of such approach is that there is no loss of information since all variables are considered in levels. Besides, concerning the growth rate of all variables, we have concluded that all of them are stationary at 1%, and then the OLS procedure can be adopted.

Table 1: Results of Unit Roots Tests.

Series\Tests	ADF		PP		KPSS		Concl.		Series\Tests	ADF	PP	KPSS	Concl.
	Level	Diff.	Level	Diff.	Level	Diff.	Level	Diff.					
LN(realexch)	-3.13**	-7.28***	-3.12**	-9.85***	0.12	0.18	I(0)	I(0)	g(realexch)	-7.28***	-9.85***	0.18	I(0)
LN(xprim)	-0.49	-7.86***	-0.41	-9.24***	0.87△△△	0.11	I(1)	I(0)	g(xprim)	-7.73***	-9.17***	0.03	I(0)
LN(xcrudem)	-0.13	-7.40***	-3.29*	-7.74***	0.85△△△	0.11	I(1)	I(0)	g(xcrudem)	-7.27***	-7.65***	0.05	I(0)
LN(xlowm)	-1.49	-4.42***	-1.45	-4.45***	0.71△△	0.17	I(1)	I(0)	g(xlowm)	-4.40***	-4.26***	0.08	I(0)
LN(xmidm)	-1.00	-7.37***	-0.76	-9.22***	0.86△△△	0.12	I(1)	I(0)	g(xmidm)	-8.70***	-9,21***	0.08	I(0)
LN(xhighm)	-2.10	-7.09***	-2.15	-7.09***	0.86△△△	0.37△	I(1)	I(0)	g(xhighm)	-7.64***	-7.32 ***	0.05	I(0)
LN(xotherm)	-1.37	-7.30***	-1.38	-7.30***	0.85△△△	0.18	I(1)	I(0)	g(xotherm)	-7.21***	-7.25***	0.09	I(0)
LN(mprim)	-1.24	-7.54***	-1.31	-8.19***	0.17△△	0.09	I(1)	I(0)	g(mprim)	-7.08***	-7.02***	0.06	I(0)
LN(mcrudem)	-2.01	-8.08***	-3.31**	-7.83***	0.22△△△	0.38△	I(1)	I(0)	g(mcrudem)	-7.19***	-7.13***	0.05	I(0)
LN(mlowm)	-0.71	-7.76***	-0.63	-8.42***	0.86△△△	0.07	I(1)	I(0)	g(mlowm)	-7.45***	-9.57***	0.03	I(0)
LN(mmidm)	-1.02	-6.06***	-1.10	-6.39***	0.85△△△	0.15	I(1)	I(0)	g(mmidm)	-6.22***	-6.18***	0.08	I(0)
LN(mhighm)	-0.77	-6.46***	-0.80	-6.97***	0.86△△△	0.12	I(1)	I(0)	g(mhighm)	-6.46***	-6.,53***	0.07	I(0)
LN(motherm)	-1.01	-5.92***	-1.04	-5.83***	0.86△△△	0.14	I(1)	I(0)	g(motherm)	-5.67***	-5.53***	0.12	I(0)
LN(gdpmex)	-1.64	-6.61***	-2.22	-5.91***	0.96△△△	0.25	I(1)	I(0)	g(gdpmex)	-5.65***	-5.40***	0.03	I(0)
LN(gdpwld)	-2.05	-3.90***	-2.35	-3.84***	0.96△△△	0.44△	I(1)	I(0)	g(gdpwld)	-4,.32***	-3,81***	0.06	I(0)

Source: Elaborated by the author.

(1) * Stationary at 10%; ** stationary at 5%; *** stationary at 1%.

(2) △ Non stationary at 10%; △ △ non stationary at 5%; △ △ △ non stationary at 1%.

Due to the lack of data available for the sectoral prices in the period considered, we used the rate of the effective bilateral real exchange rate (US-Mexico) as a proxy for the real exchange growth rate sector, which corresponds to the growth rate of the effective bilateral real exchange rate. Besides, we have taken into account that sector 'prim' and 'crudem' import intermediate goods that are used to produce the final goods of the 'midm' sector. This choice rested on the fact that the 'midm' sector is essentially a final good sector. Hence, the following equations were estimated:

$$\hat{m}_{k_2} = \varepsilon_{Dk_2}\hat{R}_{k_2} + \eta_{Dk_2}\hat{Y}_D + \gamma_{Dk_2}\hat{x}_2 \tag{14}$$

$$\hat{x}_i = \varepsilon_{Fi}\hat{R}_i + \eta_{Fi}\hat{Y}_F \tag{15}$$

$$\hat{m}_i = \varepsilon_{Di}\hat{R}_i + \eta_{Di}\hat{Y}_D \tag{16}$$

According to Blecker (2009), there are four external factors that explain the fluctuations in the growth rate of GDP of Mexico, namely, i) the growth rate of the United States, ii) net financial flows, iii) the actual price oil and iv) real exchange rate lagged one year. Moreover, there were a structural breaks in the some of these variables due to trade liberalization in 1987, the NAFTA Decree in 1994 and China's entry into the World Trade Organization (WTO) in 2001. Besides, we have taken into account the first (1973) and second (1979) oil crisis, and the recent worldwide crisis (2008). Hence, the Chow structural break in the following years 1973, 1979, 1987, 1994, 2001 and 2008 are presented in Table 2 for all estimations that the test is relevant.[1]

As can be noted, the Chow test shows that there is evidence for structural breaks in some of the series during the period under consideration. This implies the need to divide the series into seven sub-samples (1962-1973, 1974-1979, 1980-1987, 1988-1994, 1995-2001, 2002-2008, 2009-2014) in order to obtain a more accurate approximation of the parameters in some regressions. However, such task can not be rightly performed due to the lack of robustness in estimating parameters with a small number of observations in each subperiod.

Table 2: Result of Chow Breakpoint Test For Specific Years.

Equations	F-statistic					
	1973	1979	1987	1994	2001	2008
$\hat{x}_1 = \varepsilon_{F1}\hat{R}_1 + \eta_{F1}\hat{Y}_F$	9.25***	1.69	2.48*	3.36**	0.03	0.44
$\hat{x}_2 = \varepsilon_{F2}\hat{R}_2 + \eta_{F2}\hat{Y}_F$	2.59*	3.53**	5.21***	6.44***	2.04	2.04
$\hat{x}_3 = \varepsilon_{F3}\hat{R}_3 + \eta_{F3}\hat{Y}_F$	1.78	10.10***	5.40***	2.53*	1.27	0.53
$\hat{x}_4 = \varepsilon_{F4}\hat{R}_4 + \eta_{F4}\hat{Y}_F$	2.22	1.86	0.69	0.76	0.36	0.25
$\hat{x}_5 = \varepsilon_{F5}\hat{R}_5 + \eta_{F5}\hat{Y}_F$	0.81	0.65	1.61	0.26	0.47	0.05
$\hat{x}_6 = \varepsilon_{F6}\hat{R}_6 + \eta_{F6}\hat{Y}_F$	0.13	0.18	0.60	0.41	0.17	0.01
$\hat{m}_1 = \varepsilon_{D1}\hat{R}_1 + \eta_{D1}\hat{Y}_D$	0.28	0.69	1.53	1.15	0.10	0.05
$\hat{m}_2 = \varepsilon_{D2}\hat{R}_2 + \eta_{D2}\hat{Y}_D$	0.42	3.42**	2.86*	0.51	0.74	0.53
$\hat{m}_3 = \varepsilon_{D3}\hat{R}_3 + \eta_{D3}\hat{Y}_D$	0.51	0.71	1.32	1.58	3.09*	1.33
$\hat{m}_4 = \varepsilon_{D4}\hat{R}_4 + \eta_{D4}\hat{Y}_D$	0.21	1.98	1.74	3.99**	0.10	0.04
$\hat{m}_5 = \varepsilon_{D5}\hat{R}_5 + \eta_{D5}\hat{Y}_D$	0.12	0.44	4.25**	3.01*	0.46	0.26
$\hat{m}_6 = \varepsilon_{D6}\hat{R}_6 + \eta_{D6}\hat{Y}_D$	0.03	0.00	2.73*	5.93***	1.01	0.28
$\hat{m}_{k_2} = \varepsilon_{Dk_2}\hat{R}_{k_2} + \eta_{Dk_2}\hat{Y}_D + \gamma_{Dk_2}\hat{x}_2$	0.03	0.73	0.94	0.65	0.50	0.59

Source: Elaborated by the author.
(1) 1, 2, 3, 4, 5 and 6 represents the sectors prim, rbm, lowm, midm, highm and others, respectively.
(2) * There exists structural break at 10%; ** There exists structural break at 5%; *** There exists structural break at 1%.

Table 3 presents the results of the econometrically estimated parameters by OLS and Johansen methods. Firstly, it may be noted that practically all pa-

[1]Note that only the equations which parameters were estimated by OLS is necessary to make structural break test. In this way, the elasticities extracted through Johansen method (1991) allow us to prescind of realization of structural break test, because the cointegration ensures a long term stable relationship between the variables and the short term deviation are corrected by the Vector Error Correction (VEC).

rameters concerning to real exchange rate are statistically significant, in both estimation methods. It might be concluded that changes in the terms of trade play a role [Ibarra and Blecker (2016)], that is, effects from real exchange rate affected substantially the Mexican trade performance in recent decades. This is especially true for the 'prim', 'lowm' and 'others'. Furthermore, as expected, all sectoral parameters related to the growth rate of both domestic and foreign income were statistically significant at 1% by Johansen method. But, some sectors as 'lowm' exporter and 'prim' importer has shown no statistical significance for the income elasticities in OLS estimation. In the one hand, the results highlight 'others' and 'highm' as the most important for growth in Mexico during the period analyzed in terms of the ratio of the income elasticities. On the other hand, the intermediate import sectors have shown to been playing a negative effect both on the elasticity ratio and on the growth performance, because the elasticities ratio of this sector is less than one unit.

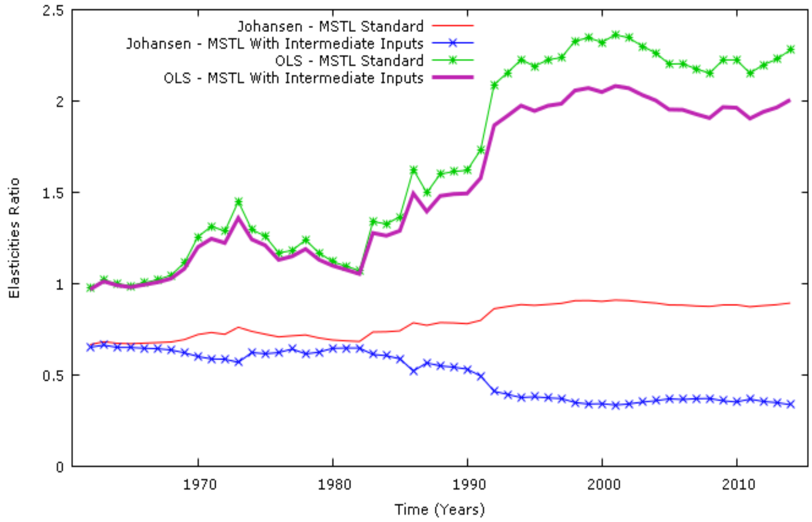
Table 3: Estimated Parameters for the Mexican Economy in Both Methods (1962-2014).

Sectors/Param.	η_{Fi}		ε_{Fi}		ε_{Di}		η_{Di}		ε_{Dki}		η_{Dki}		γ_{Dk_i}	
	OLS	J.	OLS	J.	OLS	J.	OLS	J.	OLS	J.	OLS	J.	OLS	J.
prim	1.61***	0.82***	-0.35**	1.18**	1.63***	3.46***	1.13	1.15***	1.58***	1.66**	0.96	0.37**	0.51***	0.72***
	(0.49)	(0.03)	(0.15)	(0.38)	(0.42)	(0.94)	(0.91)	(0.09)	(0.40)	(0.72)	(0.85)	(0.18)	(0.17)	(0.17)
crudem	1.27*	0.75***	0.37*	0.74	0.78***	1.36***	1.35***	0.94***	0.75***	0.55*	1.28**	0.59***	0.22**	0.32***
	(0.68)	(0.04)	(0.22)	(0.51)	(0.23)	(0.39)	(0.49)	(0.03)	(0.22)	(0.28)	(0.48)	(0.07)	(0.10)	(0.06)
lowm	1.63	0.83***	0.81*	1.14	0.88**	5.43***	2.17***	1.32***	-	-	-	-	-	-
	(1.49)	(0.24)	(0.48)	(2.94)	(0.34)	(1.30)	(0.73)	(0.12)						
midm	1.93**	0.93***	0.12	2.49**	1.30***	4.67***	1.70***	1.29***	0.86**	2.08**	2.13***	0.59***	0.13	0.49***
	(0.85)	(0.09)	(0.27)	(1.15)	(0.24)	(1.05)	(0.51)	(0.10)	(0.34)	(0.90)	(0.74)	(0.13)	(0.15)	(0.09)
highm	5.00***	1.25***	-0.02	6.06*	0.88***	4.18***	1.74***	1.29***	-	-	-	-	-	-
	(1.08)	(0.29)	(0.35)	(3.56)	(0.18)	(0.89)	(0.40)	(0.08)						
others	3.47***	1.21***	0.25	6.04**	0.90***	5.00***	1.81***	1.31***	-	-	-	-	-	-
	(1.06)	(0.21)	(0.34)	(2.59)	(0.23)	(1.37)	(0.50)	(0.13)						

Source: Elaborated by the authors.
(1) * Statistically significant at 10%; ** Statistically significant at 5%; *** Statistically significant at 1%.
(2) Standard error in parentheses.

Graph 4 shows the evolution of the ratio of the income elasticities weighted by the sector share in the Mexico trade by using parameters estimated by the two methods. Note that for both methods, the ratio of the elasticities in the model with intermediate inputs is lower than the ratio of the elasticities in the traditional MSTL. However, until 1982, the difference between the ratios of elasticities is almost negligible, while from 1982 on, that difference increased substantially and passed to amount to a significant difference between the two versions. This fact indicates that the imports of intermediate inputs did not matter significantly to explain the Mexican growth performance in the first twenty years of the series. In the mid-eighties, however, such imports acquired a central importance due to the government stimulus to the maquilas. Therefore, we conclude that the imports of intermediate goods due to the maquilas is of key importance to understanding the reduction both in the ratio of the income elasticities and the growth rate of the Mexican economy.

Graph 4: Evolution of The Mexican Ratio of Income-Elasticities Between 1962 and 2014.



Source: Elaborated by the authors.

Table 5 reports the actual Mexican growth rate and the Mexican growth rate estimated by the two models as well as the absolute error between the actual and estimated models. The elasticities that fed the numerical simulations were estimated by using the Johansen method. We have found that the average absolute error of the forecast made by the traditional model was 3.90% while the model with intermediate goods, 3.00% p.p. Therefore, there is a difference of approximately 30% between the predictions of both models. Moreover, the results show that the intermediate goods version of the MSTL generates better forecast results for Mexico's growth rate in the observed period.

Table 4: Observed and Foreseen Economic Growth Rates of The Mexico Between 1962 and 2013.

Years/Variables	$\hat{Y}_D(1)$	$\hat{Y}_D^S(2)$	Absolute Error (2) - (1)	$\hat{Y}_D^I(3)$	Absolute Error (3) - (1)
1962	0.081	0.032	0.049	0.032	0.050
1965	0.061	0.043	0.018	0.042	0.019
1967	0.094	0.035	0.060	0.032	0.062
1970	0.038	0.034	0.004	0.029	0.008
1972	0.079	0.073	0.006	0.065	0.013
1975	0.044	-0.021	0.065	-0.022	0.066
1977	0.090	0.066	0.023	0.063	0.026
1980	0.088	0.045	0.043	0.042	0.046
1982	-0.042	-0.007	0.035	-0.009	0.033
1985	-0.038	-0.097	0.060	-0.099	0.062
1987	0.012	0.191	0.179	0.179	0.166
1990	0.042	0.079	0.036	0.068	0.026
1992	0.041	0.070	0.030	0.063	0.022
1995	0.059	0.129	0.071	0.119	0.060
1997	0.047	0.012	0.035	-0.002	0.049
2000	-0.006	0.065	0.072	0.059	0.065
2002	0.014	-0.064	0.078	-0.087	0.101
2005	0.049	0.040	0.010	0.019	0.031
2007	0.014	0.007	0.007	-0.001	0.014
2010	0.039	0.045	0.006	0.030	0.009
2012	0.014	0.077	0.063	0.063	0.049
2013	0.022	0.005	0.017	-0.008	0.030
Mean	0.038	0.039	0.043	0.030	0.045

Source: Elaborated by the authors.

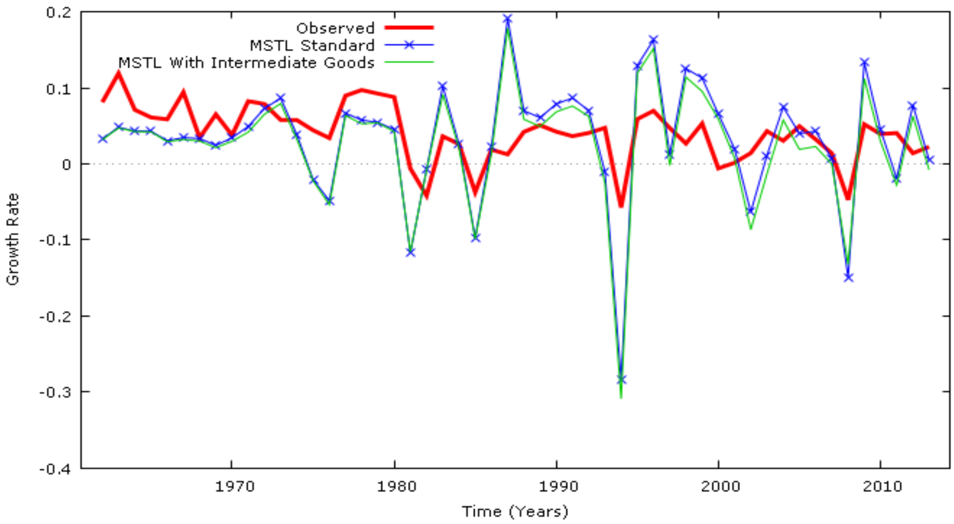
Notes: (1) represents the true Mexican growth rate;

(2) the Mexican growth rate foreseen by the LTMS standard and

(3) the Mexican growth rate foreseen by the LTMS with intermediate goods.

Graph 5 shows the intuition of what is presented in Table 5, focusing on the evolution of the tree series: observed growth rate, and growth rate predicted by the traditional model [Araujo and Lima (2007)] and by the extended version for the Mexican economy. Note that, for some periods, the observed growth rate is higher than the predicted one by the two methods but, for others, the predicted growth rate is lower than the observed ones. In the first ten years, the observed growth rates were, consistently, higher than the predicted growth rate by both methods. The results also show that by considering the original MSTL the Mexican growth experience after Nafta is not constrained by the balance-of-payments, a result that is tantamount to the one obtained by Ibarra and Blecker (2016). According to them, other factors than the balance-of-payments constraint should be taken into account to explain Mexican growth performance since 1962.

Graph 5: Comparison Between the Mexican Economic Growth Rate Observed and Foreseen.



Source: Elaborated by the authors.

In order to decide which model best fit the data, a regression of the rate observed with the rates set by the two cases was performed. Table 5 shows the degree of growth rate adjustment provided for in both cases (R-squared). As can be seen, the results show that MSTL with intermediate goods have a better predictive power than the data than the original MSTL in the period under consideration, with the estimates from the Johansen method presenting a better fit the data than the estimates obtained by OLS.

Table 5: Comparison Between the Adjusted Level of Both Forecasts.

$\hat{Y}_D$	LTMS Standard		LTMS with Intermediate Goods	
	Johansen	OLS	Johansen	OLS
Coefficient	0.2645 ***	0.3107 ***	0.2739 ***	0.3962 ***
	(0.0564)	(0.090)	(0.0563)	(0.1076)
Intercept	0.0316 ***	0.0242 ***	0.0336 ***	0.0213 **
	(0.0047)	(0.006)	(0.0044)	(0.006)
R-squared	0.3054	0.1924	0.3209	0.2132
Adjusted R-squared	0.2915	0.1763	0.3073	0.1974

Source: Elaborated by the authors.
(1) * Statistically significant at 10%; ** Statistically significant at 5%; *** Statistically significant at 1%.
(2) Standard error in parentheses.

These results show that at least for the case of the Mexican economy since 1962, the version with intermediate goods is better to explain the mexican economic growth than the original MSTL. A possible interpretation of such result is that the imports of intermediate goods did play a decisive role in explaining the Mexican growth experience during the analyzed period. In order to further investigate this issue, the econometric results for the Mexican economy were used to feed a numerical routine. To this end, we have obtained via Monte Carlo simulation results from equation (13) with and without disaggregation to determine the Mexico growth rate. The sectoral income elasticities were from Johansen method adopted in the numerical simulation were drawn from table 3, and the share of each sector in exports and imports were obtained from COMTRADE. These parameters were used to compare the performance of the Mexican economy under two scenarios, namely with and without disaggregating the imports in terms of intermediate goods. With respect to the share of each sector in imports and exports, we have chosen to made them constant through time thus keeping the composition of exports and imports according to the values observed in 2014. With respect to the growth rate of world income, we have used expression (17) below to reckon it in each period:

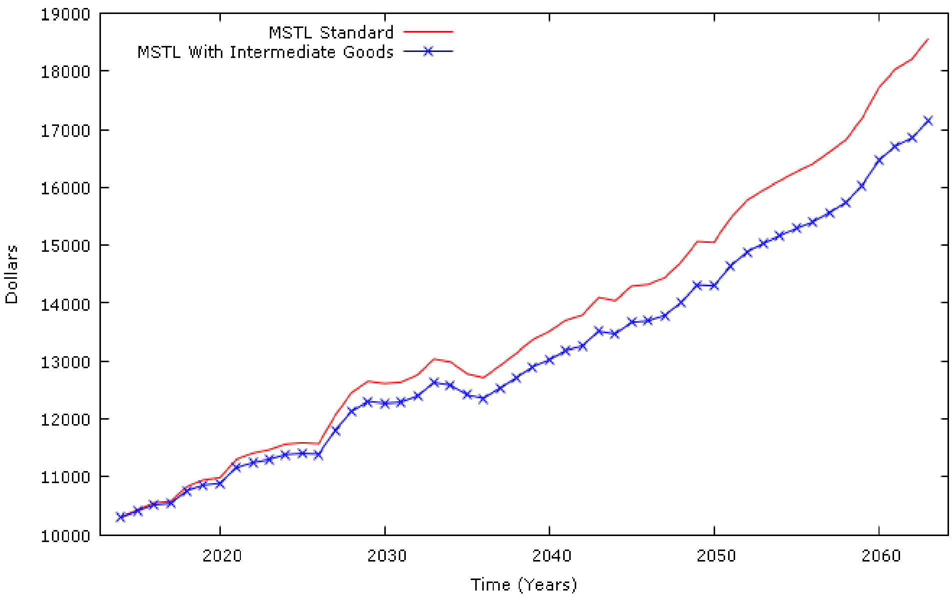
$$X_t = \mu + \sigma \epsilon_t \tag{17}$$

where X_t is a stochastic process with mean μ and standard error σ. The term ϵ_t is a white noise. Then by considering the time span from 1962 to 2014 we have obtained $\mu = 0.0133$ and $\sigma = 0.0132$. With such information, and by using the parameters estimated econometrically it was possible to generate the growth rate of the Mexico economy under the two scenarios, namely with and without intermediate goods by using the following expression:

$$Y_{D_T} = Y_{D_1}\left[\prod_{t=1}^{T}(1+g_t)-1\right] \tag{18}$$

where Y_{D_t} is the per capita income at the end of the period and $Y_{D_1}$is the per capita income at time one. g_t is the growth rate of income in the period t. Graph 5 shows the trajectory of per capita income in Mexico for the two simulated cases. In the scenario that ignores the import of intermediate goods, from the current amount of US$ 10,300.00, a per capita income of US$ 18,565.46 is reached after 50 periods. In the alternative scenario, which considers the imports of intermediate goods, an income per capita of US$ 17,135.86 was reached after the same period.

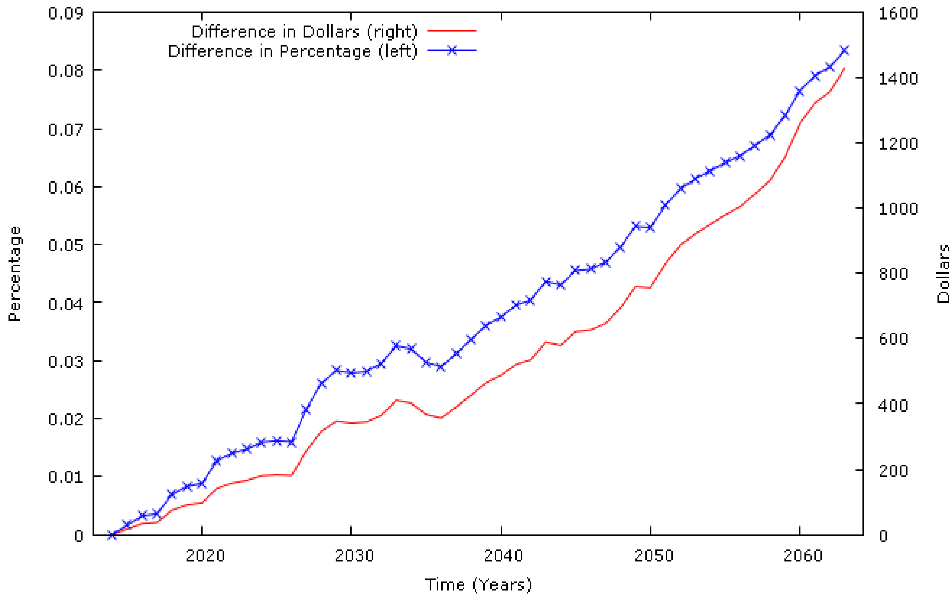
Graph 6: Mexico PNB per capita Evolution Foreseen in Both Versions of LTMS (US$).



Source: Elaborated by the authors.

Note that for each year the difference between the simulated economic growth rates is increasing - see graph 6 - resulting in a not negligible difference in the values of per capita incomes in the end of the period - see graph 7. In the long run, the value of the difference in dollars corresponds to approximately to US$ 1,400.00, and in percentage it amounts to 8.50%.

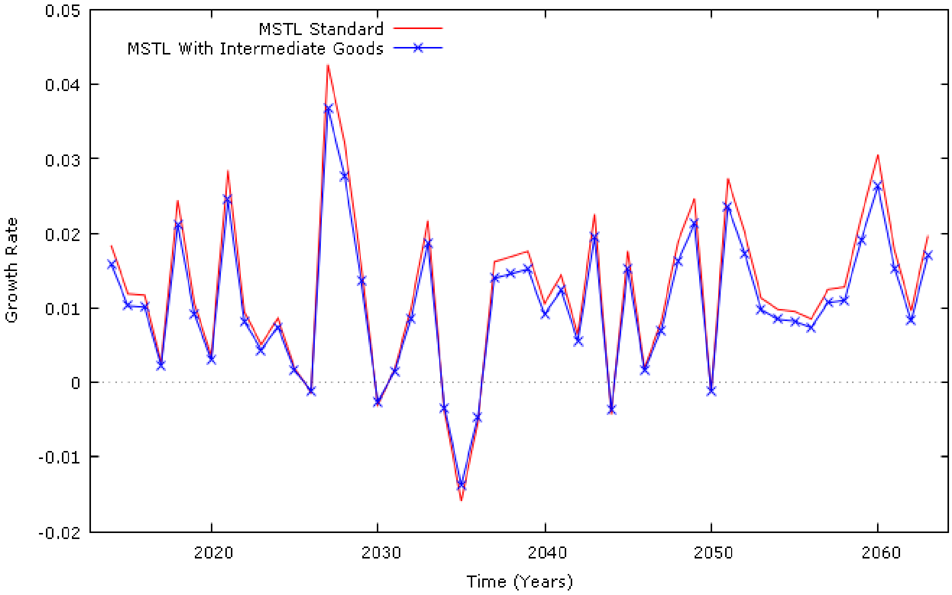
Graph 7: Difference Between Accumulated Mexico Foreseen PNB per capita in Dollars and Percentage.



Source: Elaborated by the authors.

Finally, graph 8 decisively shows that a growth strategy based on imports of intermediate inputs with high-elasticity with respect to exports may give rise to a worse growth performance than that without intermediate inputs. This result allows us to conclude that, although Mexico has obtained a certain success in terms of growth performance, the strategy of relying on massive imports of intermediate inputs seems to be flawed since it reduces the chance of catching-up with advanced economies in the long run. In this vein, such results suggest that it is important to Mexico to reduce its dependence on imports of intermediate goods with high income elasticity with respect to exports.

Graph 8: Annual Growth Rates of the Mexico In Both Scenarios.



Source: Elaborated by the authors.

So we conclude that a growth strategy driven by the absence of imports of intermediate high income elasticity goods is superior in terms of growth performance than an strategies based on imports of such goods. In this case, if on the one hand a strategy based on the imports of intermediate inputs would allow the country to export manufactured goods with higher income elasticity of demand by enhacing the average income elasticity of exports, on the ohter hand, it also increases the average income elasticity of imports, mainly if the intermediate inputs present high elasticity with respect to exports. The final outcome, namely if such strategy is beneficial or harmful to growth, is an empirical question addressed in this paper.

4 Concluding Remarks

In this paper, we study the effects of the imports of intermediate inputs on the growth performance. With such analysis we aimed at determining whether the presence of those goods in the imports of a country would imply a significant reduction in the balance-of-payments-constrained growth rate. To that end, we have adopted a procedure similar to Blecker and Ibarra (2013) who included the imports of intermediate goods in the export functions of manufactured goods. By using this strategy within the structural economic dynamic model [Pasinetti (1993) and Araujo and Teixeira (2003)] it was possible to establish an extended version of the MSTL taking into account imports of intermediate goods, which shows that the presence of intermediate goods in the imports can indeed lead to a reduction in the growth rate compatible with the intertemporal equilibrium in the balance-of-payments.

This result was econometrically tested for the Mexican economy by comparing the balance-of- payments-constrained growth rate by using the traditional MSTL and the one derived here with intermediate inputs. From 1962 to 1982, we have found that the estimates from the two versions are close but from 1982 on, when a strategy based on imports of intermediate inputs was adopted, the growth rate reckoned by the two methods present a significant difference, with the performance with intermediate goods being worse than what would be without such goods. By using the parameters from the two versions of the MSTL we ran numerical simulations that showed that the imports of intermediate inputs can dampen the growth performance of the economy in the long run, confirming the econometric findings. From these results we can infer that had Mexico not relied so much on the imports of intermediate inputs it could have experienced higher growth rates. Therefore these findings reassert the central message of the MSTL, namely that, in the end, the growth rate of a country will depend on its structure, which is strongly reflected in the weighted export and import elasticities.

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Appendix A

Table 6: Technologial Classification

Classification	Examples
Food and live animals	Meat, fish, cereals, fruits, cofee, tea, spices.
Crude materials, inedible, except fuels	Hides, skins, some animals skins, oil seeds.
Mineral fuels, lubricants and related materials	Coal, coke, lignite, petroleum, distillate fuels.
Manufact goods classified chiefly by material	Leather, rubber manufactures, paper, cork manufactures.
Machinery and transport equipment	Nuclear reactors, water turbines, walking tractors.
Miscellaneous manufactured	Sanitary, plumbing, travel goods, handbags, umbrellas.

Source: Authors' calculations according to the Standard International Trade Classification, Rev. 1.