Metroeconomica 54:2 & 3 (2003) 346–365

CAPITAL FLOWS, INTEREST PAYMENTS AND THE BALANCE-OF-PAYMENTS CONSTRAINED GROWTH MODEL: A THEORETICAL AND EMPIRICAL ANALYSIS

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ABSTRACT

The analytical framework known as the balance-of-payments constrained growth model introduced by Anthony P. Thirlwall more than two decades ago, and further developed by him and N. Hussain, was a major contribution to understanding the relevance of a foreign exchange constraint on the long-run growth performance of open economies. In its simplest expression this model is known as Thirlwall's law. Recent contributions have revised this analytical model in order to ensure that the pattern of foreign debt accumulation, implicit in the economy's balance-of-payments constrained growth path, is sustainable.

Up to now most theoretical presentations of Thirlwall's law do not incorporate interest payments explicitly and, moreover, the empirical studies carried out within this tradition do not take them into account. This omission may be a major shortcoming in the analysis of the long-term growth path of economies—like many developing ones—whose net interest payments abroad are a large debit item in the current account of their balance of payments. In the present paper we introduce an extension of the balance-of-payments constrained growth model that explicitly captures the influence on foreign interest payments of the economy's long-run rate of growth—while at the same time guaranteeing that foreign indebtedness is not on an explosive track—and test its empirical adequacy by applying it to examine the Mexican case.

1. INTRODUCTION

The notion that the availability of foreign exchange may be a fundamental constraint on the long-term rate of expansion of economic activity was put forward by Anthony Thirlwall in the late 1970s. He introduced a simple analytical model to show that if a country's external indebtedness cannot

* The original version of this paper was presented at the conference entitled 'Old and New Growth Theories: an Assessment,' Pisa, Italy, 5–7 October 2001. Comments from Adriano Birolo, Amitava Dutt, Belén Fernández Castro, Julio López, Carlo Panico, Martín Puchet, Carlos Ricoy, Tony Thirlwall, Gennaro Zezza and an anonymous referee as well as valuable research assistance from Jesus Santamaria are gratefully acknowledged. The opinions here expressed may not necessarily coincide with those of the United Nations.

expand indefinitely then its long-run rate of economic growth will be restricted by its foreign trade performance, more precisely by the size of the income elasticity of its imports relative to the pace of expansion of its exports (Thirlwall (1979)). In its simplest expression the model is referred to as Thirlwall's law. His analytical contribution—here referred to as the balance-of-payments constrained growth (BPC) model—was later extended to allow for the influence of foreign capital flows on economic growth (Thirlwall and Hussain (1982)). In recent years it has been further revised to ensure that the economy's long-run growth is consistent with a sustainable path of foreign indebtedness (McCombie and Thirlwall (1997), Moreno-Brid (1998–99, 2001)).[1]

Up to now, most representations of Thirlwall's law do not explicitly capture the influence of foreign interest payments and the empirical studies fail to take them into account. Relevant exceptions are McCombie and Thirlwall (1997) and Dutt (2001) who, however, assume that interest rates are fixed in the long run. Moreover, even recent contributions whose theoretical framework acknowledges the potential relevance of interest payments fail to explicitly consider them in their empirical analysis.[2] Clearly, estimates of the income elasticity of import or export demand relate only to the evolution of trade in goods and services, and not to that of net interest payments abroad. Therefore, when such payments are a large part of current flows, the empirical applications—of the BPC model—that either assume away such payments or implicitly treat them as an item of the import bill may have poor predictive powers.[3]

The purpose of this paper is twofold. The first is to present a version of the BPC model that explicitly takes interest payments into account and—though not necessarily imposing as a long-run condition the constancy of the interest rate—guarantees a sustainable path of external debt accumulation. The second is to validate the empirical adequacy of this model by applying it to the analysis of the Mexican case.

The paper has four sections, the first being this introduction. The second section puts forward a version of the BPC model that captures the influence of interest payments abroad on economic growth and is consistent with a long-term sustainable path of debt accumulation. The third section tests, for

[1] For a somewhat recent survey of theoretical models examining the relation between the balance of payments and macroeconomic performance see Blecker (1999).

[2] A recent example is Dutt (2001) who, notwithstanding that interest payments play a key role in his theoretical model, does not explicitly consider them in his empirical analysis.

[3] I am grateful to Tony Thirlwall for bringing to my attention this potential limitation of the predicting power of the BPC model as traditionally applied for economies whose interest payments abroad represent an important item in their balance of payments.

the Mexican case, the empirical relevance of the BPC model in the revised version here put forward. The conclusions are presented in the final section.

2. FOREIGN INTEREST PAYMENTS AND BPC GROWTH: THE THEORETICAL MODEL

2.1 The BPC model

Adapting the version put forward by Thirlwall and Hussain (1982) to explicitly include interest payments, the BPC model may be summarized by the following equations:[4]

$$\frac{\mathrm{d}x}{x} = \eta\left(\frac{\mathrm{d}p}{p} - \frac{\mathrm{d}p^*}{p^*}\right) + \pi\mathrm{d}w \tag{2.1}$$

$$\frac{\mathrm{d}m}{m} = \varphi\left(\frac{\mathrm{d}p^*}{p^*} - \frac{\mathrm{d}p}{p}\right) + \xi\frac{\mathrm{d}y}{y} \tag{2.2}$$

$$\frac{\mathrm{d}p^*}{p^*} + \frac{\mathrm{d}m}{m} = \theta_1\left(\frac{\mathrm{d}p}{p} + \frac{\mathrm{d}x}{x}\right) - \theta_2\left(\frac{\mathrm{d}r}{r} + \frac{\mathrm{d}p}{p}\right) + (1 - \theta_1 + \theta_2)\left(\frac{\mathrm{d}f}{f} + \frac{\mathrm{d}p}{p}\right) \tag{2.3}$$

$$\theta_1 = px/p^*m \tag{2.4}$$

$$\theta_2 = pr/p^*m \tag{2.5}$$

Equations (2.1) and (2.2) are the standard demand functions for exports and imports but expressed in terms of their rates of growth, where x stands for real exports, m for real imports, p for domestic prices, p^* for foreign prices, w for the world's real income, y for domestic income in real terms, $\eta < 0$ and $\pi > 0$ for the price and income elasticities of exports, while $\varphi < 0$ and $\xi > 0$ are the respective elasticities of imports.

Equation (2.3) corresponds to the dynamic expression of the balance-of-payments identity, where r stands for net interest payments abroad measured in real terms and the product $pf = F$ represents the net inflow of foreign capital measured in units of local currency. For simplification purposes the nominal exchange is taken to be fixed and assumed to be equal to one. In turn, $\theta_1 > 0$ represents the proportion of the import bill covered by export

[4] Lower-case letters denote variables measured in constant prices; asterisks denote variables measured in foreign prices. The notation $\mathrm{d}z/z$ denotes the rate of change of the variable z. To ease the exposition, the nominal exchange rate is assumed to be fixed and equal to one.

earnings, and $\theta_2 > 0$ stands for the proportion of net interest payments abroad relative to imports (both of them measured at the beginning of the period). Note that the negative sign in the second term on the right-hand side of (2.3) assumes that the country is a net debtor.[5] To ensure that the accumulation of external debt is not on an explosive track we follow Moreno-Brid (1998–99, 2001) and impose a long-term constraint defined as a constant ratio of the current account deficit (F) to income (Y):

$$F/Y = k \tag{2.6}$$

where k is a constant.[6] And, recalling that by definition $F = pf$ and $Y = py$, equation (2.6) is equivalent to

$$\frac{\mathrm{d}f}{f} + \frac{\mathrm{d}p}{p} = \frac{\mathrm{d}y}{y} + \frac{\mathrm{d}p}{p} \tag{2.7}$$

Solving the system of equations (2.1)–(2.5) and (2.7) leads to the following expression of the economy's BPC growth rate y_b:

$$y_\mathrm{b} = \frac{\theta_1 \pi \mathrm{d}w/w - \theta_2\, \mathrm{d}r/r + (\theta_1\eta + \varphi + 1)(\mathrm{d}p/p - \mathrm{d}p^*/p^*)}{\xi - (1 - \theta_1 + \theta_2)} \tag{2.8}$$

Recall that by construction this formulation of the BPC model captures the influence of interest payments and, at the same time, guarantees a sustainable long-run trajectory of external debt accumulation. Now, if the terms of trade have no significant long-run variation, equation (2.8) yields

$$y_\mathrm{b} = \frac{\theta_1\, \mathrm{d}x/x - \theta_2\, \mathrm{d}r/r}{\xi - (1 - \theta_1 + \theta_2)} \tag{2.9}$$

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[5] θ_1 and θ_2 are non-negative; thus the term $1 - \theta_1 + \theta_2$ is equal to the ratio of foreign capital flows relative to imports. The balance of payments identity behind equation (2.3) may be expressed in nominal terms as $M = X - R + F$, where M stands for total imports, X for total exports, $R > 0$ for net interest payments abroad and F for the current account deficit.

[6] McCombie and Thirlwall (1997, 1999) adopted a different equilibrium condition defined by a long-run constant ratio of the *stock* of external debt (D^*) to domestic income (Y). Their analysis, however, assumed constant terms of trade. Dutt (2001) constrained debt accumulation by expressing its long-run value as a ratio of exports. Note that, as an anonymous referee pointed out, the various BPC models do not use a uniform notion of 'long-run equilibrium'. In this regard, an alternative long-term constraint of the model here presented could have been the constancy of the terms of trade and the rate of interest. Such analysis should be explored in future work.

In addition, if the current account deficit is zero ($1 - \theta_1 + \theta_2 = 0$), the following version of Thirlwall's law is obtained:[7]

$$y_b = \frac{\theta_1 \, \mathrm{d}x/x + (1-\theta_1)\mathrm{d}r/r}{\xi} \tag{2.10}$$

If net interest payments abroad may be assumed constant ($0 = \mathrm{d}r/r$) or not significant ($1 = \theta_1$) then equation (2.10) is expressed as Thirlwall's law

$$y_b = \frac{\mathrm{d}x/x}{\xi} \tag{2.11}$$

Equations (2.8)–(2.10) show that net interest payments abroad may alter the long-run rate of economic growth compatible with the balance-of-payments constraint.

Note that equation (2.9) extends the formulation of the BPC growth rate introduced in Moreno-Brid (1998–99, 2001) and McCombie and Thirlwall (1997):

$$y_b = \frac{\theta \mathrm{d}x/x}{\xi - (1-\theta)} \tag{2.12}$$

where θ stood for the ratio of exports to imports.

The next section contrasts the empirical relevance of the simple version of Thirlwall's law introduced here (equation (2.9)) against its previous most well known ones (equations (2.11) and (2.12)). This empirical work will help to show the relevance of the BPC model—even in its simple versions—as an analytical tool to understand the long-run economic growth performance of developing countries.

3. EMPIRICAL TESTS OF THE BPC MODEL[8]

3.1 Background

The applied analysis of the BPC model relies on the methodology put forward by McCombie (1997). Thus, it gauges the empirical relevance of the

[7] If $1 - \theta_1 + \theta_2 = 0$ then $1 - \theta_1 < 0$ because, by assumption, $\theta_2 > 0$.

[8] This section is a revised and extended version of chapter IV of Moreno-Brid (2001).

model by testing whether the long-run income elasticity of import demand ξ does not significantly differ from its hypothetical equilibrium values ξ_H.[9] To carry out this task, ξ is estimated using time series techniques tailored to study long-run phenomena. Now, this test requires defining ξ_H as the value of the income elasticity of import demand that would equate the actual growth rate of the economy, dy/y, with its BPC growth rate y_b in the period under consideration. According to this testing procedure, if there is no significant difference between ξ and ξ_H the BPC model is empirically relevant for the case in point.

Clearly, the conclusions are contingent on the underlying formulation of the BPC growth rate y_b. As mentioned above, we test the three alternative versions of it given by equations (2.11), (2.12) and (2.9). The first corresponds to the original formulation of Thirlwall's law (based on the assumption of no long-run current account deficit). The second consists of the revised version of the BPC model that guarantees a sustainable path of foreign indebtedness but does not explicitly consider the influence of interest payments. And the last one is its extension here constructed to explicitly capture the influence of foreign interest payments.

A key aspect is to calculate the corresponding hypothetical equilibrium values of the income elasticity of imports. For the original version of Thirlwall's law, such equilibrium value is derived by, first, substituting in equation (2.11) the actual value of dy/y instead of the BPC rate y_b and then solving for ξ. For notational purposes such value is subsequently here referred to as ξ_T:

$$\xi_T = \frac{dx/x}{dy/y} \tag{3.1}$$

For the revised version of the BPC model that is consistent with the notion of long-run equilibrium defined as a constant ratio of the current account deficit to nominal income but does not capture the influence of foreign interest payments, the hypothetical equilibrium elasticity may be derived from equation (2.12). First, substitute in it the actual average growth rate of GDP in real terms, dy/y, for the BPC growth rate y_b, and then solve for ξ. The value thus obtained will be here denoted as ξ_x:

$$\xi_x = (1-\theta) + \frac{\theta\, dx/x}{dy/y} \tag{3.2}$$

[9] An evaluation of econometric tests of the BPC model is given in Thirlwall and McCombie (1997).

Finally for the extended revised BPC model, introduced in the previous section, to explicitly allow for the influence of foreign interest payments, the hypothetical equilibrium elasticity of imports is derived from equation (2.9). It is here defined as ξ_M:

$$\xi_M = (1 - \theta_1 + \theta_2) + \frac{\theta_1 \, dx/x - \theta_2 \, dr/r}{dy/y} \tag{3.3}$$

Note that the calculations of ξ_T, ξ_x and ξ_M are all based on the assumption that the terms of trade are not important determinants of the economy's long-run growth rate in the period of analysis. The data for Mexico for the period under analysis (1967–99) show an average annual rate of 0.2 per cent change in them, which may not be too inconsistent with this assumptions. ξ_T may be interpreted as a special case of ξ_x which, in turn, may be seen as a special case of ξ_M. Having thus explained the procedure to calculate the hypothetical income elasticity of imports corresponding to each of the three versions of the BPC model here considered, in the following section we proceed to estimate the actual long-run income elasticity of Mexican imports through the use of cointegrating techniques.

3.2 Estimation of Mexico's long-run import demand[10]

3.2.1 Methodological note

Econometric studies of imports are typically based on the 'imperfect substitutes' model. The model is built upon the assumption that domestic and foreign goods are not perfect substitutes and concludes that import demand is determined by the importing country's income, the own price of imports, and the domestic price of locally produced tradable goods and services. In addition, monetary illusion is frequently assumed away and a zero-homogeneity restriction is imposed to guarantee that the foreign and the domestic price elasticities of import demand have the same magnitude in absolute terms. Furthermore, an infinite elasticity of supply is generally taken for granted, thus validating the use of single-equation econometric methods to estimate import flows.[11] The standard functional specification of long-run import demand is

[10] This section is based on parts of chapter IV of Moreno-Brid (2001).

[11] Goldstein and Khan (1985) present a synthetic view of the imperfect and the perfect substitutes theoretical models. Houthakker and Magee (1969) is the classic work on the empirical

$$\ln(m_t) = \beta_0 + \beta_y \ln(y_t) + \beta_p \ln(\mathrm{Pm_t}/\mathrm{Pd}_t) + \upsilon_t \tag{3.4}$$

where υ_t stands for a white noise disturbance term, m_t for real imports and y_t for the real domestic income of the importing country. Pd_t and Pm_t stand for domestic price indices of respectively locally produced tradable output and imported goods and services expressed in local currency. The parameters $\beta_y \geq 0$ and $\beta_p \leq 0$ correspond to the long-run income and price elasticities of import demand. Being an expression of a long-run equilibrium relation, the log-linear function in equation (3.4) does not consider any short-run lagged influences.[12] Most empirical studies of Mexico's import demand have adopted this framework. However, given the country's historic reliance—until the late 1980s—on tariff and non-tariff barriers to shield its domestic market from foreign competition, it seems necessary to modify it to capture the effects of such protectionist measures. To capture their effects we included as regressors variables that mirror the incidence of non-tariff restrictions on trade flows.[13]

In general, earlier studies of Mexican imports applied econometric methods that paid insufficient attention to the stationarity properties of time series and thus their results suffer problems of spurious correlation, bias and inconsistency of the estimated parameters (Rao (1994), Enders (1995), Carone (1996)). The exceptions are Galindo and Cardero (1999), López and Guerrero (1998), Senhadji (1998) and Sotomayor (1997). However, either their sample periods were too short and failed to consider Mexico's era of trade liberalization, or they applied single-equation methods whose results critically depend on the variable chosen to normalize the cointegrating relation (Maddala and Kim (1998)).

The empirical analysis of Mexico's long-term import demand carried out in this section applies Johansen's cointegration methods and covers a period that extends from Mexico's trade protectionist era in the 1960s to the implementation of trade liberalization since the mid-1980s and until 1999 with

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estimation of long-run export and import functions. Caporale and Chui (1999), Krugman (1989), Márquez (1999) and Hooper *et al.* (1998) estimate trade elasticities for OECD and other countries in recent periods.

[12] The concept of long-run equilibrium adopted in the BPC literature is not the same as the theoretical notion of a steady-state growth path. The latter requires a unitary income elasticity of import demand to keep a constant import–output ratio in the steady state when relative prices Pm/Pd remain unaltered.

[13] For similar approaches see Salas (1982, 1988), Ize (1992) and Sotomayor (1997). For other approaches relying on 'dummy' variables see Dornbusch and Werner (1994) and Sarmiento (1999).

NAFTA in its sixth year of operation. It explicitly allows for the effects of non-tariff restrictions on import demand. To capture this effect we use an index of the production-weighted coverage of import licences. This index avoids the downward bias inherent in the use of trade-weighted average coverage of licences in situations where trade protection is very severe (Cameron *et al*. (1999)).[14] Other indicators of trade restrictions, like the average and dispersion of tariff rates or the indicators of the degree of exchange rate controls, may not be so useful for the present case. First, the impact of tariff rates is already taken into account in the estimation of import demand, through their effect on relative prices. Second, in the Mexican case, exchange rate controls were relevant only for a few years (Lustig and Ros (1987)).

Denoting the index of the production-weighted coverage of import licences as q and introducing it directly in the right-hand side of equation (3.4) leads to the following specification of long-run import demand:

$$\ln(m_t) = \beta_0 + \beta_y \ln y_t + \beta_p \ln p_t + \beta_q q_t + \upsilon_t \tag{3.5}$$

where for simplification the ratio of relative prices $\mathrm{Pm}_t/\mathrm{Pd}_t$ expressed in common local currency is denoted as p_t. By construction the value of q falls between zero and one ($0 \leq q \leq 1$). It equals zero when all licence requirements on imports have been eliminated, and it equals one when they are mandatory on every importable good or service. Given Mexico's commitment in the last 15 years to liberalizing its domestic market to foreign competitors, it seems reasonable to assume that the long-run value of q is zero. The expected sign of β_q is negative. To interpret this parameter it is useful to differentiate equation (3.5) with respect to time and thus obtain the following expression for the long-run rate of growth of import demand:

$$\frac{\mathrm{d}m}{m} = \beta_y \frac{\mathrm{d}y}{y} + \beta_p \frac{\mathrm{d}p}{p} + \beta_q \frac{\mathrm{d}q_t}{\mathrm{d}t} \tag{3.6}$$

Therefore β_q represents the increase in the long-run rate of growth of import demand ($\mathrm{d}m/m$) that *ceteris paribus* would be caused by the elimination of import licensing in a fully protected domestic market, i.e. when $\mathrm{d}q$ takes its minimum value ($\mathrm{d}q = -1$).

[14] Production-weighted indices of import licences to mirror quantitative trade restrictions were used in the World Bank's Trade Policy Loans to Mexico in the 1980s (Ten Kate (1992)).

Equation (3.5) is the basis for the estimation of Mexico's long-run import demand conducted here.[15] It was carried out with annual data because no quarterly data were available for some variables before 1980. The time series for real imports and real GDP and in nominal terms were derived from National Accounts data published by the Instituto Nacional de Estadistica, Geografia e Informática. The relative price was computed as the ratio of the implicit-price deflators of imports and of GDP. Data for q, the production-weighted index of the coverage of import permits for 1967–94, were obtained from Secretaría de Comercio y Fomento Industrial (SECOFI). And for 1995–99 they were calculated by the author based on official data. lack of information on the incidence of import licences on Mexico's tradable output prior to 1967 impeded tracing the index q further back, thus limiting the estimation of Mexico's long-run import demand to 1967–99.

3.2.2 Cointegration tests of Mexico's demand for imports: 1967–99

Following standard procedure, the first step in the econometric analysis of Mexico's import demand via Johansen methods was to apply Dickey–Fuller (DF) and augmented Dickey–Fuller (ADF) tests to examine the stationarity properties of the data.[16] Selection of the optimum lag k for the ADF tests was done with the Akaike information criterion (AIC) and the Schwarz Bayesian criterion (SBC). The findings indicate that all four variables, i.e. the production-weighted coverage of import permits, and the log-levels of real GDP, real imports and relative prices, are **I**(1) processes and their first differences are **I**(0) processes (see table 1).

Applying the AIC and SBC, an optimum one-year lag was identified for the unrestricted vector autoregression (VAR) system for import demand under the assumption of no deterministic trends (see table 2). The variable q was assumed to be an exogenous **I**(1) process in the VAR. Such assumption does not rule out short-run effects among all the variables in the VAR system (Pesaran and Pesaran (1997)) but implies that in the long run the imposition of prior permit requirements on imports is not determined by the evolution of the endogenous variables (real GDP, real imports or relative prices). This assumption may be justified by the fact that in the last 15 years,

[15] The inclusion of q in long-level form in equation (3.4) is not recommended because it would imply that, unless $\beta_q = 0$, the elimination of import licences *a fortiori* causes an unbounded increase in the long-run demand for imports in real terms, even assuming constant domestic income and relative prices.

[16] A synthetic description of Johansen's testing procedure may be found in Enders (1995).

Table 1. Mexico: DF and ADF tests on selected variables to estimate its long-run import demand, 1967–99

(A) $\Delta z_t = \alpha + \rho z_{t-i} + \Sigma k(\gamma_i \Delta z_{t-i}) + \xi_t$

(B) $\Delta z_t = \alpha + \lambda t + \rho z_{t-i} + \Sigma k(\gamma_i \Delta z_{t-i}) + \xi_t$

	Lag k selected by AIC		*Lag k selected by SBC*	
	Lag k	*ADF*	*Lag k*	*ADF*
Equation (A)				
$\ln y$	0	–3.187*	Same as AIC	
$\Delta \ln y$	0	–3.800*	Same as AIC	
$\ln m$	2	–0.042	0	–0.099
$\Delta \ln m$	1	–4.668*	Same as AIC	
$\ln p$	1	–2.652	0	–2.139
$\Delta \ln p$	1	–5.355*	Same as AIC	
q	1	–1.112	Same as AIC	
Δq	0	–3.531*	Same as AIC	
Equation (B)				
$\ln y$	0	–1.774	Same as AIC	
$\Delta \ln y$	0	–4.338*	Same as AIC	
$\ln m$	1	–2.867	Same as AIC	
$\Delta \ln m$	1	–4.651*	Same as AIC	
$\ln p$	3	–2.095	0	–2.015
$\Delta \ln p$	1	–5.345*	Same as AIC	
q	1	–2.454	Same as AIC	
Δq	0	–3.489*	Same as AIC	

Notes: y, real GDP; m, real imports; p, ratio of implicit price deflators of imports relative to domestic output; q, production-weighted coverage of prior import licensing requirements. Δ stands for first differences. The asterisk denotes significance with DF's 5 per cent critical values.
Source: Own calculations with Microfit 4.0.

and independently of the evolution of domestic economic activity, Mexico has been persistently eliminating its licences and quantitative restrictions to imports and refraining from imposing additional barriers to foreign trade. In fact, even in the midst of the acute balance-of-payments crisis suffered in 1995, Mexico moved ahead in its trade liberalization strategy and continued honouring its commitments to NAFTA.

Lagrange multiplier tests were conducted to check for residual serial correlation of the individual equations of the VAR(1) system. In all cases, the

Table 2. Mexico: statistical specification of VAR system to estimate long-run import demand (based on annual data, 1967–99)

	Test statistics and optimal order for VAR system			*Order chosen*	*LM serial correlation tests for individual equations of VAR(1) system (p values)*		
Period	*AIC*	*SBC*	*ALR*	*k*	ln *m*	ln *y*	ln *p*
1967–99	143.6 *k* = 1	132.4 *k* = 1	0.477 *k* = 1	1	0.260	0.405	0.054

Notes: The VAR system was estimated taking the production-weighted coverage of import licences as an **I**(1) exogenous variable. ALR, adjusted likelihood ratio; LM, Lagrange multiplier, *y*, real GDP; *x*, real exports; p, ratio of implicit price deflators of imports relative to domestic output.
Source: Own calculations with Microfit 4.0.

results could not reject the hypothesis of no serial correlation with a 5 per cent critical level (see again table 2). Johansen tests were applied on this VAR(1) system to estimate a cointegrating vector for Mexico's import demand. No deterministic trend was assumed, but two different specifications for the intercept were explored. Under the assumption of an unrestricted intercept, the tests identified one cointegration vector for import demand. But two vectors were identified when the intercept was restricted to the cointegrating space. In such instance, the vector corresponding to the largest eigenvalue was chosen as the adequate estimate of Mexico's long-run import demand, once checked that its cointegrating coefficients were consistent with the theoretical model of import demand.

The assumption regarding the intercept's specification, as restricted or unrestricted, did not lead to qualitatively different estimates for Mexico's long-run import demand in 1967–99 (see table 3). Under either specification at least one cointegrating vector was identified. And the respective coefficients were very similar, reporting an estimated long-run income elasticity β_y around 1.8, a long-run price elasticity β_p close to –0.5 and an estimated parameter for the long-run effect of import permits β_q around –1.0. Individual significance of the cointegrating coefficients was tested by imposing over-identifying restrictions equalizing each one to zero. The results of the respective tests based on the likelihood ratio statistics (LRS) always rejected the null hypothesis of a zero income elasticity, $\beta_y = 0$. They also rejected the null hypothesis of non-significant effects of import licences, $\beta_q = 0$. However, the tests could not reject the hypothesis that the price elasticity of Mexico's

Table 3. Mexico's long-term import demand, 1967–99 (estimated with Johansen's cointegration procedures)[a]

$$\ln m = \alpha + \rho_y \ln y + \rho_p \ln p + \rho_q q + \upsilon$$

	Test on max eigenvalue			*Test on trace*			*Cointegration vector and χ^2 test on the significance of ρ_p and ρ_q*
	H_0	H_1	*LRS*	H_0	H_1	*LRS*	
(A) Results for VAR(1) system with three endogenous variables: $\ln m$, $\ln y$ *and* $\ln p$							
Unrestricted intercept	$r = 0$	$r = 1$	48.7*	$r = 0$	$r \geq 1$	67.7*	A_1: $\ln m = 1.777 \ln y - 0.536 \ln p - 1.044q$
($\alpha = 0$)	$r \leq 1$	$r = 2$	14.1	$r \leq 1$	$r \geq 2$	19.0	(0.12) (0.27) (0.16)
	$r \leq 2$	$r = 3$	4.9	$r \leq 2$	$r = 3$	4.9	$\chi^2(\rho_p = 0)$ *p* value = 0.193 $\chi^2(\rho_q = 0)$ *p* value = 0.000
Restricted intercept	$r = 0$	$r = 1$	72.2*	$r = 0$	$r \geq 1$	103.9*	A_2: $\ln m = 1.872 \ln y - 0.577 \ln p - 0.983q - 6.52$ [b]
($\alpha \neq 0$)	$r \leq 1$	$r = 2$	20.8*	$r \leq 1$	$r \geq 2$	31.8*	(0.15) (0.28) (0.15) (2.16)
	$r \leq 2$	$r = 3$	11.0	$r \leq 2$	$r = 3$	11.0	$\chi^2(\rho_p = 0)$ *p* value = 0.187 $\chi^2(\rho_q = 0)$ *p* value = 0.000
(B) Results for VAR(1) system excluding the relative price of imports $\ln p$							
Unrestricted intercept	$r = 0$	$r = 1$	41.7*	$r = 0$	$r = 1$	49.9*	B_1: $\ln m = 1.772 \ln y - 1.269q$
($\alpha = 0$)	$r \leq 1$	$r = 2$	8.3	$r \leq 1$	$r = 2$	8.3	(0.18) (0.19)
Restricted intercept	$r = 0$	$r = 1$	56.9*	$r = 0$	$r = 1$	75.2*	Not available[b]
($\alpha \neq 0$)	$r \leq 1$	$r = 2$	18.3*	$r \leq 1$	$r = 2$	18.3*	

Notes:

[a] Tests carried out assuming no deterministic trend and taking the coverage of import licence requirements (q) as an exogenous **I**(1) process.

[b] In part (A), when two cointegrating vectors were identified, the one associated with the largest eigenvalue is reported here. In part (B), since there are only two endogenous variables there can be at most one linearly independent cointegrating relation between them. The identification of two such vectors by Johansen tests may reflect specification errors in the VAR system.

H_0, null hypothesis; H_1, alternative hypothesis; r, number of cointegrating vectors; y, real GDP; m, real imports; p, ratio of the implicit price deflators of imports relative to domestic output; q, production-weighted coverage of import licences. An asterisk denotes significance with a 5 per cent critical level. Asymptotic standard errors of the estimated cointegration coefficients are reported in parentheses.

Source: Own calculations with Microfit 4.0.

import demand during 1967–99 was not significantly different from zero:[17] $\beta_p = 0$ (see table 3, part (A)).

Given this result, Mexico's long-run import demand was again estimated for 1967–99 but excluding the relative price variable from the VAR system. The results of Johansen's tests assuming an unrestricted intercept identified one cointegrating vector among the log-levels of GDP and of imports and the index of non-tariff restrictions q (see table 3, part (B)). The estimated long-run income elasticity of import demand was $\beta_y = 1.772$, practically the same as the corresponding estimate obtained using the larger VAR system.

The estimates for the long-run income elasticity obtained here are well within the range of earlier findings on Mexican import demand. However, the non-significance of the price elasticity contrasts with previous results. The contrast may be due to the fact that earlier studies of Mexican imports focused on rather short periods, in which the influence of relative prices may have been relevant. Finally, our findings concerning the significantly negative influence of quantitative trade restrictions on its import demand are consistent with results of earlier studies of Mexican imports.

For the VAR system that excluded relative prices, the application of Johansen's tests under the assumption of a restricted intercept led to results that were not satisfactory. They suggested the presence of specification problems in the VAR system. Therefore the cointegrating vector estimated under the assumption of an unrestricted intercept for the trivariate VAR system was considered as our preferred result for Mexico's log-run import demand during 1967–99.

3.3 Testing the BPC model for the Mexican economy

This section applies McCombie's procedure to examine the comparative adequacy, for the Mexican case, of Thirlwall's law in its original version and in two other forms. As mentioned above, essentially it tests whether the long-run income elasticity of Mexican imports ξ—estimated via cointegration analysis in the previous section—is significantly different from its hypothetical equilibrium value alternatively given by ξ_T, ξ_x or ξ_M. Figures 1 and 2 illustrate the relevance of Mexico's foreign interest payments during 1967–99. Note in particular the vast amount they represented in the mid-1980s relative to exports and imports.

[17] If the null hypothesis formulated as an over-identifying restriction on the coefficients of the normalized cointegration vector holds, the LRS is asymptotically distributed as χ^2 with one degree of freedom (Pesaran and Pesaran (1997)).

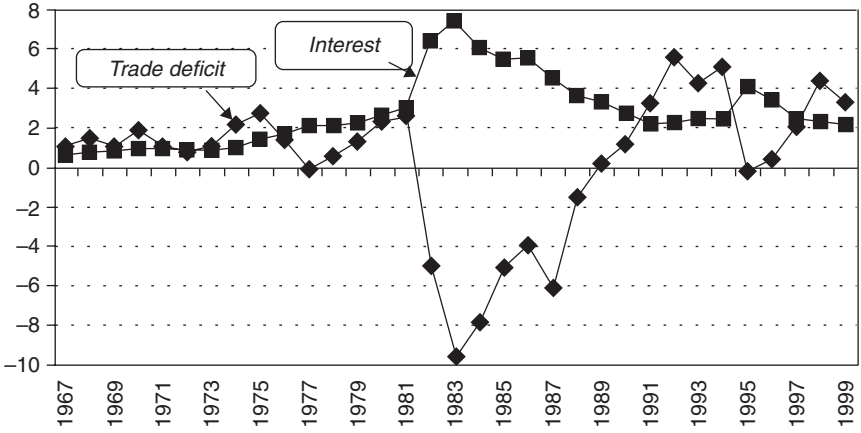

Figure 1. Mexico: trade deficit and net interest payments abroad (1967–99, proportions of GDP, %).

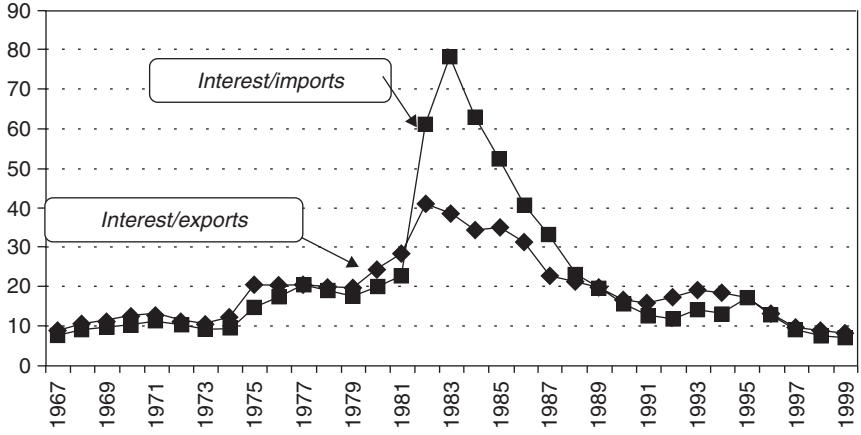

Figure 2. Mexico: exports, imports and net interest payments abroad (1967–99, selected ratios, %).

Using official data on the average annual rate of growth of Mexico's real GDP and real exports, and measuring υ_1 and υ_2 as the ratios observed at the beginning of the period under study, equations (3.1), (3.2) and (3.3) lead to the following estimates for the hypothetical equilibrium value of the income elasticity of import demand during 1967–99: $\xi_T = 2.189$, $\xi_x = 1.991$ and $\xi_M = 1.913$.[18] These three figures are not too distant from the estimated coefficient

[18] An alternative option would be to measure υ_1 and υ_2 as the average values of the period under study. This should be done in future work.

of 1.777 obtained as the long-run income elasticity of import demand via Johansen's techniques (see table 4). Neither do they differ very much from the alternative estimate of the long-run income elasticity $\xi = 1.772$ derived by the cointegration tests applied on the trivariate VAR system that excluded relative prices. But, the significance of such differences must be formally tested.

The LRS calculated to test the over-identifying restriction H_0: $\xi = \xi_T$ imposed on the cointegrating vector for the full VAR system (including relative prices) reject the null hypothesis at a 5 per cent critical level of significance (see table 4). This suggests that Thirlwall's law, in its original formulation, does not offer an adequate interpretation of Mexico's long-run economic growth during 1967–99. On the other hand, when adopting the alternative definition of the BPC growth rate that allows for a long-run stock/flow equilibrium position, the conclusions of the LRS tests are the opposite. Indeed, their results could not reject the null hypothesis $\xi = \xi_x$ even at a 10 per cent level of significance. Finally, the favourable results were even stronger for the tests carried out on the BPC model that explicitly allowed for the influence of interest payments abroad and guaranteed a long-run constant ratio of the current account deficit to norninal income. This should perhaps not be surprising given the conspicuous amounts of interest payments that Mexico had to incur during an important part of the period analysed.

Thus these results give strong support to the modified versions of Thirlwall's law given as a relevant hypothesis for the Mexican case. These results may help to claim that the new generation of BPC models recently introduced—including the relatively straightforward modification put forward in section 2 of the present paper—may strengthen the empirical relevance of the theory of BPC economies.

The results of the LRS tests on the cointegrating vector identified in the analysis of the trivariate VAR system for 1967–99 (excluding relative prices) also support the conclusion that, for the Mexican case, the new generation of the BPC model—particularly when explicitly capturing the influence of interest payments abroad—may be more relevant than the original one (see again table 4). Indeed, they did not reject the null hypotheses H_0: $\xi = \xi_x$ or that $\xi = \xi_M$. With p values of 0.282 and 0.468, they strongly confirm the adequacy of the modified versions or Thirlwall's law given by equations (2.9) and (2.12) for the empirical analysis of Mexico's long-run economic growth. However, the LRS test of the null hypothesis H_0: $\xi = \xi_T$ using the cointegrating vector estimated for the trivariate VAR system, i.e. excluding relative prices, reported a p value of 0.072. This result rejects the null hypothesis at the 10 per cent critical level, though not at the 5 per cent level. It gives support

Table 4. Test of the empirical relevance of Thirlwall's law (original and extended versions) for the Mexican economy, 1967–99 (based on McCombie's procedure)

VAR system for import demand	*Income elasticity of import demand*				*LRS tests of equality of the long-run income elasticity and its hypothetical equilibrium values (p values)*[a] *Null hypothesis*		
	Johansen's cointegration coefficient	*Hypothetical equilibria consistent with Thirlwall's law as expressed in the:*					
		original BPC model[b]	*extended BPC models*[c]				
	ξ	ξ_T	ξ_x	ξ_M	$\xi = \xi_T$	$\xi = \xi_x$	$\xi = \xi_M$
(A) With four variables $\ln m$, $\ln y$, $\ln p$ and q	1.777	2.189	1.991	1.913	0.048	0.177	0.337
(B) With three variables[d] $\ln m$, $\ln y$, and q	1.772	2.189	1.991	1.913	0.072	0.282	0.468

Notes:

[a] p values of the χ^2 corresponding to the LRS to test the over-identifying restriction equalizing the cointegrating coefficient for the income elasticity of import demand to its hypothetical equilibrium derived from three versions of Thirlwall's law.

[b] ξ_T is derived from equation (3.1).

[c] θ_x is derived from equation (3.2) taking θ (the export–import ratio) reported for the beginning of the period. ξ_M is derived from equation (3.3) calculated with the values of θ_1 and θ_2 given by the ratio of exports to imports and of interest payments abroad to imports reported at the beginning of the period.

[d] Because the coefficient for price elasticity in the cointegrating vector in the full VAR system for 1967–99 was not significant, these tests were also conducted based on the cointegration vector estimated from the trivariate VAR system (excluding relative prices).

Source: Own calculations with Microfit 4.0.

to the empirical adequacy of Thirlwall's law in its original version; but somewhat weaker support than that given to the revised versions expressed in equations (2.9) and (2.12).

4. CONCLUSIONS

This paper introduced a simple extension of the BPC model that allowed for the influence of interest payments abroad and simultaneously ensured a sustainable path of external debt accumulation. This model led to a formulation of the economy's BPC growth rate that is a rather straightforward extension of the new version of the model recently introduced in the post-Keynesian literature. Our empirical results show that the balance of payments was a binding constraint on Mexico's long-run economic growth in 1967–99. Moreover, they indicate that during these years foreign interest payments were an important determinant of Mexico's long-run economic growth. The results enhance the empirical relevance of the BPC model. These conclusions have been derived relying on empirical tests of versions of the BPC model that have not considered the influence of the terms of trade or of changes in the ratio of the current account deficit to national income. Taking account of their influence could perhaps have given a significantly better estimate of Mexico's economic growth during the period under study. For now, this issue will be left for future research. In any case, it is hoped that the extended version of the BPC model introduced here will be useful for the empirical study of long-run growth in other economies.

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