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Balance-of-payments–constrained growth in Brazil: a test of Thirlwall's Law, 1890–1973

Abstract: *The paper offers a time-series test of Thirlwall's Law for Brazil during the 1890–1973 period. The results confirm the existence of a long-run relationship between Brazilian gross domestic product (GDP), terms-of-trade, and world income, as Thirlwall's Law predicts. In addition, an error correction model is estimated, which shows that adjusting toward Thirlwall's Law equilibrium explains a substantial part of total variation of real GDP in the short run.*

Keywords: *Brazil, Keynesian growth models, Thirlwall's Law.*

Thirlwall's Law states that in the long run demand-side variables play a key role in economic growth through the balance-of-payments constraint: a country cannot grow at a rate higher than what is consistent with its balance-of-payments equilibrium. This has gradually become the standard framework in which Keynesian growth models are formulated. The theoretical interest in balance-of-payments–constrained growth models has been matched by an increasing amount of empirical work. Recent time-series tests using cointegration techniques have been fairly successful in finding a long-term relationship between the evolution of gross domestic product (GDP) and variables related to international trade

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(terms-of-trade, exports, specialization, and world income), confirming Thirlwall's Law predictions.[1]

This paper aims to contribute to the empirical literature in two ways. First, it offers a time-series test of Thirlwall's Law for Brazil covering a very long period, which includes both a phase of export-led growth (the classical liberal era, 1890–1930) and the heydays of import-substituting industrialization (from the Great Depression to the fall of the Bretton Woods system, 1930–1973). The study stops just before the period of debt-led growth (1974–1980), for reasons discussed below.

Second, the paper provides an estimation of the short-run dynamics of real GDP, along with an estimation of the long-run equilibrium given by Thirlwall's Law. Most papers on the empirics of Thirlwall's Law focus on the latter. This is perfectly coherent with the idea that Thirlwall's Law holds in the long run. But from both a theoretical and a policy point of view, it is interesting to know how the economy moves toward equilibrium. In this paper, an error correction model for changes in Brazilian real GDP is estimated, which includes the effects on short-run fluctuations of adjusting to deviations from the steady state.

The model

Thirlwall's Law is formulated out of two constant-elasticity-of-demand functions, namely, the demand for exports (Equation (1)) and the demand for imports (Equation (2)), plus the static condition for balance-of-payments equilibrium with no capital inflows (Equation (3)). By differentiating the logs of Equations (1), (2), and (3) with respect to time, we obtain the proportionate rates of growth of the volume of exports (Equation (4)) and imports (Equation (5)), along with the dynamic condition for balance-of-payments equilibrium (Equation (6)). By substituting Equations (4) and (5) into Equation (6), we get the canonical Thirlwall's Law Equation (7), which renders the proportional rate of growth compatible with balance-of-payments equilibrium (McCombie and Thirlwall, 1994, pp. 246–249).

$$X = (P/P^* \cdot E)^{\psi} \cdot Z^{\varepsilon} \tag{1}$$

$$M = (P^* \cdot E/Ps)^{\nu} \cdot Ys^{\pi} \tag{2}$$

[1] Cf. McCombie (1997), Atesoglu (1993, 1997), and Hieke (1997). There are few time-series tests of Thirlwall's Law in Latin America. See Moreno-Brid (1999) and Moreno-Brid and Pérez (1999) for an application of cointegration techniques in the study of economic growth in Mexico and Central America, respectively.

$$P \cdot X = P^* \cdot E \cdot M \tag{3}$$

$$x = \psi\,(p - p^* - e) + \varepsilon z \tag{4}$$

$$m = \nu(p^* + e - p) + \pi y \tag{5}$$

$$p + x = p^* + e + m \tag{6}$$

$$y^* = [(1 + \psi + \nu) \cdot (p - p^* - e) + \varepsilon \cdot z]/\pi, \tag{7}$$

where X is the volume of exports, M is the volume of imports, P is the domestic price level, P^* is the international price level, E is the nominal exchange rate (and hence (P/P^*E) represents the terms of trade), Z is world income, Y is domestic income, ψ and ν are price elasticities, and ε and π are income elasticities. Small letters represent proportionate growth rates (for example, $x = (dX/dt)/X$). y^* is the rate of growth of income that keeps the balance-of-payments in equilibrium. It is assumed that in the long run the role of net capital inflows can be ignored.

If one assumes that purchasing power parity (PPP) holds, then $p - p^* - e = 0$, the effect of the terms of trade vanishes, and Equation (7) becomes Equations (8) and (8′), where the ratio (ε/π) is non-price competitiveness:

$$y^* = (\varepsilon/\pi) \cdot z = x/\pi, \text{ or} \tag{8}$$

$$y^*/z = \varepsilon/\pi. \tag{8′}$$

Thirlwall's Law does not neglect the influence of supply-side variables. Yet it suggests that at an aggregate level this influence is fully reflected in the ratio of the income elasticities of the demand for exports and imports (non-price competitiveness). This will be the focus of our study. But it should be borne in mind that supply-side variables shape non-price competitiveness and therefore the distribution of effective demand across countries. As argued by many authors of Keynesian and Schumpeterian persuasion, as well as by the structuralist tradition in Latin America, this supply side is a function of technology, structural change, and the pattern of specialization.[2]

[2] See McCombie and Thirwall (1994, ch. 6) and Thirlwall (1997). As put by McCombie: "Non-price competitiveness reflects such supply-side characteristics as quality, after-sale service, the effectiveness of the distribution networks, and so on. Consequently, while this approach stresses the importance of the growth of the demand for exports in the growth process, this is a function of what may be termed a country's supply characteristics" (1997, p. 346). Fagerberg (1988, 1994) and Verspagen (1993, ch. 5) relate the evolution of non-price competitiveness to technological learning. Cimoli (1988) analyzes how technology shapes specialization in a Ricardian multisector model, highlighting the role of international specialization in relative growth.

Equation (8′) shows that a country will grow in equilibrium at a higher (lower) rate than the rest of the world if its non-price competitiveness is higher (lower) than unity. If $\psi^*/z = \varepsilon/\pi = 1$, the country's distance respecting the rest of the world will remain steady. Thus, Thirlwall's Law can be seen as a different approach to the debate on international convergence and divergence. This debate has been dominated by growth accounting studies in which international economic relations take the form of technological spillovers from advanced countries toward less developed countries.[3] Thirlwall's Law permits inclusion of other forms of economic interdependence, like those related to competitiveness, market shares in international trade, and patterns of demand and specialization.

Equations (7) and (8) express the same basic insight of Thirlwall's Law: economic growth cannot exceed in the long run the rate that is compatible with balance-of-payments equilibrium. Whether or not the terms-of-trade should be included in the long-run relation is basically an empirical matter and must be tested—that is, the testing procedure must begin from the less restricted Equation (7).

Empirical analysis: Brazil, 1890–1973

The empirical study covers a large part of Brazilian economic history, embracing both a period of primary exports-led growth and a period of growth based on import-substitution industrialization (ISI). We decided to end the study in 1973 because the 1970s represented a new particular phase from the perspective of balance-of-payments constraints. In effect, in the 1970s these constraints were temporarily challenged by massive foreign capital inflows and a qualitative change in the degree of external indebtedness (Castro and Souza, 1985). Since we use the simpler version of Thirlwall's Law, which lends no role to capital inflows,[4]

[3] The mainstream debate on the empirics of convergence and divergence is summarized in Barro and Sala-i-Martín (1995, ch. 12). For a critical review, see Durlauf and Quah (1998).

[4] Moreno-Brid (1998–1999) shows that if one allows for capital inflows, but assumes that the ratio of the current account deficit relative to domestic income remains constant, then the basic conclusions of Thirlwall's Law are still valid. However, in this case, the identification of the parameters of Thirlwall's Law is modified. If this is true, our estimation of the non-price competitiveness of Brazil may have been inflated by capital inflows to the Brazilian economy. Still, we keep the standard approach of not including capital inflows, as the focus of our work is on the role of non-price competitiveness and the terms-of-trade in economic growth.

it was necessary to exclude from the empirical study the post-Bretton Woods years, characterized by financial turbulence and debt-led growth.

Thirlwall's Law and the phases of economic growth in Brazil

Latin America in general and Brazil in particular represent especially interesting cases for balance-of-payments–constrained growth models. Some Latin American countries (of which Brazil is an outstanding example) achieved very high rates of growth in this century, but this took the form of "stop and go" cycles beset by balance-of-payments disequilibria, debt, and currency crisis.[5] Moreover, early less-formal versions of the theory of demand-constrained growth could already be found in Latin America in the 1940s and 1950s, in the center-periphery models developed by Raúl Prebisch and the Economic Commission for Latin America (ECLA). ECLA believed that the low-income elasticity of exports, along with the high-income elasticity of imports in Latin America (which in turn were related to the nature of its international specialization), could lead to persistent external imbalances and to slower growth, as proposed by Thirlwall's Law.[6]

Concerns with balance-of-payments constraints figured prominently in the Brazilian debate. The historiography on Brazil's long-run growth gives considerable attention to how the country changed its pattern of specialization—by means of both import-substituting industrialization and the promotion of industrial exports—so as to expand the external and domestic markets for Brazilian goods.[7] Two periods can be identified in this respect.

After 1890, Brazil experienced a period of rapid modernization, prompted by the abolishment of slavery (1888) and the overthrow of the

[5] For a description of Brazilian growth as a process of recurrently overcoming external constraints, see Tavares (1972). A most interesting work, which relies on a similar perspective in the case of Argentina, is Katz and Kosacoff (1989). Using a technique different from ours, Martins (2001) offers evidence in favor of Thirlwall's Law in Brazil.

[6] Cf. Rodríguez (1980) and Prebisch (1986).

[7] The bibliography in this field is very extensive. An inevitably very partial list of key contributions may include the classical book by Furtado (1959), who analyzes the impact of exports cycles on Brazil's growth and industrialization; Malan et al. (1977), who discuss external constraints on economic policy in a period in which there was no full convertibility in the international economy; Abreu (1985), who offers a detailed account on how Brazil succeeded to obtain external support to diversify its industrial structure during World War II; and Leopoldi (1991), who analyzes industrial policy and structural change in the Kubitschek period. For a long-run view on the evolution of the Brazilian industry broadly consistent with Thirlwall's Law, see Suzigan (1986, 2000).

monarchy (1889). From 1890 until 1929, growth depended on the exports of a few primary commodities, among which coffee was the most significant. This was an era dominated by liberal policies and the defense of the agrarian interests, with just temporary, timid measures in favor of industry (Suzigan, 2000, p. 14).

The pattern of growth changed from 1930, when Brazil increasingly adopted a vigorous policy of industrial diversification. This policy took primarily the form of import-substitution industrialization in 1930–1960, prompted by severe restrictions on imports in the context of the Great Depression, World War II, and the "dollar shortage" of the 1950s.[8] A critical period of rapid structural change occurred during the *Plano de Metas* (Targets Plan), set forth by president Juscelino Kubitschek in the second half of the 1950s, when several branches of the metal-mechanical and chemical industries were established, with a leading role for the automobile industry (Suzigan and Villela, 1997, pp. 37–42).

After 1967, more emphasis was given to export promotion, although import-substitution industrialization was not abandoned at all.[9] Tariff and nontariff barriers, the exchange rate policy, and export subsidies were devised with a view to reshaping the country's integration into the international economy. Formally, these efforts at diversifying the economic structure of the country can be seen as an effort to foster non-price competitiveness, that is, to increase the ratio between the income elasticity of the demand for imports and exports. In our empirical model, this long-run effort toward industrial diversification is captured by a time trend.

The long run: cointegration analysis

The first step in time-series analysis is to identify the order of integration of the variables[10] included in the model: real GDP (Y), terms-of-trade ($TT = P/P^*E$), and world real income (Z).[11] Table 1 shows that all

[8] See Yeager (1968).

[9] A new major effort at structural change based on import-substitution and external debt occurred during Ernesto Geisel's Second National Development Plan, in 1974–1978 (Castro and Souza, 1985), a period not included in our study.

[10] With the econometric tests we present detailed information about data sources.

[11] The variable world income (Z) consists of the summation of the real GDP of the countries that represented Brazil's main markets, weighted by their participation in total Brazilian exports on annual basis. These countries included Argentina, Belgium, France, Germany, the Netherlands, Italy, the United Kingdom, and the United States. They absorbed on average about 80 percent and 70 percent of Brazilian total exports in 1900–1939 and 1946–1973, respectively. It should be observed that as the participation of each market changed every year, the weight of each country in Z was correspondingly adjusted yearly.

Table 1
Unit root tests, 1890–1973

Variable	*t*-adf	Σ lag		*t*-lag	*t*-prob
Lbgdp	2.9344	0.046793	5	–0.0064524	0.9949
Lbgdp	3.1543	0.046467	4	–1.1154	0.2684
Lbgdp	2.9459	0.046544	3	0.46182	0.6456
Lbgdp	3.3102	0.046296	2	–1.5116	0.1349
Lbgdp	3.0009	0.046691	1	–1.3004	0.1974
Lbgdp	2.7564	0.046903	0	—	—
Lzb	1.6087	0.044327	5	–1.5238	0.1320
Lzb	1.3271	0.044732	4	–0.98589	0.3275
Lzb	1.1638	0.044723	3	–1.7854	0.0783
Lzb	0.85484	0.045379	2	0.054209	0.9569
Lzb	0.87819	0.045077	1	2.1406	0.0356
Lzb	1.2516	0.046127	0	—	—
Lttb	–3.2338*	0.16031	5	0.72588	0.4703
Lttb	–3.1669*	0.15979	4	0.79575	0.4288
Lttb	–3.0741*	0.15938	3	1.7040	0.0926
Lttb	–2.7127	0.16142	2	–0.53235	0.5961
Lttb	–2.9438*	0.16065	1	0.75727	0.4513
Lttb	–2.8529	0.16020	0	—	—
DLbgdp	–3.1206*	0.047963	5	–0.25000	0.8033
DLbgdp	–3.4946*	0.047646	4	–1.1767	0.2432
DLbgdp	–4.3670**	0.047773	3	0.98507	0.3279
DLbgdp	–4.4505**	0.047763	2	–0.72926	0.4682
DLbgdp	–6.4609**	0.047612	1	0.75517	0.4525
DLbgdp	–8.6316**	0.047475	0	—	—
DLzb	–3.6622**	0.044919	5	–1.0637	0.2911
DLzb	–4.8491**	0.044961	4	1.2333	0.2215
DLzb	–4.8686**	0.045123	3	0.70079	0.4857
DLzb	–5.3047**	0.044965	2	1.6895	0.0954
DLzb	–5.1047**	0.045525	1	–0.18031	0.8574
DLzb	–6.6137**	0.045231	0	—	—
DLttb	–3.8695**	0.17067	5	0.97398	0.3334
DLttb	–3.8088**	0.17061	4	0.18306	0.8553
DLttb	–4.1917**	0.16946	3	0.071454	0.9432
DLttb	–4.8067**	0.16830	2	–1.0587	0.2932
DLttb	–7.0168**	0.16844	1	1.2237	0.2250
DLttb	–8.6606**	0.16900	0	—	—

Notes: Critical values: 5% = –2.899; 1% = –3.515; constant included. * denotes significance at the 0.05 level; ** denotes significance at the 0.01 level. The null is that the system has a unit root (nonstationary).

variables have to be differenced once to become stationary, which means that they have a unit root—the series in levels are integrated of order one, I(1). Therefore, for these variables to have a meaningful long-run

relationship, as proposed in Equation (7), they must cointegrate—that is, they must yield a linear combination that is stationary.[12]

The second step consists of defining how many lags should be used in the cointegration test. Beginning with a generous lag-structure (12 lags), the model was made more parsimonious by reducing the number of lags sequentially. It was found that the model with seven lags achieved the best performance on the basis of both the Hannan-Quinn criteria and sequential F-tests for model reduction.[13] In addition, the model includes a deterministic trend in the cointegrating vector and an intercept in the short-run model. As mentioned, the deterministic trend is expected to reflect secular changes in technological diffusion and international competitiveness.[14]

The cointegration test was performed using the Johansen procedure (Table 2). The null that there was no cointegrating vector was rejected against the alternative of having at least one cointegrating vector. In addition, the null that there is more than one cointegrating vector could not be rejected at the 5 percent significance level.

We found two cointegrating equations:

$$LY = 0.6190\ LZ + 0.1922\ LTT + 0.02968\ \text{trend} \tag{9}$$

$$1.105LY = LZ - 1.256\ LTT - 0.07859\ \text{trend}, \tag{9'}$$

where LY is real GDP (in logs), LZ is real-world income (in logs), LTT are the terms-of-trade (in logs), and *trend* is a time trend.

Finally, we imposed some theoretical structure on the results (see Doornik and Hendry, 1994, p. 75) by testing the restrictions proposed by the balance-of-payments–constrained growth theory. We tested for weak exogeneity of LTT and LZ by imposing a linear restriction in the weight matrix α[15] of a unique cointegrating vector, which affects solely the variable GDP.[16] We could not reject the restrictions given by Thirlwall's Law at a 5 percent level of significance (Table 3).

[12] Cuthbertson et al. (1992, pp. 130–132).

[13] Not reported, but readily available on request.

[14] As mentioned, since 1930, Brazilian policies have consistently sought to stimulate structural change and a change in the pattern of international specialization.

[15] This matrix gives the weight of each cointegrating vector in the short-run models for GDP, world income, and the terms-of-trade.

[16] Weak exogeneity of the variables on the parameters of interest implies that all the relevant information necessary for obtaining valid statistical inference is in the conditional model, and therefore information from the marginal models can be neglected (Hendry, 1995, pp. 162–164). Moreover, in the presence of weak

Table 2
Cointegration analysis, 1890–1973

Ho:rank = p	–Tlog (1–μ)	Using T–nm	95 percent	–Tlg (1–μ)	Using T–nm	95 percent
$p = 0$	29.29*	20.75	25.5	56.73**	40.18	42.4
$p \leq 1$	17.74	12.57	19.0	27.44*	19.44	25.3
$p \leq 2$	9.701	6.871	12.2	9.701	6.871	12.2

Standardized β′ eigenvectors

Lbgdp	Lzb	Lttb	Trend
1.000	–0.6190	–0.1922	–0.02968
1.105	1.000	–1.256	–0.07859
7.905	–7.760	1.000	–0.1070

Standardized α coefficients

Lbgdp	–0.2048	0.07107	0.01214
Lzb	0.2369	0.02782	0.02118
Lttb	0.6100	0.3151	–0.03404

Long-run matrix Po = αβ′, rank 3

	Lbgdp	Lzb	Lttb	Trend
Lbgdp	–0.03029	0.1036	–0.03776	–0.0008058
Lzb	0.4351	–0.2832	–0.05930	–0.01148
Lttb	0.6893	0.2017	–0.5471	–0.03923

Notes: Number of lags used in the analysis: 7; variables entered unrestricted: constant; variables entered restricted: trend. * denotes significance at the 0.05 level; ** denotes significance at the 0.01 level.

We therefore estimated the restricted cointegrating vector,[17] which rendered the following result:

$$LY = 0.7868\ LZ + 0.1106\ LTT + 0.02662 \text{ trend}. \qquad (10)$$

exogeneity, we can estimate the short-run model using a single equation approach, without having to estimate a system. In this paper, the conditional model is given by the long-run Thirlwall's Law equation, and the parameters of interest are those that catch the effect of world income and the terms-of-trade on real GDP. The marginal models, in turn, describe the behavior of world income and the terms-of-trade as a function of the *lagged* exogenous and endogenous variables.

[17] The vector is restricted because we tested and accepted the theoretical structure of Thirlwall's Law—that is, that there is a unique cointegrating vector and that *LTT* and *LZ* are weakly exogenous variables. This means that we have zeros in the lines of the α weight matrix corresponding to the weakly exogenous variables.

Table 3
Testing for weak exogeneity (restricted cointegration analysis, 1902–1973)

α matrix, imposing linear restrictions

Lbgdp	1.000
Lzb	0.0000
Lttb	0.0000

Standardized β′ eigenvectors

Lbgdp	Lzb	Lttb	Trend
1.000	–0.7868	–0.1106	–0.02662

Standardized α coefficients

Lbgdp	–0.2402
Lzb	0.0000
Lttb	0.0000

Restricted long-run matrix Po = αβ′, rank 1

	Lbgdp	Lzb	Lttb	Trend
Lbgdp	–0.2402	0.1889	0.02657	0.006392
Lzb	0.0000	0.0000	0.0000	0.0000
Lttb	0.0000	0.0000	0.0000	0.0000

Reduced-form β′

	Lzb	Lttb	Trend
Lbgdp	0.7868	0.1106	0.02662

Notes: LR-test, rank = 1: $\chi^2(2) = 4.8818$ [0.0871].

Although the coefficients of the expansion of world markets (*LZ*) and of the time trend (trend) show the expected signals, the coefficient of *LTT* is positive, which contradicts the Marshall-Lerner condition. However, we tested the hypothesis—by imposing a linear restriction in the β matrix of parameters of the cointegrating equation—that the coefficient of the terms-of-trade is zero (see Table 4). This could not be rejected at a significance level of 5 percent. On the other hand, both the coefficients for world income and the time trend are significantly different from zero. The latter, however, is of a small magnitude, whereas the effect of world income is close to unity. Thus, our results suggest that the influence of the terms-of-trade can be considered negligible and that of the time trend

Table 4
Testing the significance of the coefficients of the cointegrating vector

β matrix

Lbgdp	1.000
Lzb	–0.7868
Lttb	0.0000
Trend	–0.02662

Standardized $\beta' = [H:\phi]'$ eigenvectors

Lbgdp	Lzb	Lttb	Trend
1.000	–0.7868	–0.0000	–0.02662

Standardized α coefficients

Lbgdp	–0.2122
Lzb	0.08012
Lttb	–0.06713

Restricted long-run matrix $Po = \alpha\beta'$, rank 1

	Lbgdp	Lzb	Lttb	Trend
Lbgdp	–0.2122	0.1669	0.0000	0.005648
Lzb	0.08012	–0.06304	0.0000	–0.002133
Lttb	–0.06713	0.05281	0.0000	0.001787

Reduced-form β′

	Lzb	Lttb	Trend
Lbgdp	0.7868	0.0000	0.02662

Notes: LR-test, rank = 1: $\chi^2(3) = 5.1106$ [0.1639].

very small. The largest effect on real GDP is due to real-world income, as predicted in the simpler model expressed in Equation (8).[18]

As the variable terms-of-trade was not significant, we reestimated the long-run equilibrium excluding this variable. We found the following equation (see also Table 5):

$$LY = 0.9725\ LZ + 0.02171\ \text{trend}. \qquad (11)$$

[18] Still, as we observed above, the testing procedure must begin from the more general specification (Equation 7), since the validity of purchasing power parity is an empirical matter that can be readily tested.

Table 5
The long-run equilibrium excluding the terms-of-trade

Lbgdp =	+ 0.9725 Lzb	+ 0.02171 Trend
(SE)	(0.04803)	(0.003345)

WALD test $\chi^2(2) = 424.62$ [0.0000] **.

Equation (11) shows that the long-run elasticity of world income on Brazilian real GDP is very close to unity, whereas the coefficient of the time trend is small but statistically significant. These variables cointegrate, confirming the existence of a long-run relationship among them.

Finally, we tested for strong exogeneity of the variable world income. Our results confirm the hypothesis that world income is strongly exogenous—that is, GDP does not Granger-cause world income (Table 6). This is consistent with the small-country assumption of Thirlwall's Law, and also with the idea that exogenous exports determine the long-run rate of growth. This also means that Thirlwall's Law is a good predictive model, to the extent that past values of *LY* will not affect predictions of *LY* conditioned on world income.

Short-run dynamics

A key question in the formulation of the error correction model is whether the short-run dynamics of real GDP can be estimated using a single equation approach or a system approach. As we have already tested for weak exogeneity of the variables terms-of-trade and world income, and found that they were at least weakly exogenous, we know that we can estimate the dynamic model using a single equation method. The dynamic model includes the variables in first differences plus the error correction term, which contains the residual of the cointegrating Equation (10) and therefore gives the deviation of the real GDP from its equilibrium value.

The final parsimonious error correction model for the Brazilian GDP was obtained by applying the "general-to-specific" approach to model reduction (Cuthbertson et al., 1992, ch. 4). Beginning with five lags, the reduction process arrived at the statistical data-generating mechanism presented in Table 7. The final model produced the lowest value of the Schwarz criterion and successfully "passed" the battery of tests provided by the "summary test" of PCGive.[19]

[19] The summary test checks for heteroscedasticity, autocorrelation, normality of the residuals, and functional form specification (cf. Doornik and Hendry, 1994, pp. 332–337).

Table 6
Testing for strong exogeneity of Lzb (1900–1973)

Variable	Coefficient	Standard error	*t*-value	*t*-prob	PartR^2
Lbgdp_1	–0.075929	0.15627	–0.486	0.6295	0.0053
Lbgdp_2	0.16427	0.20551	0.799	0.4284	0.0143
Lbgdp_3	–0.076005	0.20515	–0.370	0.7128	0.0031
Lbgdp_4	0.32973	0.20187	1.633	0.1095	0.0572
Lbgdp_5	–0.24669	0.19237	–1.282	0.2064	0.0360
Lbgdp_6	0.30175	0.18561	1.626	0.1111	0.0567
Lbgdp_7	–0.27484	0.18711	–1.469	0.1490	0.0467
Lbgdp_8	0.12849	0.18573	0.692	0.4927	0.0108
Lbgdp_9	–0.097947	0.15923	–0.615	0.5416	0.0085
Lbgdp_10	–0.042367	0.11484	–0.369	0.7140	0.0031
Lzb_1	1.0862	0.15536	6.991	0.0000	0.5263
Lzb_2	–0.18647	0.23096	–0.807	0.4238	0.0146
Lzb_3	–0.096688	0.22348	–0.433	0.6674	0.0042
Lzb_4	–0.12572	0.22455	–0.560	0.5784	0.0071
Lzb_5	0.024757	0.23766	0.104	0.9175	0.0002
Lzb_6	0.30962	0.23395	1.323	0.1925	0.0383
Lzb_7	0.016868	0.24586	0.069	0.9456	0.0001
Lzb_8	–0.31193	0.23245	–1.342	0.1865	0.0393
Lzb_9	0.074230	0.23372	0.318	0.7523	0.0023
Lzb_10	0.054722	0.15413	0.355	0.7242	0.0029
Lttb_1	0.065758	0.039731	1.655	0.1050	0.0586
Lttb_2	–0.026735	0.053361	–0.501	0.6189	0.0057
Lttb_3	–0.0020379	0.054025	–0.038	0.9701	0.0000
Lttb_4	–0.038812	0.053953	–0.719	0.4757	0.0116
Lttb_5	0.054927	0.051696	1.062	0.2938	0.0250
Lttb_6	–0.065921	0.053075	–1.242	0.2208	0.0339
Lttb_7	0.022022	0.052749	0.417	0.6784	0.0039
Lttb_8	–0.042676	0.050377	–0.847	0.4015	0.0160
Lttb_9	0.020560	0.049190	0.418	0.6780	0.0040
Lttb_10	0.053196	0.037726	1.410	0.1656	0.0432

$R^2 = 0.999958$; * R^2 does *not* allow for the mean *; RSS (residual sum of squares) = 0.08858038258 for 30 variables and 74 observations.
Diagnostic tests:
AR 1 – 2F(2, 42) = 0.81543 [0.4493]
ARCH 1 F(1, 42) = 0.6903 [0.4108]
Normality χ^2 (2) = 1.2364 [0.5389]
RESET F(1, 43) = 0.0038624 [0.9507].
Wald Test for linear restrictions (Subset):
LinRes F(10, 44) = 1.1396 [0.3561]
Zero restrictions on: Lbgdp_2 Lbgdp_3 Lbgdp_4 Lbgdp_5 Lbgdp_6 Lbgdp_7 Lbgdp_8 Lbgdp_9 Lbgdp_10 Lbgdp_1.
Wald Test for linear restrictions (Subset):
LinRes F(10, 44) = 1.2167 [0.3071]
Zero restrictions on: Lttb_1 Lttb_2 Lttb_3 Lttb_4 Lttb_5 Lttb_6 Lttb_7 Lttb_8 Lttb_9 Lttb_10.
Wald Test for linear restrictions (Subset):
LinRes F(10, 44) = 16.828 [0.0000]**
Zero restrictions on: Lzb_1 Lzb_2 Lzb_3 Lzb_4 Lzb_5 Lzb_6 Lzb_7 Lzb_8 Lzb_9 Lzb_10.

Table 7
The statistical generating mechanism: modeling the short-run dynamics of real GDP (1896–1973)

Variable	Coefficient	Standard error	*t*-value	*t*-prob	PartR^2
DLzb	0.23710	0.10434	2.272	0.0259	0.0636
ECM_1	–0.10292	0.014020	–7.341	0.0000	0.4149

R^2 = 0.595702; * R^2 does *not* allow for the mean *; RSS = 0.1505845277 for 2 variables and 78 observations.

Diagnostic tests:

AR 1 – 2F(2, 74) = 0.28351 [0.7539]
ARCH 1 F(1, 74) = 0.23039 [0.6327]
Normality $\chi^2(2)$ = 0.83309 [0.6593]
Xi2 F(4, 71) = 2.3832 [0.0594]
Xi*Xj F(5, 70) = 1.97 [0.0938]
RESET F(1, 75) = 1.1342 [0.2903].

The results of the final model are presented in Equation (12).

$$y = 0.23710\, z - 0.10292\, \mathrm{ECM}_{-1}, \tag{12}$$

where y and z are the rates of growth of Y and Z, and ECM is the error correction term. As mentioned, ECM gives the distance between the effective real GDP and the real GDP of equilibrium. We included in the regression the variation of the terms-of-trade (with several lags), but the coefficients were not significant. Therefore, this variable was excluded, and it appears neither in the long-run nor in the short-run models.

The results show a key role for Thirlwall's Law in short-run fluctuations. Approximately 41 percent of the variation in real GDP can be attributed to adjustments toward the long-run solution given by Thirlwall's Law. When the effective value of real GDP is above the steady state (and hence the error correction term is positive), the error correction mechanism produces a negative change in the rate of growth of real GDP that moves it back to the path consistent with balance-of-payments equilibrium. Changes in world income play a role as well in shaping fluctuations, but far less significant.[20] In sum, the balance-of-payments–

[20] The model succeeds in explaining a large part of the short-term fluctuations in real GDP (R^2 of about 60 percent). One may think of other variables entering the short-run model, which could improve the goodness-of-fit, like dummy variables for especially turbulent periods (wars and international crises) and data of capital inflows. Exogenous changes in expectations may also represent a key source of short-term fluctuations, as traditionally argued by Post Keynesians. Still, these possible refinements of the short-term model were not considered in this paper.

constrained growth theory is a useful point of departure to understand the sources of GDP fluctuations in the short run.

Concluding remarks

The paper tested the canonical Thirlwall's Law model (Equation (7)) using Brazilian data for the 1890–1973 period, ending the study just before the escalation of external debt in the second half of the 1970s. We did find a long-run relationship between Brazilian GDP, the terms-of-trade, and world income, as Thirlwall's Law predicts. The estimated parameters for world income and for the time trend presented the signals and values expected. The estimated parameter of the variable terms-of-trade was not statistically significant, which suggests that the simpler Equation (8) can be used. We therefore estimated the model without the terms-of-trade, finding that the elasticity of Brazil's GDP to world income is about unity, whereas the effect of the time trend is small but statistically significant.

The Keynesian literature correctly emphasizes the role that financial instability, short-run shocks, and volatile expectations play in shaping GDP fluctuations in the short run. Thirlwall's Law, on the other hand, is a model that explains the equilibrium rate of growth in the long run. Still, the short-run and long-run dynamics can be seen working together by estimating an error correction model that includes the residuals of the cointegrating equation. The error correction model suggests that adjusting toward Thirlwall's Law equilibrium explains a substantial part (about 41 percent) of the total variation of real GDP in the short run.

Finally, there are two suggestions for further research. First, studies including capital inflows would be necessary to model balance-of-payments–constrained growth in Brazil in the 1970s, 1980s, and 1990s. The 1970s were years of high capital inflows and debt-led growth; the 1980s were a period of capital exports from Brazil to service the debt; in the 1990s, capital came back, especially after the implementation of the "Real Plan." This should have led to deviations from Thirlwall's Law, especially in the 1970s and 1980s, when the impact of capital inflows and outflows produced a remarkable debt-led cycle. Second, the long-run processes of technological learning and structural change (which slowly altered Brazil's international competitiveness) are represented in our work through a time trend. It would be highly desirable to include variables directly related to technological learning and specialization. As mentioned in the first section, authors like Cimoli, Dosi, Fagerberg, and Verspagen, among others, have attempted to build a bridge between

Keynesian demand-driven growth and Schumpeterian technology-driven competitiveness. Moving forward in this research agenda could substantially strengthen the explanatory power of Thirlwall's Law and could also open windows of opportunity for the cross-fertilization of the Keynesian and Schumpeterian traditions.

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Appendix

Key to the variables in the econometric tests

Lbgdp = Natural logarithm of the index of Brazil's real GDP (*LY*)
Lttb = Natural logarithm of the index of Brazil's terms-of-trade (*LTT*)
Lzb = Natural logarithm of the index of the real GDP of the main Brazilian markets, weighted by the participation of each country in total Brazilian exports, estimated on annual basis (*LZ*).

Note: Dlbdgp, Dlttb, and Dlzb are first differences of the above-mentioned variables.

Sources of data

Real GDP

1890–1899: Goldsmith (1986).
1900–1920: Haddad (1979).
1920–1950: Zerkowsky and Veloso (1982).
1950–1973: Summers and Heston (1991) (Penn Tables).

Real-world income

Maddison (1995).

Terms-of-trade

Gonçalves (1981).

The raw data used in the econometric study are readily available on request. Tests performed using PCGive 8.0.