Trade Liberalization and the Balance of Payments Constraint with Intermediate Imports: The Case of Mexico Revisited

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Abstract

Previous studies have found that a tightening of the balance of payments (BP) constraint can explain the slowdown in Mexico's growth after trade liberalization. This paper develops a disaggregated model of the BP constraint with two types of exports (manufactured and primary commodities) and two types of imports (intermediate and final goods). Econometric estimates show that the BP-equilibrium growth rate did not fall, but instead rose in the post-liberalization period, so this model cannot account for the actual growth slowdown. Instead, the analysis points to the need to consider the real exchange rate as well as internal obstacles and policies.

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1. Introduction

During the past two decades, a large empirical literature has applied the model of balance-of-payments-constrained growth (BPCG), originally developed by Thirlwall (1979),[1] to a variety of countries and situations. One case in which the BPCG model appears to have had strong success is in explaining the growth slowdown in Mexico following its liberalization of trade in the late 1980s. Moreno-Brid (1999, 2002), López and Cruz (2000), Guerrero de Lizardi (2003), Pacheco-López and Thirlwall (2004), Pacheco-López (2005), and Cardero and Galindo (2005) all found that Mexico's income elasticity of import demand increased significantly during the post-liberalization period (or after the formation of the North American Free Trade Agreement, NAFTA), without a compensating acceleration of the country's export growth. In the BPCG framework, this implies a reduction in the growth rate consistent with balance of payments equilibrium, i.e., the growth rate just low enough to prevent chronically increasing trade deficits caused by imports rising faster than exports.

There is no question that Mexico's average growth rate has declined since the country opened its economy in the aftermath of the 1980s debt crisis. Mexico's growth rate has averaged about 3% per year since 1987, barely half of what the country achieved between the 1940s and the 1970s (omitting the debt crisis years of the early and mid-1980s). Similarly, the average growth rate of per capita income fell from about 3% to 1% per year between the same two periods (the gap is smaller in per capita terms because of slower population growth).[2] Given that the country's liberalization policies were motivated by a desire to achieve more rapid and more

[1] See McCombie and Thirlwall (1994, 2004) for later extensions and applications. For skeptical views see Krugman (1989), Razmi (2011), and Ros (2012).

[2] Data are from International Monetary Fund, *International Financial Statistics* and *World Economic Outlook*, on-line databases, and Urquidi (2003).

sustainable long-term growth (see Lustig, 1998), this disappointing growth performance has naturally brought forth a large literature seeking to explain it (see Moreno-Brid and Ros, 2009, pp. 222–51, and Hanson, 2010, for critical surveys).

Although many possible explanations have been offered, they broadly fall into two camps. On the one hand, based on the neoclassical focus on productive efficiency and supply-side factors in the growth process, some economists have emphasized that reform of the domestic economy has lagged behind the liberalization of the external sector. In this view, the absence (or poor design) of reforms in areas such as fiscal policy, energy, telecommunications, labor markets, and the financial sector has put a drag on the country's growth (e.g., Arias et al., 2010; Hanson, 2010; Kehoe and Ruhl, 2010). On the other hand, analyses informed more by a Keynesian emphasis on demand-side constraints have argued that the slow growth in the post-liberalization era can be attributed to some combination of inadequate investment spending (especially deficient public spending on infrastructure), restrictive monetary and fiscal policies, and various external constraints (e.g., Ibarra, 2008; Blecker, 2009; Moreno-Brid and Ros, 2009). The BPCG analysis can be seen as a special case of a Keynesian explanation, in which relative price (real exchange rate) effects are assumed to be negligible in the long run (see, e.g., Alonso and Garcimartín, 1998–99). The studies (cited above) that apply the BPCG approach to Mexico essentially claim that the opening to imports has outweighed the benefits of increased export growth, thus forcing the country to restrain the growth of its gross domestic product (GDP) to avoid large and growing current account deficits.

However, the applications of the BPCG model to Mexico to date have mostly ignored certain crucial (and changing) structural features of Mexico's external trade. In particular, the proportion of Mexico's imports that consists of intermediate goods has risen from about half in

the pre-liberalization period to about two-thirds (excluding maquiladoras) or three-quarters (including them) in the post-liberalization period. Furthermore, manufactured exports, which are highly intensive in the use of imported intermediate inputs, have also risen to account for a majority of total exports during the post-liberalization period (about two-thirds excluding maquiladoras, and four-fifths including them).

By neglecting these structural characteristics and changes, econometric models that estimate aggregate import behavior may be misspecified and, in particular, estimates of income elasticities may be biased. What appears to be a rise in the income (GDP) elasticity of import demand may be, rather, a reflection of the increases in the shares of manufactured exports and intermediate imports in their respective totals. In this vein, Ibarra (2011a, 2011b) has shown that the income elasticity of demand for imports of intermediate goods did not increase significantly, once one controls for the fact that the demand for such imports is also a function of manufactured exports. However, Ibarra's work leaves open the question of whether the balance of payments (BP) constraint on Mexico's growth was not tightened in another way, by the increasing share of manufactured exports in total exports or the rising share of intermediate goods in total imports. Moreover, it remains to be seen whether the elasticity of intermediate imports with respect to manufactured exports increased in the post-liberalization period, and whether the behavior of imports of final goods as well as non-manufactured exports had an impact on equilibrium growth.

Indeed, trade liberalization may have contradictory effects on BP-equilibrium growth: by facilitating access to intermediate imports as well as access to foreign markets, it may boost the growth of manufactured exports, but at the same time, the intensive use of intermediate imports in producing those exports diminishes the benefits in terms of relaxing the constraints on the rate

of output growth consistent with BP equilibrium. Thus, the net impact of trade liberalization on the BP-equilibrium growth rate is an empirical question that has yet to be resolved with an adequate model.

The present paper addresses this question by constructing a more complete BPCG model that explicitly incorporates two different kinds of imports (intermediate and final goods) and two different kinds of exports (manufactures and primary products). In this extended model, the solution for the equilibrium growth rate of GDP that satisfies the BP constraint (hereafter, the "BP-equilibrium growth rate") takes account of the composition of imports and exports as well as the income elasticities and other estimated coefficients (especially, the elasticity of intermediate imports with respect to manufactured exports). Somewhat surprisingly, we find that, according to new econometric estimates of this model provided below, and taking into account the changes in the composition of exports and imports as well as the relevant estimated elasticities, the BP-equilibrium growth rate did not actually decrease after Mexico liberalized its trade in the late 1980s, but instead increased. Although the income elasticity of demand for imports of final goods did increase post-liberalization, neither the income elasticity of intermediate import demand nor the elasticity of this demand with respect to manufacturing exports increased significantly in a statistically adequate model. Furthermore, our estimates imply that Mexico grew faster than the rate predicted by our augmented BPCG model in the 1960s and 1970s, and has grown notably more slowly than the BPCG rate since the late 1980s. These results suggest that other factors, rather than a tightening of the BP constraint (at least as specified in the BPCG approach, which ignores real exchange rates), have accounted for the post-liberalization slowdown in Mexican growth. These other factors may include other indicators of external constraints more broadly defined (especially, the real exchange rate), as well as various internal

policies and obstacles—all of which are beyond the scope of the present paper, but will be considered in future research.

Before proceeding further, two caveats are in order. First, as a result of limitations in the available data for the maquiladora sector, the econometric analysis in this paper is conducted using two alternative sets of measures of Mexico's manufactured exports and intermediate imports—one set including maquiladora data and one excluding them—and all the data series end in 2006.[3] These two sets of data yield estimates that differ quantitatively in some significant ways (and in intuitively reasonable directions), but they yield qualitatively similar conclusions about the utility of the BPCG model for explaining Mexico's post-liberalization growth slowdown. Second, the model used in this paper does not include capital flows and net transfers. However, this omission does not undermine our main results, and if anything strengthens them, because net transfers (primarily family remittances) and net capital inflows both increased modestly as percentages of GDP in the post-liberalization period.[4] Hence, if anything the omission of these parts of the Mexican BP biases our results toward finding less of an increase (or more of a decrease) in the BP-equilibrium growth rate in the post-liberalization period.

The rest of the paper is organized as follows. Section 2 surveys the relevant literature. Section 3 presents the modified BPCG theoretical model. Section 4 discusses the data set and econometric estimates, while section 5 analyzes the implications of the results for the BP-equilibrium growth rate as predicted by our modified BPCG model. Section 6 concludes with

[3] Until 1979, Mexico did not include the maquiladora industries in its export and import statistics, and therefore maquiladora exports and imports prior to 1980 had to be estimated based on other available information (see appendix for details). In contrast, since 2007 Mexico has reported only total trade statistics including maquiladoras; separate data for maquiladoras are no longer reported so data series excluding them cannot be computed for those years. Therefore, for consistency, both sets of time series end in 2006, which still gives us adequate numbers of observations pre- and post-liberalization.

[4] The average capital account balance (including the error component from the balance of payments) increased slightly, from 2.9% of GDP (measured at the market exchange rate) during 1960–1986, to 3.2% during 1987–2006. Net transfers also increased, from 0.6% to 1.6% of GDP between the same periods.

some thoughts on explaining the results and directions for future research.

2. Literature survey

Economists have sought to explain the causes of the slow growth of the Mexican economy over the past few decades through a wide variety of theoretical and ideological lenses. For neoclassical economists, the fact that a country that was once the "poster child" for liberalizing reforms has grown so slowly since it adopted those reforms poses a special challenge. The neoclassical response has generally been that reforms did not go far enough, and especially that large components of the domestic economy remain overregulated, monopolized, or inefficient. Many studies have applied neoclassical growth accounting to the Mexican case. For example, Kehoe and Ruhl (2010) decompose per capita output into the capital-output ratio, the employment rate (ratio of employment to labor force), and the residual which is known as "total factor productivity" (TFP), in a comparison of Mexico and China. Because the capital-output ratio and employment rate tend to be relatively constant over long periods of time, it is not surprising that most of the fluctuations in output appear to be "explained" by changes in TFP in both countries. Therefore, Kehoe and Ruhl claim that most of the rising income gap between Mexico and China is accounted for by faster growth of TFP in the latter. However, this usage of a statistical residual as a causal factor is methodologically suspect, and many critics have argued that such growth accounting exercises are flawed and TFP is not an independent causal factor in the growth process.[5]

Also within a neoclassical paradigm, other analyses have focused on the availability,

[5] For various skeptical views, see Rosenberg (1976), McCombie (2000–1), Felipe and McCombie (2006), and Aghion and Howitt (2009), among many others. Although Kehoe and Ruhl's methodology for computing TFP is a bit unusual, qualitatively similar results for TFP growth in Mexico have been found using more conventional approaches by Bergoeing, et al. (2009) and others cited in Moreno-Brid and Ros (2009, pp. 231–32).

quality, or cost of productive inputs. Arias et al. (2010) emphasize an alleged lack of qualitative improvements in labor inputs due to stress on families and inadequate early childhood education. The "capture of its educational system by powerful labor unions" has also been cited as a cause of Mexico's weak educational performance (Hanson, 2010, p. 998). However, Moreno-Brid and Ros (2009, pp. 235–38) argue that the rising levels of educational attainment in Mexico make it implausible that educational deficiencies are the source of slow growth, and argue that slow employment growth has failed to absorb the rising cohorts of more educated workers in the formal sector. Similarly, it could be argued that "stress on families" is a consequence and not a cause of slow growth and stagnant incomes.

Both Arias et al. (2010) and Hanson (2010) focus on the informalization of the Mexican labor force, i.e., the relegation of a large proportion of Mexican workers to informal sector activities that have lower productivity (and slower productivity growth) compared with formal sector activities. Another line of research has focused on "imperfections" or "distortions" in Mexico's financial markets (Beck et al., 2005; McKenzie and Woodruff, 2008; Haber, 2009). Mexico has an unusually low level of domestic credit flowing to the private sector, from banks and other financial institutions, for a country at its level of development (Hanson, 2010). This lack of credit provision has been blamed on various legal and institutional impediments that allegedly don't provide enough protection for creditors, such as inadequate bankruptcy laws as emphasized by Bergoeing et al. (2002). More broadly, many analysts have stressed the continued lack of competition in many key sectors of the economy, including energy, telecommunications, and other utilities, which create excessive costs for consumers and other producers alike (del Villar, 2009; Chiquiar and Ramos Francia, 2009; Levy and Walton, 2009; Castañeda Sabido, 2010). Kehoe and Ruhl (2010, p. 1024) argue that Mexico needs to adopt "reforms that eliminate

the barriers to growth of an inefficient financial system, lack of rule of law, and rigidities in the labor market."

In contrast, economists using a Keynesian analytical framework have tended to emphasize demand-side constraints on Mexican growth, either internal or external. On the internal side, Máttar et al. (2003) and Moreno-Brid and Ros (2009, pp. 238–43) have focused on the lack of adequate investment spending since the debt crisis and liberalizing reforms of the 1980s.[6] These authors argue that weak public investment in infrastructure as well as slow accumulation of capital in the private sector have caused the slow growth of formal sector employment, which in turn accounts for the increasing informalization of the labor force. They also criticize fiscal policies that have been targeted on the fiscal balance itself, rather than on growth and employment objectives, as well as an overly strict inflation-targeting monetary policy that has helped to keep the peso overvalued (see Galindo and Ros, 2008; Esquivel, 2010; Ros, 2010). Based on econometric estimates for the post-liberalization period, Ibarra (2008) shows that a real appreciation of the peso reduces the profit share in the Mexican manufacturing sector, and that this has a negative effect on aggregate investment (see also Ibarra 2010). In effect, these authors argue that some of Mexico's "reforms" have undermined, rather than supported, the growth process.

On the international side, Blecker (2009) revived an older approach from the 1970s and 1980s by analyzing the role of external constraints on Mexican growth. He found that four external variables (the US growth rate, net financial inflows, real oil prices, and the one-year lagged real exchange rate) explain most of the annual fluctuations in Mexico's growth, with structural breaks in the magnitude or significance of some of these effects after Mexico's initial

[6] These authors tend to view weak investment expenditures, both public and private, mainly as imposing demand-side constraints, but one could also argue that these have negative supply-side effects as well, and that the lack of adequate public infrastructure can itself be an obstacle to greater private investment.

trade liberalization (1987) or the enactment of NAFTA (1994).[7] However, Blecker's econometric approach, which uses data in growth rate or ratio form, only explains short-term fluctuations in growth rates rather than their long-run averages. Also on the external front, many economists have found evidence that Chinese exports have significantly reduced or displaced Mexican exports since China joined the WTO in 2001, particularly in the US market (e.g., Gallagher et al., 2008; Hanson and Robertson, 2009; and Feenstra and Kee, 2009). However, no one has connected this convincingly with Mexico's growth performance, which began to slow down long before China surpassed Mexico in the US market in the early 2000s.

Many Keynesian economists who have focused on external constraints have applied the BPCG model to the Mexican case, starting with Moreno-Brid (1998). The canonical form of this model can be expressed as follows. The export demand function, written in growth rate form, is

(1) $x = \varepsilon_x(e + p^* - p) + \eta_x y^*$

where x is the growth rate of exports, e is the rate of nominal depreciation of the home currency, p^* is the foreign inflation rate, p is the home inflation rate, and y^* is the growth rate of foreign real GDP.[8] Thus, $e + p^* - p$ is the rate of change in the real exchange rate (RER) or rate of real depreciation, and ε_x and η_x are (respectively) the price (RER) and income elasticities of export demand (assumed to be constant for mathematical convenience). The import demand function is

(2) $m = -\varepsilon_m(e + p^* - p) + \eta_m y,$

where m is the growth rate of imports, y is the growth rate of home real GDP and ε_m and η_m are (respectively) the price (RER) and income elasticities of import demand, again assumed constant. Assuming no net capital flows, transfers, or net flows of factor income, balance of

[7] In particular, the impact of US growth only becomes significant post-NAFTA, while the effects of oil prices diminished and the effects of the real exchange rate increased post-liberalization.

[8] Note that exports are assumed to consist of the same goods as domestic output and hence sell at the same price.

payments equilibrium in the long run requires that (in growth rate form)

(3) $p + x = e + p^* + m$.

In the simplest and most basic version of the model, the real exchange rate is assumed to be constant, i.e., relative purchasing power parity (PPP) holds in the long run, so $e + p^* - p = 0$, and substitution of (1) and (2) into (3) under this assumption yields the following well-known solution for the BP-equilibrium growth rate:[9]

(4) $y_B = \eta_x y^* / \eta_m = x / \eta_m$.

According to this model, trade liberalization increases (decreases) a country's BP-equilibrium growth rate if it raises the growth rate of exports proportionately more (less) than it increases the income elasticity of import demand. For the Mexican case, econometric studies by Moreno-Brid (1999, 2002), López and Cruz (2000), Guerrero de Lizardi (2003), Pacheco-López and Thirlwall (2004), Pacheco-López (2005), and Cardero and Galindo (2005) generally found that the income elasticity of import demand increased significantly post-liberalization (or post-NAFTA), and that this increase outweighed the corresponding increase in export growth, leading to a decrease rather than an increase in the BP-equilibrium growth rate (4). The intuition is straightforward: for any given rate of export growth, a rise in the income elasticity implies that a given GDP growth rate results in faster import growth, so the GDP growth rate must decrease to maintain external equilibrium.

However, Ibarra (2011c) argues that there are no signs of foreign exchange pressure in the Mexican economy when growth accelerates and that investment does not respond strongly to variations in the level of foreign capital inflows—which shouldn't be the case under a binding

[9] Perraton (2003) refers to the solution x/η_m as the "weak" form of the model, and the solution $\eta_x y^*/\eta_m$ as the "strong" form. The strong form requires the assumption of PPP ($e + p^* - p = 0$); the weak form can be derived either under this assumption or the alternative assumption that the Marshall-Lerner condition does not hold ($\varepsilon_x + \varepsilon_m \approx 1$).

external constraint. Furthermore, Ibarra (2011a, 2011b) argues that the standard BPCG model as specified above ignores an important feature of Mexico's economic structure, which is the heavy dependence of its manufacturing sector (including export industries) on imports of intermediate inputs.[10] In this respect, there is a direct connection between exports of manufactures and imports of intermediate goods that is missed in the standard analysis. Ibarra (2011a) demonstrates that there is no statistically significant increase in the income elasticity of intermediate imports post-liberalization (defined as 1987–2006) compared with the pre-liberalization period, using a demand function for intermediate imports that controls for manufactured exports (in a sample of annual data for 1960–2006, excluding maquiladora trade). A model omitting manufactured exports from the intermediate import equation is also shown to be misspecified using this data set. Ibarra (2011b) shows that omitting the role of manufactured exports leads to an upward bias in estimates of the output elasticity of Mexico's intermediate imports for the post-liberalization period, using monthly trade data that includes maquiladoras for 1988–2006.[11] .

These findings do not necessarily imply that there was no change in Mexico's BP-equilibrium growth rate after trade liberalization, because the increase in the share of manufactured exports (which are highly intensive in imported intermediate goods) in total exports could raise the overall demand for imports in the Mexican growth process. Once one distinguishes different types of imports (intermediate versus final goods) and exports (manufactures

[10] The strong dependence of Mexican manufacturing on imported intermediate goods and the consequently low ratio of value added to the gross value of manufacturing output have been emphasized previously by other authors, including Ruiz-Nápoles (2004) and Moreno-Brid et al. (2005), but these authors mainly focused on other issues (such as employment generation) and did not incorporate intermediate imports into a BPCG modeling framework.

[11] In order to increase his sample size, Ibarra (2011b) used monthly data, and since GDP is not available on a monthly basis, he used an industrial production index as the output variable instead of GDP. Hence, we use the term "output" here instead of the more conventional "income" (which usually refers to GDP in the context of an import demand function). Ibarra (2011b) also finds that a model for intermediate imports that excludes manufactured exports as a dependent variable is econometrically misspecified and that the output elasticity of intermediate import demand did not change significantly after Mexico joined NAFTA in 1994.

versus primary products), one clearly needs a more complete BPCG model than the standard version in which there are no distinctions between different types of imports or exports. Thus, Ibarra's results suggest the need to construct a more complete BPCG model that can take these differences into account, which is critical for applying this model to the unique structural characteristics of the Mexican economy.

3. A BPCG model with imports of intermediate goods

This section presents a simple extension of the BPCG model that incorporates two different kinds of exports (manufactured and other goods) and two different kinds of imports (intermediate goods and final goods). All variables are measured in growth rates (logarithmic differences) so that the coefficients can be interpreted as elasticities. However, all the equations in log differences can be derived from the corresponding, underlying equations that are multiplicative in levels (the so-called "Cobb-Douglas" form, in which the parameters are exponents) or linear in log levels (in which case the exponents are converted to coefficients), and it will be important to keep this in mind in regard to the econometric specification in the next section.

The growth rate of demand for manufactured exports (x_n), measured in the same units as domestic output, is determined by the function,

(5) $$x_n = \varepsilon_n(e + p^* - p) + \eta_n y^*$$

where e, p^*, p, and y^* are defined as before (except now p^* and p refer to inflation rates for prices of industrial goods only), and ε_n and η_n are the price and income elasticities for manufactured exports. For simplicity, we assume that other exports (primary commodities, chiefly oil and agricultural products, measured in their own physical units) grow at the exoge-

nously given rate x_o, and their prices change at the exogenously given rate p^*_o denominated in foreign currency (i.e., US dollars), presuming that their quantities and prices are determined by conditions in global commodity markets that are outside the scope of the present model.

The demand function for intermediate goods (in growth rate form) is given by

(6) $m_i = -\varepsilon_i(e + p^* - p) + \eta_i y + \alpha x_n,$

where the coefficient α is the elasticity of demand for imports of intermediate inputs with respect to manufactured exports.[12] The demand function for imports of final (consumption and capital) goods (also in growth rate form, and with fairly obvious notation) is

(7) $m_c = -\varepsilon_c(e + p^* - p) + \eta_c y,$

where it is assumed that these imports are not a function of manufactured exports (as will be verified in the econometric estimates below). Imports are measured in units of foreign output. Here we also assume, admittedly somewhat artificially, 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.

Again assuming no capital flows or transfers, the balance of payments equilibrium condition expressed in terms of foreign currency (US dollars) can be written (also in growth rate form) as

(8) $\mu(p - e + x_n) + (1 - \mu)(p^*_o + x_o) = \theta(p^* + m_i) + (1 - \theta)(p^* + m_c),$

where μ is the share of manufactures in total exports and θ is the share of intermediate goods in

[12] Note that the value of α depends on two factors, which are not modeled here explicitly. On the one hand, it depends on the underlying elasticity of imports of intermediate goods for use in export industries with respect to the production of manufactured exports. On the other hand, it depends on the proportion of intermediate goods imports that are devoted to export production (as opposed to domestic production). In principle, it would be desirable to model these two factors explicitly, which would require specifying the supply side of the model for production of exported and domestic manufactured goods. However, the available data do not distinguish intermediate goods imports according to whether they are used in the production of exported or domestic goods (except for the maquiladora industries, where it can be presumed that all imports are used in export production). Thus, the model as specified here is congruent with the data available for econometric estimation for the Mexican case.

total imports. Substituting (5), (6), and (7) into (8) and solving for the home country growth rate y, we obtain (after much manipulation):

$$(9) \qquad y_B = [\theta\eta_i + (1-\theta)\eta_c]^{-1}\{(\mu - \alpha\theta)\eta_n y^* + (1-\mu)(p_o{}^* + x_o - p^*)$$

$$+ [(\mu - \alpha\theta)\varepsilon_n + \theta\varepsilon_i + (1-\theta)\varepsilon_c - \mu](e + p^* - p)\}$$

which is the most general expression (under the above assumptions) for the BP-equilibrium growth rate y_B. Note that the term in brackets [·] multiplying the rate of RER depreciation ($e + p^* - p$) would have to be positive, i.e., $(\mu - \alpha\theta)\varepsilon_n + \theta\varepsilon_i + (1 - \theta)\varepsilon_c - \mu > 0$, for a faster rate of real depreciation to increase the BP-equilibrium growth rate y_B.[13]

If we assume that the RER is constant in the long run, i.e., long-run PPP prevails, then $e + p^* - p = 0$, and the solution (9) simplifies to:

$$(10) \qquad y_B = \frac{(\mu - \alpha\theta)x_n + (1-\mu)(p_o{}^* + x_o - p^*)}{\theta\eta_i + (1-\theta)\eta_c}$$

where we use the fact that (from equation 5) $x_n = \eta_x y^*$ when $e + p^* - p = 0$. Under this assumption, y_B is independent of the various price (RER) elasticities or changes in the RER (i.e., the relative competitiveness of domestic goods), but y_B does depend on:

- x_n, the growth rate of manufactured exports;
- $p^*_o + x_o - p^*$, the growth rate of the real value of non-manufactured exports in terms of domestic output (which is affected by the change in the terms of trade, $p^*_o - p^*$);
- μ, the share of manufactures in total exports;
- θ, the share of intermediate goods in total imports;
- α, the elasticity of intermediate imports with respect to exports of manufactures; and

[13] This condition can be thought of as an extended Marshall-Lerner condition for the present model. Note that this condition is stronger (i.e., more difficult to satisfy) than the standard Marshall-Lerner condition, to the extent that the weight $(\mu - \alpha\theta)$ on ε_x is less than unity, although it is weaker (i.e., easier to satisfy) to the extent that $\mu < 1$.

- η_i and η_c, the income elasticities of import demand for intermediate goods and final (capital and consumption) goods, respectively.

In order to calculate y_B in equation (10), then, we only need econometric estimates of equations (6) and (7) for imports of intermediate and final goods, respectively, in order to obtain estimates of the parameters α, η_i, and η_c. On the assumption of PPP, none of the coefficients in the manufactured export equation (5) are included in (10). All the other parameters that go into the calculation of (10) can be obtained from the descriptive statistics. In the following sections, we produce calculations of the BP-equilibrium growth rate based on this assumption. In future work we intend to explore the possibility that long-term trends in the RER have affected Mexico's BP-equilibrium growth rate by estimating equation (5) and using the estimated coefficients (elasticities) in the more general solution (9) to calculate y_B.

For Mexico, we are also interested in how all of these elasticities or parameters changed after trade liberalization in the late 1980s. Ibarra (2011a) showed that η_m did not significantly increase post-liberalization, once the term αx_n is included in the import function, but he did not consider how the other determinants of y_B changed. Therefore, it is also important to estimate whether there was a statistically significant increase in α after trade liberalization, as well as how the other elasticities, shares, and growth rates changed between the pre- and post-liberalization periods. The next section presents estimates of equations (6) and (7), including tests for structural breaks, while the following section reports the implications for the BP-equilibrium growth rate per equation (10).

4. Econometric estimates

In this section we present estimation results for import demand equations in Mexico.[14] As specified in equations (6) and (7), we provide separate estimates for imports of final (consumption and capital) goods and intermediate goods. The purpose is not only to estimate the values of the elasticities contained in those equations, but also to test for the possibility of significant changes in these elasticities after the liberalization of the trade regime starting in the late 1980s.[15] Furthermore, as a result of issues of data availability for Mexico's maquiladora sector, we also provide two sets of estimates for imports of intermediate goods: one using total imports of intermediate goods and exports of manufactures (including our own estimates of maquiladora imports and exports for years in which those were not reported), and one using imports of intermediate goods and exports of manufactured goods excluding maquiladoras. The latter data are obviously less inclusive, but they offer the advantage of being based entirely on officially reported statistics, and not requiring any estimation or extrapolation of data series. Moreover, although a more inclusive measure may seem superior, the combination of maquiladora and non-maquiladora imports of intermediate goods into a single aggregate may combine two types of imports that differ significantly in their behavior and determinants, as will be discussed further below. In any event, the two alternative sets of estimations, with and without maquiladoras included, provide a sensitivity test for the robustness of our results given the uncertainty about the best way to handle

[14] By estimating only import demand, we effectively assume that import supply curves are horizontal, i.e., we assume that Mexico is a "small country" in the sense of being a price-taker in its import markets. Fortunately, the econometric procedure used here helps to control for possible endogeneity of the RER and other right-hand-side variables, as discussed below. Also, the RER can be considered an exogenous instrument for the relative prices of imports and domestic goods, which would be more likely to be endogenous.

[15] According to Lustig (1998), the policy shift toward trade liberalization began in 1985–86, but the reductions in trade barriers went into effect starting around 1987. In our econometric work below, we will use 1987 as the break point for the post-liberalization era.

the missing data for the maquiladora sector for the earlier part of our sample period.

In standard fashion, imports are estimated as a function of real GDP and the bilateral peso-dollar real exchange rate (BRER), with an increase in the latter representing a real depreciation of the peso. For reasons of data availability, BRER was calculated with consumer price indices, rather than industrial prices as in the theoretical equations (6) and (7). In addition, to detect "long-run" effects, which are the relevant ones for the growth analysis in this paper, the variables in the estimated equations appear in levels (rather than growth rates as in the theoretical equations). All variables are expressed in levels of natural logarithms, so that their estimated coefficients can be interpreted as elasticities as required by the theoretical model. As is well known, using variables in differenced form loses information about long-run relationships, so we prefer to express the variables in (log) levels while using an econometric procedure (described below) that controls for possible unit roots in the variables. As observed earlier, although the theoretical model was presented with the variables measured in log differences (growth rates), it can be derived from underlying equations that are linear in log levels, so we can use the latter specification for the econometric estimation.

The estimation period runs from 1960 to 2006, for a total of 47 annual observations. It is not possible to conduct consistent estimations with a more updated sample, because the official statistics have not distinguished maquiladora and non-maquiladora trade flows since 2006, so it is not possible to extend our data series excluding maquiladoras past that year.[16] The estimations were carried out using the bounds testing approach of Pesaran et al. (2001), and the tables report only the estimated long-run (or level) coefficients plus the error-correction (or speed of adjust-

[16] Of course, we could extend the total data including maquiladoras past 2006, but then the results for that set of estimates would not be comparable to the results using the data that exclude maquiladoras. Since we date liberalization as beginning in 1987, we still have 20 years of annual observations for the post-liberalization period, which is sufficient for conducting structural break tests.

ment) coefficient. The estimated short-run coefficients for the variables in first differences are not reported here for reasons of space, but are available on request.

The bounds testing approach has several attractive features. In contrast to alternative estimation procedures, it can combine variables with different orders of integration in the same equation; in particular, variables may be integrated of order one or zero. This is a critical advantage for our estimates, because our data include both types of series (see Table 1). In addition, none of the series is integrated of order two or more, as required by our estimation technique.

[Table 1. Unit root tests]

A second critical advantage is that, thanks to the use of lags in the estimation, the bounds testing approach yields unbiased estimates of the long-run coefficients even when some of the regressors are endogenous (Pesaran and Shin 1998)—a condition that presumably affects all macroeconomic series, including the ones used in this paper, to some extent. Finally, compared to data-intensive, multi-equation techniques such as Johansen's cointegrated VAR (vector autoregression) model, the bounds testing approach has good small-sample properties, given that it relies on the estimation of a single equation. However, if more than one long-run relationship exists between the variables, the present approach cannot uncover the other ones.

The purpose of the estimation is to obtain equations of the form,

(11) $$M_{LR} = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \cdots + \delta_k Z_k$$

where M_{LR} is the "long-run" level of real imports of either final or intermediate goods, there are k potential determinants Z_i, and all variables are measured in log levels to capture long-run effects. To obtain equations like (11), we proceeded in three steps. In the first step, we estimated an autoregressive distributed lag (ARDL) model in error-correction form, such as

(12) $$\Delta M_t = \sum_{j=1}^{n} a_j \Delta M_{t-j} + \sum_{i=1}^{k} \sum_{j=0}^{n} b_{i,j} \Delta Z_{i,t-j} + \sigma M_{t-1} + \sum_{i=1}^{k} d_i Z_{i,t-1} + d_0$$

where Δ indicates the first difference of the variable, and $-\sigma$ measures the speed of adjustment of imports toward the long-run equilibrium defined by equation (11).

The dependent variable M can be imports of either final (IMPF) or intermediate goods (IMPI excluding maquiladora imports, and IMPIM including them). The set of regressors Z consists of three potential determinants: GDP, BRER, and real manufactured exports (EXPM excluding maquiladora exports, and EXPMM including them). The trade series, originally expressed in current dollars, were deflated with the US producer price index (PPI) to obtain real quantities of imports and exports, while GDP corresponds to Mexican output in constant pesos. BRER is based on consumer prices, and is defined so that an increase represents a real depreciation of the peso.[17]

In the first step, we tested the statistical adequacy of each model. This involved determining the number of lags to be included, and confirming that the standard diagnostic tests were satisfied. Based on the Schwarz and Akaike criteria, the models were estimated with one lag in the variables in first differences. The inclusion of one lag was sufficient to pass the standard battery of diagnostic tests, including the absence of serial correlation. In some cases the Akaike criterion suggested the inclusion of two lags, but in those cases Schwarz was followed, given the satisfactory diagnostic test results and the small number of observations in our sample. We verified that adding more lags did not result in stronger results for the bounds tests or a larger size of the speed of adjustment coefficient.

With the statistical adequacy of the model ensured, in a second step we tested for the existence of a level or long-run relationship, using two alternative tests. The first is a t-test on the speed of adjustment coefficient, σ. For a long-run relationship to be established without

[17] See the appendix for more details on data sources and definitions, and the method of estimating maquiladora trade for the years with missing data.

ambiguity, the absolute value of the *t*-statistic must lie above the (asymptotic) upper critical value (or upper bound) calculated by Pesaran et al. (2001). In that case, the existence of a relationship can be accepted even if all the variables in the estimated equation were integrated of order one. In contrast, if the *t*-statistic falls between the lower and upper bound, then the existence of a relationship is more uncertain, as it can be accepted only conditionally on all the variables being integrated of order zero (i.e., stationary). The second is an *F*-test for the significance of the level coefficients, under the null that σ and the d_i coefficients in equation (12) are jointly equal to zero. Again, the existence of a relationship is accepted when the *F*-statistic lies above the upper critical bound. For the *F*-test, we are able to use the small-sample critical values calculated by Narayan (2005), but for the sake of comparison we also report the results using the asymptotic critical values from Pesaran et al. (2001).

After establishing the existence of a long-run relationship, in a final step we simplified the short-run segment of the model. This was done by deleting, for each variable, the longest statistically insignificant lags (provided the diagnostic tests were not compromised).[18] The simplification of the lag structure generally results in larger and more significant long-run coefficients. At the end of this step, we retrieved the long-run coefficients as $\delta_i = -d_i/\sigma$.

4.1 Imports of final goods

We begin by presenting the results for imports of final (consumption and capital) goods—"final imports," for short. In an initial specification we include only GDP and the real exchange rate as

[18] This elimination of insignificant lags was not done in Ibarra (2011a). Hence, even though some of the estimates presented here are qualitatively similar to some of those in Ibarra (2011a), the present estimates are quantitatively different and have greater statistical precision. In addition, Ibarra (2011a) did not present equations for total imports of final goods (i.e., capital and consumption goods combined) or any estimates including maquiladora trade data.

possible determinants of final imports, without allowing for a shift in coefficients after trade liberalization, and exclude a possible role for manufactured exports (see Table 2, column 1). The estimated coefficients have the expected signs, indicating that an increase in GDP tends to raise final imports, while a real depreciation of the peso (that is, an increase in BRER) tends to reduce them. The estimated equation is not very satisfactory, however: the coefficient on BRER is not statistically significant and the speed of adjustment σ is very slow; in addition, the bounds tests can reject the null hypothesis of no long-run relationship only under the condition that all variables are stationary —an unlikely condition, according to the unit root test results presented in Table 1.

[Table 2. Estimated demand functions for imports of final goods]

Allowing for a permanent shift in the estimated coefficients on GDP and BRER after the beginning of trade liberalization dramatically improves the estimation results (see Table 2, columns 2 and 3). Given that Mexico joined GATT in 1986, and that an important reduction in tariffs and in the share of import permits came afterwards, we examine whether a significant shift in the estimated coefficients took place beginning in 1987. For that purpose we defined a dummy variable (DU87) that equals 1 in 1987–2006 (and 0 previously), and included interactions of this dummy with other variables in the import equations. The dummy was interacted with both the level and the first difference of the import determinants, thus allowing for shifts in both the long- and short-run coefficients of the model; in the tables, though, only the long-run coefficients are reported.[19]

Introducing the trade liberalization dummy leads to a much better model for final imports, particularly in terms of the bounds test results, which now support the existence of a long-

[19] In Ibarra (2011a), the structural break dummies were only interacted with the levels. This is another reason why the estimates in the present paper may differ from those earlier estimates of import demand equations.

run relationship at the 1% significance level. In this improved model, there are two main results. First, the real exchange rate coefficient appears to have become statistically significant only in the post-liberalization period. This is intuitive if we think that the composition of final demand may become more responsive to changes in the relative price of local versus imported goods, after restrictions on the free international flow of goods are removed.[20] And second, there is an increase in the income-elasticity of final imports, which rose from 1.10 during 1960–1986 to 1.56 (= 1.10 + 0.46) in 1987–2006 (Table 2, column 3).

Finally, we test for the role of manufactured exports, both including and excluding maquiladoras, as a possible additional determinant of final goods imports (see Table 2, columns 4 and 5). We can see that manufactured exports have a coefficient that is not economically or statistically significant; unsurprisingly, given that lack of significance, the introduction of this variable into the import equation leaves the previous results practically unchanged. Specifically, the real exchange rate coefficient still appears to have become statistically significant only after the liberalization of trade, while the GDP coefficient (income elasticity) still shows a large increase after liberalization.

4.2 Imports of intermediate goods, excluding and including maquiladoras

We now present the estimated equations for imports of intermediate goods. Here, we have two sets of results: estimates excluding and including maquiladora data, which are shown in Tables 3 and 4, respectively. Let us start with the results excluding maquiladoras, and again we begin by showing a simple specification in which intermediate imports depend only on GDP and BRER

[20] It should be noted, however, that we have not explicitly controlled for trade barriers such as tariff rates in any of the estimates in this paper. This means that the effects of reduced trade barriers should be reflected in the structural break dummies. We intend to investigate obtaining measures of such barriers in future extensions of this research.

(see Table 3, column 1). As we found for final imports, in this initial specification the GDP and BRER coefficients have the expected signs, but again the results are not reliable: the *p*-value on the BRER coefficient is (slightly) above 10%, the speed of adjustment is slow, and the bounds tests either fail to reject the null of no relationship, or reject it but only conditional on all the variables being stationary; in addition, the RESET test for equation misspecification fails at the 5% significance level.

[Table 3. Estimated demand functions for imports of intermediate goods excluding maquiladoras]

We then add manufactured exports as a possible determinant of intermediate imports (see Table 3, column 2). The results show a significant improvement over the initial specification: the speed of adjustment more than doubles, the two bounds tests (including the small-sample *F*-test) support the existence of a long-run relationship at the 5% level, and all the coefficients are statistically significant and signed as expected. While there is a reduction in the absolute values of the GDP and BRER coefficients, both are now statistically significant, and they are estimated with greater precision.

Compared to the estimated coefficient on GDP (1.01), the export coefficient is not small (0.51). How should we interpret the positive export coefficient? As mentioned in the theoretical section, the dependent variable corresponds to the economy's total intermediate imports (excluding only those used in the maquiladoras), and is not limited to those used in export production. In addition, the equation controls for GDP. Thus, the coefficient on EXPM measures the effect of an increase in manufactured exports holding GDP constant, which implies a shift in the composition of total output toward the export sector. Thus, the positive coefficient on exports means that export production is more intensive in intermediate imports than the rest of the economy,

even excluding the maquiladoras, and a pattern of GDP growth biased toward (or led by) manufactured exports will automatically result in strong import growth.

Starting from this last specification, we now examine whether import elasticities changed after the liberalization of trade. As we did for final imports, we include short- and long-run interactions of GDP and BRER with the DU87 liberalization dummy (Table 3, column 3). In contrast to what we found for imports of final goods, once manufactured exports are included in the equation for intermediate imports, the GDP and BRER coefficients do not shift in the expected way in the post-liberalization period. Rather than increasing, the estimated GDP coefficient seems to have decreased, while the opposite happened with the BRER coefficient.[21] In addition, in this specification the bounds tests reject the null of no long-run relationship only under the condition of stationarity of all variables. Thus, once we control for the direct effect of manufactured exports, there is no evidence of an increase in the income elasticity of intermediate imports after trade liberalization.

Finally, we also examine whether the elasticity of intermediate imports with respect to manufactured exports (α, or the coefficient on EXPM) increased after trade liberalization. Such an increase could be expected, for example, from a deepening over time in the degree of vertical specialization of export production (even excluding maquiladoras, as we do here). To examine this issue, we include the interactive variable EXPM*DU87 (see Table 3, column 4). Somewhat unexpectedly, there is no statistically reliable evidence of an increase in the EXPM coefficient after trade liberalization.[22] The coefficient on EXPM*DU87 is very small and negative (–0.04);

[21] The shifts in the estimated coefficients do not seem robust, however: if the only remaining statistically significant interaction between the post-liberalization dummy and the real exchange rate in the short-run segment of the model is removed, the shifts in the long-run coefficients on GDP and *BRER* become insignificant, with *p*-values of 0.5 or more (results not shown in the table, but available upon request).

[22] Estimations using quarterly data for the liberalization period only suggest that an increase in the manufactured export-elasticity of intermediate imports may have occurred in the post-NAFTA years, especially when maquila-

moreover, including this interactive variable reduces the significance of the bounds tests. Thus, the *p*-value of 0.03 for the estimated coefficient of –0.04 is not a reliable indicator of statistical significance, because the entire equation is not statistically adequate.

[Table 4. Estimated demand functions for imports of intermediate goods including maquiladoras]

Next, we turn to the estimates that include maquiladora imports of intermediate goods and exports of manufactures. Because these regressions are parallel to the ones we ran with the data excluding maquiladoras, our discussion can be more brief and we can focus on the key quantitative differences. When the only regressors included are GDP and BRER (Table 4, column 1), only GDP is significant and the coefficient (elasticity) is very high (2.57). The insignificance of BRER is perhaps not surprising, since maquiladora imports of intermediate goods are so closely linked to maquiladora exports that they are likely to respond in the opposite direction from what we normally expect for imports to changes in BRER, rising when BRER increases (i.e., when the peso depreciates) as that would induce greater imports of intermediate goods for assembly on the expectation of increased exports of maquiladora products. Thus, mixing some imports that respond positively to BRER with others that respond negatively naturally lowers the estimated coefficient in absolute value and reduces its significance. However, this equation fails the bounds tests and is not statistically reliable.

When we add manufactured exports including maquiladoras (EXPMM) as another regressor (Table 4, column 2), the equation now passes the bounds tests at the 5% level, so the results may be deemed statistically reliable. Not surprisingly, the coefficient on manufactured exports is higher when maquiladora data are included than when they are excluded (0.71 vs. 0.51

doras are included (Ibarra 2011b). However, using our data set for the sample period 1960–2006, we did not find a significant increase in this elasticity for the post-NAFTA years (1994–2006). Also, if interactions with both the 1987–2006 and 1994–2006 dummies were included, the estimated coefficients on the interactions remained very small, the value of the bounds test statistics fell even more, and the GDP coefficient became insignificant. These results are not shown for reasons of space, but are available upon request.

in Table 3, column 2), and is strongly significant. The coefficient on BRER is larger in absolute value than in the equation omitting manufactured exports (–0.53 vs. –0.19 in Table 4, column 1), but still statistically insignificant (*p*-value of 0.17). Finally, the income elasticity (coefficient on GDP) is now statistically significant, but much reduced in magnitude compared to the analogous estimate excluding maquiladoras (0.53 vs. 1.01 in Table 3, column 2). This is understandable because maquiladora imports of intermediate goods are largely unrelated to domestic Mexican production; rather, they are linked almost exclusively to export production (which is a function of foreign GDP, not domestic GDP).

When we test for structural breaks, we find similar results to those already obtained in the equation for intermediate imports excluding maquiladoras (Table 4, columns 3 and 4). First, the existence of a long-run relationship can be accepted only on the unlikely condition that all variables are stationary. Second, the negative change in the GDP coefficient (–0.25) suggests that the income elasticity of intermediate imports decreased after the liberalization of trade, which perhaps could be explained by the inclusion of maquiladoras (whose demand for intermediate imports has little linkage to domestic output). Finally, the estimated change in the coefficient on manufactured exports is very small (–0.03) and its negative sign is counter-intuitive. On the whole, we conclude that there is no statistically reliable evidence of an increase in the elasticity of intermediate imports with respect to either income (GDP) or manufactured exports (EXPMM) when maquiladora data are included.

5. Determination of the BP-equilibrium growth rate

In this section we calculate the BP-equilibrium growth rate y_B, as specified in equation

(10) above, for the Mexican economy. For this purpose, we use the estimated elasticities from Table 2 (columns 1 and 3) for final imports[23] and Tables 3 and 4 (column 2 in each) for intermediate imports, along with the requisite descriptive statistics from the underlying data set. We calculate y_B for the entire 1960–2006 period, and then separately for the pre- and post-liberalization periods, 1960–1986 and 1987–2006, respectively. The results are shown in Table 5, which presents alternative estimates based on the data including and excluding maquiladora trade, as well as for alternative time periods (1960–1977 and 1989–2006) that exclude the volatile years of the oil boom and debt crisis in 1978–1986.

[Table 5. Actual GDP growth compared with BP-equilibrium growth and its determinants]

For the entire sample period 1960–2006, the BP-equilibrium growth rate of 4.01% per year (excluding maquiladoras) or 4.36% (including maquiladoras) closely approximates the actual average GDP growth rate of 4.28% per year (see Table 4, first column). This conforms with previous studies that have found that the BPCG model closely replicates actual average growth over very long periods of time, on the order of a half century (see, e.g., Razmi, 2005, on India). The BP-equilibrium growth rate is, of course, the outcome of various elasticities and parameters that operate in opposite directions, per equation (10). For the entire period 1960–2006, this rate was boosted, for example, by rapid growth of Mexico's manufactured exports (x_n = 11.24% per year excluding maquiladoras, and 12.94% including them) and more modest growth of other exports (x_o = 5.81%), but held down, for example, by a relatively high income-elasticity of final goods imports (η_c = 1.58) and a high manufacturing export-elasticity of intermediate imports (α = 0.51 excluding maquiladoras, and 0.71 including them). However, it is not

[23] It may be recalled that equation 1 in Table 2 rejects the null of no long-run relationship only conditional on all variables being integrated of order zero, which according to the unit root test results in Table 1 is unlikely to be the case. Nevertheless, these are the only coefficient estimates we have for imports of final goods over the whole sample period, and they seem to be plausible in magnitude, so we use them in calculating y_B for the whole period 1960–2006.

clear whether this provides a *causal* explanation of average Mexican growth for such a long period of time, as will be discussed further in the conclusions.

The question that most concerns us here is whether the BPCG model can explain the slowdown in Mexico's growth since the trade liberalization of the late 1980s. Much to our surprise, the answer provided by our estimates is no. According to our calculations, Mexico's BP-equilibrium growth rate actually increased in the post-liberalization period (1987–2006) compared with the earlier years (1960–1986)—even more so when maquiladoras are included—whereas the actual average growth rate decreased notably (see Table 4, second and third columns). The increase in y_B was the net effect of several different influences that operated in opposite directions after the liberalization of trade. On the one hand, there was an increase in the income-elasticity of final imports (η_c), which tended to reduce y_B. On the other hand, the elasticities of intermediate imports with respect to GDP (η_i) and manufactured exports (α) remained stable, regardless of whether maquiladoras were included or not. Moreover, the income elasticity of imports is lower for intermediate goods (1.01 excluding maquiladoras, 0.53 including them) than for final goods, particularly in the post-liberalization period when this elasticity for final goods (η_c) rose to 1.56. As a consequence, the increase in the share of intermediate goods in total imports (θ), from 49.1% in 1960–1986 to 64.5% in 1987–2006 excluding maquiladoras (or from 52.3% to 75.5% including them), somewhat paradoxically tended to increase the equilibrium growth rate by reducing the denominator in equation (10), where η_i and η_c are weighted by θ and $1-\theta$ respectively.

Because the growth rate of manufactured exports (x_n) was higher than the growth rate of other exports (x_o, including the effect of terms of trade changes), the increase in the share of manufactures in total exports (μ) in the post-liberalization years (by either measure, i.e.,

including or excluding maquiladoras) had a positive effect on the BP-equilibrium growth rate of GDP. However, this positive effect was offset by the automatic "leakage" of foreign exchange through imports of intermediate imports, as captured by the $-\alpha\theta$ term in (10). Even though α did not increase, θ did, thus reducing the gains from any given rate of manufactured export growth (although, in a relationship that is not captured in our model, the intensive use of intermediate imports presumably contributed to the rapid growth of manufactured exports). Surprisingly, the growth rate of manufactured exports x_n did not increase in the post-liberalization period, but rather fell slightly from 11.82% per year in 1960–1986 to 10.45% per year in 1987–2006 excluding maquiladoras (and from 13.95% to 11.58% including them). Of course, 10.45% (or 11.58%) still represents a very rapid annual growth rate, but the growth of manufactured exports was even faster (by either measure) in the earlier period due to the very low base of such exports in the early 1960s.

Thus, there were various changes acting in different directions on the BP-equilibrium growth rate in the post-liberalization period. The net impact was that the BP-equilibrium GDP growth rate actually increased after trade liberalization, rising from 4.2% during 1960–1986 to 4.7% in 1987–2006 excluding maquiladoras, or from 4.3% to 5.5% including them. Among other things, the rise in the share of manufactured exports outweighed the increase in the income-elasticity of final goods imports, while the increase in the share of intermediate imports had two opposite effects but a negative impact overall.[24]

Although, as noted earlier, the actual and the equilibrium GDP growth rates were very similar over the entire period (especially when maquiladora trade is included), they differ notably

[24] The post-liberalization rise in θ had two opposite effects on y_B in equation (10), as it tended to reduce both the numerator (via the $-\alpha\theta$ term) and the denominator (by increasing the weight on $\eta_i < \eta_c$). Under the parameter values prevailing in the post-liberalization period, it is easily calculated that the net effect of the rise in θ on y_B was negative, i.e., the effect on the numerator dominates.

within each of the two sub-periods separated by trade liberalization. Specifically, during the pre-liberalization period the actual (average annual) GDP growth rate was above the BP-equilibrium rate (5.2% versus 4.2% excluding maquiladoras or 4.3% including them), while the opposite was true during the post-liberalization period (3.0% versus 4.7% excluding maquiladoras or 5.5% including them). Thus, during the post-liberalization period the Mexican economy has under-performed, at least relative to its BP constraint, and this constraint does not appear to have been binding. Note that qualitatively similar results are obtained if we leave out the years of the oil boom of the late 1970s and the debt crisis of the 1980s, and define the pre- and post-liberalization periods as 1960–1977 and 1989–2006, respectively (Table 5, last two columns).

6. Conclusions and directions for future research

This paper has developed an extended BPCG model, which incorporates two kinds of exports (manufactured and other) and two kinds of imports (intermediate and final goods). According to our estimates, the BP-equilibrium growth rate "predicted" by this model closely fits the actual, average growth of Mexico's GDP during the 46-year period from 1960 to 2006. As in many previous studies, the model accounts for actual growth well in very long-run samples, on the order of a half century. However, it is not clear whether this is a causal explanation of the long-run growth rate, or a statistical artefact, given that the model does not predict well in either of the two sub-periods (pre- and post-liberalization). What does seem clear is that the BP constraint was binding in the first of these periods, and therefore the actual rates of growth could not be sustained, while in the second period the BP constraint was not binding and thus the fall in actual GDP growth must be attributed to other factors.

According to our estimates, Mexico outperformed its BP-equilibrium growth during the pre-liberalization years 1960–1986, and even more strongly if we omit the oil boom and debt crisis years and consider only 1960–1977. This finding is consistent with the fact that, by the end of the pre-liberalization period, by either definition, Mexico was facing a series of repeated balance of payments crises that resulted in the sharp peso devaluations of 1975–1976, 1982–1983, and 1985–1986 (crises that can perhaps be seen as having imposed a BP constraint after episodes in which it was violated).

In contrast, the estimates in this paper do not support the hypothesis that a tightening of the balance of payments constraint can account for the slowdown of Mexico's economic growth in the post-liberalization years. On the contrary, our estimates show that the BP-equilibrium growth rate actually increased in the post-liberalization period, especially when maquiladora trade data is included (but also, albeit to a lesser extent, when it is omitted), suggesting that liberalization was modestly successful in relieving the country's previous balance-of-payments constraints, and certainly did not tighten it.

Because the actual average growth of the Mexican economy fell substantially in the post-liberalization period, our estimates imply that the Mexican economy has been underperforming relative to its BP-equilibrium growth rate during this period—and the more so, if we include the maquiladora sector, which was one of the most dynamic parts of the Mexican economy especially during the late 1980s and 1990s. There are several possible explanations for this underperformance. First, as in most previous studies in the BPCG framework, we have ignored changes in the RER and focused on income elasticities (which, in this paper, are augmented by the elasticity of intermediate imports with respect to manufactured exports). Similar to some earlier work in this framework (e.g., Perraton, 2003), we have allowed for terms-of-trade effects in regard to

primary commodity exports, but not RER effects for manufactured exports and imports. Our BRER index[25] was relatively constant in the very long run, in the sense that there is no pronounced trend over the entire sample period 1960–2006 (in spite of massive fluctuations associated with the BP crises mentioned earlier and the later one in 1994–1995). Specifically, the average levels of BRER were similar during the split sample periods, pre- and post-liberalization, and the average rate of change over the whole period 1960–2006 (–0.25% per year) was very small. This may help to account for why the model's prediction for the BP-constrained growth rate closely approximates the actual average growth rate over the entire 46-year sample period.

[Figure 1. Bilateral Mexican-US real exchange rate index, 1960–2006]

The trajectories of the RER were very different, however, within the pre- and post-liberalization periods considered separately (see Figure 1). During the 1960s, the BRER index (which is based on 100 in 1996, and reflects the value of the peso inversely) was relatively stable, with an index value of about 84, and then it decreased (i.e., the peso appreciated) in two episodes during the 1970s—both of which were followed by currency crises and sharp devaluations. After the debt crisis of the early 1980s, BRER soared to 127 in 1986, so that the overall trend during the pre-liberalization period 1960–1986 was toward a real depreciation. After liberalization, there was a reversal of this trend, with a tendency for the peso to appreciate (in spite of one more maxi-devaluation in 1994–1995), and the BRER index fell to 78 in 2006. The average rates of change were +1.36% per year (depreciation) in 1960–1986 and –2.42% per year (appreciation) in 1987–2006.

The tendency of the peso to appreciate in real terms in the post-liberalization period may

[25] In this discussion, we deliberately use "RER" when referring to the real exchange rate in general and "BRER" when referring specifically to our bilateral index.

have been an important factor in the underperformance of the Mexican economy during that time. This suggests that further modification of the BPCG model to take account of RER fluctuations may be important for explaining the post-liberalization slowdown in Mexico's growth. Whether incorporating the RER improves the predictive power of the model can be tested in future research by estimating equation (5) for Mexico's manufactured exports, and then using equation (9), which includes the price (RER) elasticities, instead of (10), which excludes them, to calculate y_B.[26] Although an explanation of the growth slowdown that relies upon relative price (RER) changes would be consistent with a BP constraint in a broader sense, it would be different from the traditional BPCG model in which relative prices are assumed to have no impact.

Additionally, we can investigate changes in Mexico's BP-equilibrium growth rate during the post-liberalization period using monthly total trade data (including maquiladoras), following the earlier work of Ibarra (2011b). We could, for example, test for differences between the pre-NAFTA years (1987–1993), the early NAFTA years (1994–2000), and the years since China joined the World Trade Organization (2001–present), but we would not be able to test for structural breaks between the pre- and post-liberalization periods using only data for the latter.

Finally, it is also possible that no extension of the BPCG model will suffice to enable this framework to explain the post-liberalization growth slowdown in Mexico. In this case, it would be important to identify the other factors that could account for that slowdown. For example, the financial and fiscal constraints referred to earlier, which have depressed the nation's investment rate (both private and public), could be prime suspects. The real exchange rate could also play an

[26] Of course, any explanation that focuses on RER changes would require that the price (RER) elasticities of export and import demand were sufficiently large (in absolute value) to satisfy the (modified) Marshall-Lerner condition embedded in the model (see footnote 12 above). In the preceding estimates, the RER elasticity of final imports becomes significant only after liberalization (see Table 2, columns 3–5), while the RER elasticity of intermediate imports (excluding maquiladoras) becomes smaller in absolute value post-liberalization, so our own results are mixed. See also Ibarra (2011a, 2011b) for earlier estimates of the relative price (RER) elasticities of Mexican import demand and how they compare with previous estimates in the literature.

additional role, as the real appreciation may squeeze profit margins in the tradables sector and discourage private investment (see Ibarra 2008, 2011c).[27] Supply-side factors, such as financial sector rigidities, rule of law, monopoly control of key industries, and deficiencies in human capital formation, also discussed earlier, could also possibly play a role. One important hypothesis to consider is that the changes in macroeconomic policy since the 1990s—especially, the strict inflation-targeting monetary policy and balanced-budget targets for fiscal policy—may have led to a situation in which the country's actual growth is chronically held below its potential or BP-equilibrium rate. Such possibilities will have to be explored in future research.

Nevertheless, our results do not necessarily imply that the BPCG model is of no use in analyzing the growth process. Even if the model lacks predictive power, it may still be useful as a benchmark for analyzing particular historical episodes or growth regimes, as we have done here for the pre- and post-liberalization periods in Mexico. By calculating the BP-equilibrium growth rate for each of these periods, we have been able to compare actual, average growth with the BP-equilibrium rate (under the assumption of no RER effects). In accordance with theoretical expectations, when actual growth exceeded the BP-equilibrium rate in the pre-liberalization period, the country faced repeated BP crises and was pressured to devalue. When actual growth was below the BP-equilibrium rate in the post-liberalization period, the exchange rate was appreciating and other constraints were likely to have been operating. Thus, our finding of the models' weak explanatory power does not vitiate its utility for identifying periods in which the BP constraint was or was not binding, and this in turn can help in understanding the nature of the growth regimes prevailing in those periods.

[27] In addition, although the average level of the real exchange rate was similar in our two sub-periods, trade liberalization may have required a more depreciated level of the currency to sustain a given rate of economic growth under the new conditions of reduced tariff and non-tariff protection for domestic firms. Thus, while the real exchange rate shows similar average levels pre- and post-liberalization, it is possible that the real exchange rate was misaligned in the latter but not in the former sub-period.

Appendix. Data sources and definitions

Bilateral real exchange rate (BRER): Calculated as the ratio of the consumer price index (CPI) of Mexico to the US CPI, multiplied by the nominal peso-dollar exchange rate. Sources: US Bureau of Labor Statistics (BLS) for the US consumer price index, the *IMF's International Financial Statistics* for Mexico's CPI and nominal exchange rate from 1960 to 1967, and Banco de México (Banxico) for the same variables since 1968.

Gross domestic product (GDP): In constant prices of 1993 for 1980–2006; pre-1980 data were based on constant prices of 1980 and were spliced with the later data. Source: National accounts data from Mexico's Instituto Nacional de Estadística y Geografía (INEGI).

Imports of final goods and intermediate goods: Final goods imports (IMPF) are the sum of consumption and capital goods. Intermediate goods were calculated two alternative ways, including maquiladoras (IMPIM) and excluding them (IMPI); see below regarding maquiladora data. The original BP data, in nominal dollars, were deflated with the general US PPI for finished goods. Source: Banxico for trade data, and BLS for price index.

Manufactured exports: Calculated two alternative ways, including maquiladoras (EXPMM) and excluding them (EXPM); see below regarding maquiladora data. The original BP data, in nominal US dollars, were deflated with the general US PPI for finished goods. Source: Banxico for trade data, and BLS for price index.

Non-manufactured exports: Calculated as the difference between total exports of goods and manufactured exports. The original BP data, in nominal US dollars, were deflated with the general US PPI for finished goods. Source: Banxico for trade data, and BLS for price index.

Maquiladora exports and imports: For the years 1980–2006, Mexico reported export and import data excluding maquiladoras, but data for maquiladora exports and imports were also reported separately, so the latter were added to the officially reported data for manufactured exports and intermediate imports (respectively) to obtain total manufactured exports and total intermediate imports. For the years prior to 1980, we were not able to find Mexican data for maquiladora exports or imports, but Mexico did include a line for services of transformation (i.e., maquiladora value added) as a credit item in the current account of the balance of payments (data from Banxico, various years). For 1969–1979, we used US data for imports from Mexico under tariff sections 806.300 and 807.00 (as reported in Grunwald, 1985, p. 148, Table 4–6) for maquiladora exports (assuming that virtually all maquiladora exports were sold in the United States in those years), and then subtracted maquiladora value added to get maquiladora imports (value added for 1979 had to be interpolated). For 1966–1968, we assumed that maquiladora exports were in the same ratio to value added as the average for 1969–1970 (2.76), and then subtracted value added (as reported in the BP) from exports to get imports. We could not find any data on maquiladora value added for 1965, the year when the maquiladora program was enacted by the Mexican government, so we assumed that maquiladora exports and imports were zero in that year (if this is not accurate, the number for 1966 is so low that it must have been negligible in 1965). All these data were measured in US dollars and were converted to real terms using the US PPI for finished goods.

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Table 1. Unit root tests

Period: 1960–2006, 47 annual observations

	Augmented Dickey-Fuller (ADF)			Phillips-Perron (PP)		
	level	level with trend	first difference	level	level with trend	first difference
Bilateral real exchange rate, BRER	-3.64 ***	-3.59 **	-7.04 ***	-2.90 *	-2.87	-8.00 ***
Gross domestic product, GDP	-3.53 **	-1.55	-4.70 ***	-3.25 **	-1.55	-4.71 ***
Imports of final goods, IMPO	-0.48	-2.87	-5.70 ***	-0.04	-2.16	-6.49 ***
Imports of intermediate goods excl. maquiladoras, IMPI	-0.31	-3.47 *	-6.39 ***	-0.42	-2.62	-6.57 ***
Imports of intermediate goods incl. maquiladoras, IMPIM	-0.18	-3.39 *	-6.23 ***	-0.35	-2.55	-6.07 ***
Manufactured exports excl. maquiladoras, EXPM	-1.11	-2.50	-6.92 ***	-1.11	-2.86	-6.92 ***
Manufactured exports incl. maquiladoras, EXPMM	-1.60	-1.98	-6.80 ***	-1.62	-2.28	-6.80 ***

Source: Authors' calculations. See appendix for data sources and variable definitions.

Notes:

All variables measured in natural logarithms (GDP, imports, and exports in real terms). ADF test with intercept and lag length determined by Schwarz, with a maximum lag of 4. PP test with intercept, Bartlett kernel, and Newey-West bandwidth. Both sets of tests use MacKinnon one-sided *p*-values.

***, **, *: The null hypothesis of a unit root is rejected at the 1%, 5%, 10% significance levels.

Table 2. Estimated demand functions for imports of final goods

Dependent variable: Final goods imports, IMPO

Sample: 1960-2006, 47 observations

	(1) #	(2)	(3)	(4)	(5)
Long-run coefficients:					
Speed of adjustment, σ	-0.102	-0.161	-0.231	-0.243	-0.251
Gross domestic product, GDP	1.58 (0.02)	1.24 (0.00)	1.10 (0.00)	1.19 (0.00)	1.12 (0.00)
Real exchange rate, BRER	-1.24 (0.19)	-0.54 (0.19)			
Manufactured exports excl. maquiladoras, EXPM				-0.09 (0.46)	
Manufactured exports incl. maquiladoras, EXPMM					-0.03 (0.69)
GDP*DU87		0.15 (0.00)	0.46 (0.00)	0.54 (0.01)	0.62 (0.00)
BRER*DU87			-1.17 (0.02)	-1.39 (0.02)	-1.66 (0.01)
Diagnostics:					
Adj R-sq	0.831	0.934	0.962	0.961	0.963
Jarque-Bera	0.34 (0.84)	1.61 (0.45)	0.27 (0.87)	0.11 (0.95)	1.80 (0.41)
Breusch-Godfrey	0.35 (0.56)	0.33 (0.57)	0.13 (0.72)	0.09 (0.76)	0.40 (0.53)
ARCH	0.08 (0.77)	0.74 (0.39)	0.00 (0.99)	0.03 (0.85)	0.09 (0.77)
RESET	0.00 (0.98)	2.83 (0.10)	0.09 (0.76)	0.24 (0.63)	0.80 (0.38)
Bounds testing:					
t-stat	-2.62 a/	-5.24 ***	-6.28 ***	-5.57 ***	-5.52 ***
F-stat	3.06 b/	13.62 *** (+++)	16.88 *** (+++)	11.70 *** (+++)	13.08 *** (+++)

Source: Authors' calculations.

Notes:

To pass the normality test, eq. (1) includes a 0-1 dummy for the year 1975, while the rest of equations include dummies also for 1986, 1987, and 1993.

1) For illustrative purposes, the *p*-values of the d_i coefficients (see equation 12 in the text) are shown in parenthesis next to the long-run coefficients.

2) The intercept was removed from all equations due to lack of significance. The ARDL models were estimated initially with one lag for the variables in first differences. The estimation results shown in the table correspond to the models after the longest non-statistically significant coefficients were removed, except the results of bounds testing, which was performed with the full lag structure.

3) Diagnostics: The null hypotheses are that residuals are normally distributed (Jarque-Bera), with no serial correlation of first order (Breusch-Godfrey) and no ARCH errors, and that the equation passes Ramsey's mis-specification test using the squares of the fitted values (RESET). *F*-statistics (except χ^2 for J-B) with *p*-values in parenthesis.

4) Bounds testing: ***, **, *: Rejects the null of no level relationship at the 1%, 5%, 10% significance levels, using the asymptotic upper critical values from Pesaran et al. (2001), tables CI(i) and CII(i): no intercept and no trend. +++, ++, +: Rejects the null of no level relationship at the 1%, 5%, 10% significance level, using the small-sample upper critical values from Narayan (2005), appendix case II: restricted intercept and no trend, for n = 45 observations. Critical values are available only for the *F*-test.

a/ Rejects the null of no level relationship at 1% only under the condition that all variables are integrated of order zero.

b/ Rejects the null of no level relationship, at 5% with the asymptotical critical values from Pesaran et al. and at 10% with the small-sample critical values from Narayan, only under the condition that all variables are integrated of order zero.

Table 3. Estimated demand functions for imports of intermediate goods excluding maquiladoras

Dependent variable: Intermediate goods imports excluding maquiladoras, IMPI

Sample: 1960-2006, 47 observations

	(1)	(2)	(3)	(4)
Long-run coefficients:				
Speed of adjustment, σ	-0.109	-0.260	-0.244	-0.272
Gross domestic product, GDP	1.90 (0.05)	1.01 (0.00)	0.79 (0.05)	0.68 (0.06)
Real exchange rate, BRER	-2.05 (0.11)	-1.36 (0.00)	-1.35 (0.02)	-1.09 (0.01)
Manufactured exports excl. maquiladoras, EXPM		0.51 (0.01)	0.73 (0.00)	0.75 (0.00)
GDP*DU87			-0.37 (0.05)	
BRER*DU87			1.06 (0.06)	
EXPM*DU87				-0.04 (0.03)
Diagnostics:				
Adj R-sq	0.676	0.802	0.830	0.821
Jarque-Bera	0.34 (0.84)	1.01 (0.60)	1.15 (0.56)	1.32 (0.52)
Breusch-Godfrey	0.37 (0.55)	0.22 (0.64)	0.57 (0.45)	0.06 (0.81)
ARCH	0.38 (0.54)	1.03 (0.31)	0.03 (0.86)	0.02 (0.90)
RESET	4.79 (0.03)	0.10 (0.76)	0.22 (0.64)	0.07 (0.79)
Bounds testing:				
t-stat	-2.16 a/	-3.49 **	-3.18 a/	-3.40 *
F-stat	2.25 b/	4.65 ** (++)	2.67 c/	3.28 * d/

Source: Authors' calculations.

Notes: Same as 1) to 4) in Table 2. In addition:

a/ Rejects the null of no level relationship at 5% (at 1% in eq. 3) only under the condition that all variables are integrated of order zero.

b/ Rejects the null of no level relationship, at 10% with the asymptotical critical values from Pesaran et al., only under the condition that all variables are integrated of order zero, and cannot reject the null of no relationship, at any significance level, with the small-sample critical values from Narayan.

c/ Rejects the null of no level relationship, at 5% with the asymptotical critical values from Pesaran et al. and at 10% with the small-sample critical values from Narayan, only under the condition that all variables are integrated of order zero.

d/ Rejects the null of no level relationship, at 5% with the small-sample critical values from Narayan, only under the condition that all variables are integrated of order zero.

Table 4. Estimated demand functions for imports of intermediate goods including maquiladoras

Dependent variable: Intermediate goods imports including maquiladoras, IMPIM

Sample: 1960-2006, 47 observations

	(1) #	(2)	(3)	(4)
Long-run coefficients:				
Speed of adjustment, σ	-0.100	-0.269	-0.250	-0.289
Gross domestic product, GDP	2.57 (0.04)	0.53 (0.03)	0.29 (0.34)	0.42 (0.14)
Real exchange rate, BRER	-0.19 (0.90)	-0.53 (0.17)	-0.27 (0.56)	-0.46 (0.22)
Manufactured exports incl. maquiladoras, EXPMM		0.71 (0.00)	0.86 (0.00)	0.80 (0.00)
GDP*DU87			-0.25 (0.09)	
BRER*DU87			0.72 (0.12)	
EXPMM*DU87				-0.03 (0.03)
Diagnostics:				
Adj R-sq	0.604	0.761	0.834	0.791
Jarque-Bera	4.17 (0.12)	0.44 (0.80)	0.02 (0.99)	0.16 (0.93)
Breusch-Godfrey	1.25 (0.27)	1.20 (0.28)	0.71 (0.40)	0.70 (0.41)
ARCH	0.96 (0.33)	0.46 (0.50)	0.27 (0.61)	0.15 (0.70)
RESET	1.45 (0.16)	0.75 (0.39)	0.34 (0.57)	0.70 (0.41)
Bounds testing:				
t-stat	-2.17 a/	-3.41 **	-3.32 b/	-3.16 b/
F-stat	1.72 a/	4.05 ** (++)	2.97 * c/	2.99 d/

Source: Authors' calculations.

Notes: Same as 1) to 4) in Table 2. In addition:

Includes an intercept. The lag structure was not simplified, as that caused problems with the diagnostic tests.

a/ Fails to reject the null of no level relationship, at any level of significance and order of integration of the variables.

b/ Rejects the null of no level relationship at 5% (at 1% in eq. 3) only under the condition that all variables are integrated of order zero.

c/ Rejects the null of no level relationship at 5% with the critical values from Narayan only under the condition that all variables are integrated of order zero.

d/ Rejects the null of no level relationship, at 5% with the critical values from both Pesaran et al. and Narayan, only under the condition that all variables are integrated of order zero.

Table 5. Actual GDP growth compared with BP-equilibrium growth and its determinants

Period	Whole sample	Pre-liberalization	Post-liberalization	Excluding oil boom and debt crisis	
	1960-2006	1960-1986	1987-2006	1960-1977	1989-2006
Actual GDP growth rate (y)	**4.28**	**5.24**	**2.98**	**6.02**	**3.15**
BP-equilibrium growth rate (y_B): a/					
Excluding maquiladoras	**4.01**	**4.16**	**4.65**	**4.10**	**4.60**
Including maquiladoras	**4.36**	**4.33**	**5.50**	**4.43**	**5.33**
Average annual growth rates: b/					
Manufactured exports (x_n)					
Excluding maquiladoras	11.24	11.82	10.45	12.90	9.29
Including maquiladoras	12.94	13.95	11.58	15.54	10.23
Non-manufactured exports ($p^*_o + x_o - p^*$)	5.81	5.57	6.13	4.52	6.98
Shares					
Share of manufactures in total exports (μ)					
Excluding maquiladoras	45.0%	28.5%	67.3%	30.1%	69.1%
Including maquiladoras	55.4%	36.9%	80.4%	36.4%	82.0%
Share of intermediate goods in total imports (θ)					
Excluding maquiladoras	55.6%	49.1%	64.5%	40.7%	63.6%
Including maquiladoras	62.2%	52.3%	75.5%	43.0%	74.9%
Elasticities c/					
GDP-elasticity of final goods imports (η_c)	1.58	1.10	1.56	1.10	1.56
GDP-elasticity of intermediate imports (η_i)					
Excluding maquiladoras	1.01	1.01	1.01	1.01	1.01
Including maquiladoras	0.53	0.53	0.53	0.53	0.53
Manufactured-export elasticity of intermediate imports (α)					
Excluding maquiladoras	0.51	0.51	0.51	0.51	0.51
Including maquiladoras	0.71	0.71	0.71	0.71	0.71

Source: Authors' calculations. See appendix for data sources and variable definitions.
Notes:
a/ The BP-equilibrium growth rate is calculated using equation (10) in the text.
b/ All growth rates are measures as log differences in real series, where the nominal values were deflated using the US PPI for finished goods.
c/ Elasticities were taken from Tables 2-4.

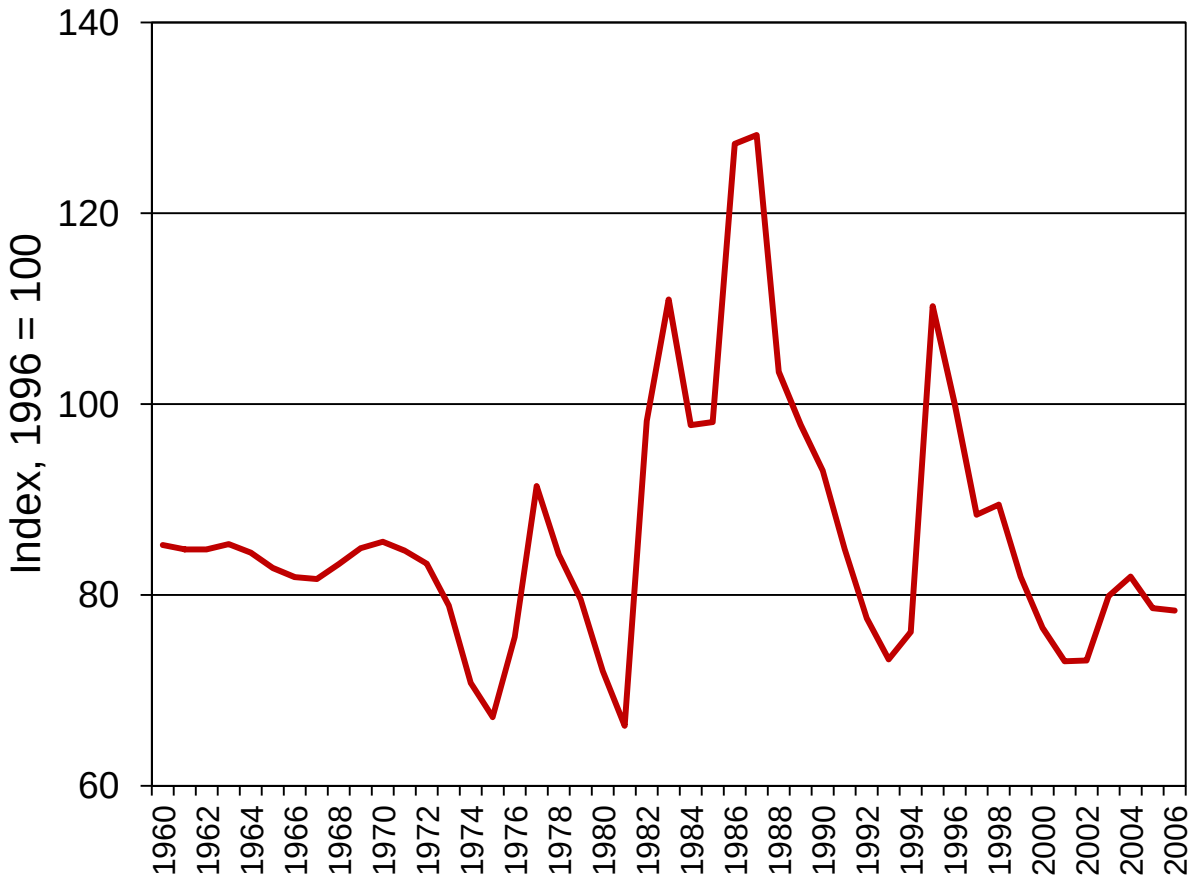

Figure 1. Bilateral Mexican-US real exchange rate index (BRER), 1960–2006.

Note: The nominal exchange rate in pesos per dollar was multiplied by the ratio of the US CPI to the Mexican CPI. This index measures the relative price of foreign (US) goods, so a higher number indicates a real depreciation of the peso.