

The economics of demand-led growth. Theory and evidence for Brazil

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ABSTRACT

This article describes the theory of demand-led growth and provides evidence that a demand-led growth regime exists in the Brazilian economy. Based on the methodology developed by Atesoglu (2002), econometric tests of this hypothesis show that almost 85% of the growth rate of real gdp in the period 1990-2005 is explained by demand-side variables, mainly exports and government consumption. As the current fiscal crisis rules out fiscal expansion, Brazil's only option is to adopt an export-led growth model. The article also shows that the maintenance of undervalued real exchange rate is a major determinant of export growth in developing countries such as Brazil.

KEYWORDS

Economic growth, development models, supply and demand, exchange rates, exports, econometric models, macroeconomics, Brazil

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I

Introduction

Over the last 25 years, the Brazilian economy has grown at an average rate of 2.6% per year—considerably less than in the period 1950-1980 and lower than average growth rates in other emerging economies such as Russia, India and China. As Brazil's population is growing by nearly 1.5% per year, GDP per-capita is rising by almost 1% annually. At this rate, it will take nearly 70 years for per-capita GDP to reach the current levels of Spain or Portugal. In this respect, the Brazilian economy is now in a situation of near-stagnation.

In the late 1980s and early 1990s, this situation was seen as the result of the persistent high inflation prevailing in the Brazilian economy. In March 1990, the last month of President Sarney's term of office, this developed into hyperinflation as prices rose at a monthly rate of 72%. Annual inflation rates were brought down to below 10% by the successful implementation of Real Plan during President Fernando Henrique Cardoso's first term. This process involved anchoring inflation on the exchange rate, under the crawling-peg exchange rate regime implemented from 1995 to 1998.

Stabilization was not followed by a sustained acceleration of growth, however. The faster growth recorded in the first two years of Real Plan—with average rates of almost 5% per year—was brought to an end due to contagion from the external crises in Mexico, East Asia and Russia.

In early 1999, following a massive loss of international reserves caused by a sudden stop in capital flows to the Brazilian economy, as confidence in the sustainability of the Brazilian exchange-rate regime evaporated, the country's monetary authorities adopted a flexible exchange-rate regime.

The new macroeconomic model was completed in 1999 with the adoption of inflation-targeting enhanced by a fiscal policy that aimed to generate substantial primary surpluses to prevent the public-debt/GDP ratio from exploding.

The new macroeconomic model allowed for sharply lower real interest rates—they fell from almost 25%

per year in the period 1994-1998 to nearly 10% in the period 1999-2005—and for a devaluation of the real exchange rate, which was crucial for eliminating the current-account deficits recorded in the period 1994-1998, which reached a level of almost 4% of GDP. Moreover, a fiscal policy that generated significant primary surpluses made it possible to reduce the public-debt/GDP from a peak of 63% in 2002 to its current level of around 45%.

Despite lower real interest rates, less external fragility and stabilization of the public debt, the growth performance of the Brazilian economy remains very weak. Average annual growth in the period 1999-2005 was only 2.3% compared to 3.22% in the period 1994-1998.

Against this backdrop, the key problem is how to produce a persistent increase in the growth rate in the Brazilian economy.

There are two answers to this. The first, based on neoclassical growth models and the growth-accounting methodology, argues that the reason for the Brazilian economy's weak growth performance over the last 25 years is to be found on the supply side of the economy. More specifically, the reasons for the low GDP growth rate were a low level of domestic savings—owing to the negative contribution of the public sector and weak incentives for private savings—and lack of technological dynamism reflected in a very low total-factor-productivity (TFP) growth rate. On this view, a sustained rise in the growth rate would require reform of the social security system to increase government saving, supported by a more open economy to stimulate higher productivity in Brazilian firms.

The second approach to this issue is based on the idea that the macroeconomic model adopted in Brazil in the last decade has undermined aggregate demand and is hampering the real GDP growth rate. This is because the combination of still high real interest rates and the generation of significant (and, in recent years, increasing) primary surpluses is depressing demand. According to this view, the solution for the near-stagnation of the Brazilian economy would be to replace the current macroeconomic model which is based on inflation-targeting under flexible exchange rates and the generation of primary surpluses.

In the belief that both of these views are mistaken, this article adopts a Keynesian approach in which the determinants of long-run growth are to be found on the demand side of the economy rather than on the supply

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side. Nonetheless, the naïve Keynesian view that growth can be stimulated by any policy that increases aggregate demand is rejected. The fiscal crisis in Brazil imposes clear constraints on growth policies based on increasing government consumption. A sustained increase in the growth rate of the Brazilian economy requires the adoption of a new growth model, in which exports drive aggregate demand and thus serve as the engine of long-run growth. Adopting this growth model, however, requires an exchange-rate regime that can keep the real exchange rate undervalued.

This article is organized in five sections, including the introduction. Section II describes the theory of demand-led growth in which the long-run growth-rate of real GDP is a weighted average of the growth rates of government consumption and exports. Section III, based

on the methodology developed by Atesoglu (2002), reports econometric tests of the hypothesis that the Brazilian economy is in a demand-led growth regime. The results of the tests showed that nearly 85% of GDP growth in the period 1990-2005 is explained by demand-side variables. Moreover, tests based on the methodology developed by Ledesma and Thirlwall (2002) show that the Brazilian economy's natural growth rate is endogenous, and considerably higher in boom periods. These results show that there are no supply-side constraints preventing a sustained increase in the growth rate of the Brazilian economy. Section IV provides an empirical analysis of the relation between the real exchange rate and the income-elasticity of exports, to show that an export-led growth model requires a competitive real exchange rate levels. Section V summarizes the conclusions.

II

The theory of demand-led growth: the Keynesian view

1. Long-run endogeneity of the supply of factors of production

Neoclassical growth models assume that the fundamental limit to long-run growth is the supply of factors of production. Aggregate demand is relevant only for determining the degree of capacity utilization, but has no direct influence over the rate of growth of productive capacity. In the long-run, Say's law is assumed to hold: supply creates its own demand.

But is the supply of factors of production really independent of demand? This question, originally raised by Kaldor (1988), gave rise to the theory of demand-led growth, premised on the notion that the means of production in a modern capitalist economy are themselves goods produced within the system. The "supply" of means of production should never be taken as given and independent of the demand for them. In this theoretical framework, the fundamental economic problem is not to allocate a given amount of resources between alternative uses; but to determine of the rate at which those resources are created.

The long-run endogeneity of factors of production can be understood by starting with the supply of capital. The quantity of capital that exists at any point

in time—or the productive capacity that exists in the economy—is the outcome of past investment decisions. Thus the stock of capital is not a quantity determined by "nature", but depends on the rate at which entrepreneurs wish to increase it.

This means that investment decisions are the fundamental determinants of the "capital stock". Investment, in turn, is determined by two sets of variables: (i) the opportunity cost of capital (mainly determined by the short-term interest rate set by the central bank); and (ii) expectations for the future growth of sales and production. In this context, if entrepreneurs foresee a strong and sustainable increase in demand for the goods they produce—as would be expected in an economy with a persistently high growth rate—they will make large investment expenditures.

In other words, investment is an endogenous variable that is aligned with the expected growth of aggregate demand, provided one fundamental condition is satisfied: the expected rate of return on capital must be higher than the cost of capital. If this condition is met, the "supply of capital" should not be considered as a constraint on long-run growth.

Although production in the short and medium terms cannot exceed the maximum productive capacity

of the economy, long-run productive capacity must be increased—through investment expenditures—to satisfy the increase in aggregate demand.

The second focus is the “supply of labour”, which this theory also does not see as limiting production growth in the long run.

Firstly, the number of hours worked can easily be increased to raise the level of output.

Secondly, the participation rate—the labour force as a proportion of the total working-age population—can increase in response to a strong increase in labour demand (Thirlwall, 2002, p.86). In fact, during boom periods, the opportunity cost of leisure increases, stimulating a vigorous increase in the participation rate. Thus the labour force may grow faster during boom periods as individuals decide to enter the labour force in response to the incentives created by a booming labour market.

It should be noted that population and the labour force are not fixed for the economy as a whole. A shortage of labour—even of skilled workers—can be solved by immigration from other countries. For example, countries such as Germany and France were able to sustain high growth rates during the 1950s and 1960s by employing immigrant workers from the European periphery (Spain, Portugal, Greece, Turkey and southern Italy).

Lastly, it is worth considering whether the rate of technological progress acts as a constraint on long-run growth. Growth will be limited by the pace at which knowledge of information and communications technologies (ICTs) expands if technological progress is exogenous to the economic system; but that is not the case.

Firstly, the pace at which firms innovate is largely determined by their rate of capital accumulation; since a large proportion of technological innovations is embodied in new machinery and equipment.¹

Secondly, even the small part of technical progress that is disembodied is determined by dynamic economies of scale such as learning-by-doing. A structural relationship therefore exists between the rate of growth of labour productivity and the rate of growth of output, known

as the “Kaldor-Verdoorn Law”.^{2, 3} In this framework, an increase in aggregate demand will cause labour productivity to grow faster, since output growth will accelerate in the wake of stronger demand growth.

From this standpoint there is no such a thing as long-run potential or full-employment output, since the supply of factors of production and the rate of technological progress are both demand-determined. “Full-employment” is essentially a short-run concept that ignores that endogeneity of the long-run “natural growth rate”.

2. The determinants of long-run growth

If the supply of factors of production cannot be considered a constraint on long-run growth, what are the determinants of economic growth in the long run? From the Keynesian standpoint, the ultimate determinant of economic growth is aggregate demand. Firms raise their production levels in response to an increase in aggregate demand, provided two conditions are satisfied: (i) profit margins are high enough to give to entrepreneurs the desired rate of return; (ii) the actual profit rate must be higher than the cost of capital. If these two conditions are met, then the rate of growth of real output will be determined by the rate of growth of “autonomous demand”—the part of aggregate demand that is independent of the level of output and income, variations therein, or both.

In the case of open economies, autonomous demand has two components: exports and government consumption expenditure (Park, 2000). Investment is not a component of autonomous demand, since decisions to invest in capital assets are basically determined by the expectations entrepreneurs hold for the future growth of production and sales, according to the “accelerator” investment model (Harrod, 1939). In other words, investment is not an exogenous variable in the growth

¹ This idea was originally expressed by Kaldor (1957) through the “technical progress function”, which posits the existence of a structural relationship between the growth rate of output per-worker and the growth rate of capital per worker. According to Kaldor, it is impossible to isolate the increase in labour productivity caused by the introduction of new technologies from that caused by an increase in capital per worker. The reason is that nearly all technological innovations that raise labour productivity require more capital per worker, since the innovations are embodied in new machines and equipment.

² Econometric evidence on the validity of the “Kaldor-Verdoorn Law” for the United States can be found in McCombie and De Ridder (1984).

³ Ledesma (2002) estimates a demand-led growth model for 17 countries that are members of the Organization for Economic Cooperation and Development (OECD) (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom and United States) in the period 1965-1994. Based on this econometric evidence, a structural relationship can be identified between the growth rate of labour productivity and a set of other variables including the rate of output growth. The estimated structural equation is:

$$r = -0.015 + 0.642y + 0.0002(I/O) + 0.617K + 0.021GAP,$$

where r is the growth rate of labour productivity; y is the growth rate of real output; (I/O) is investment as a proportion of real GDP; K is an index of technological innovation; and GAP is an estimate of the technological gap.

process, since it is actually driven by output growth. The long-run growth rate of real output is thus a weighted average of the rate of growth of exports and the rate of growth of government consumption expenditure.

For a small open economy that does not have its own convertible currency, export growth is the exogenous variable in the growth process. If government consumption grows faster than export growth, then real output and income will outpace exports. Assuming the income-elasticity of imports is greater than 1 (as is usually the case in open economies), then imports will grow faster than exports, generating a ever larger trade deficit (assuming constant terms of trade), which will be unsustainable in the long-run.⁴

⁴ It is important to note that export growth that outpaces the growth of government consumption is not a sufficient condition for a sustainable growth process in the long-run; balance of payments equilibrium is also required. For open economies with zero-capital mobility this means that the long-run growth rate will be equal to the ratio between the

The rate of growth of exports is calculated as the product of the income-elasticity of exports (ε) and the rate of growth of world income (z). Thus the long-run rate of growth of real output (g^*) in the demand-led growth model is given by:

$$g^* = \varepsilon z \quad (1)$$

In other words, the growth rate of real output is equal to the product of the income-elasticity of exports and the rate of growth of world income.

income-elasticity of exports and the income-elasticity of imports, with this ratio being multiplied by the growth rate of world income known as “Thirlwall’s Law” (Thirlwall, 1997). The introduction of capital flows does not significantly alter the long-run equilibrium growth rate (McCombie and Roberts, 2002, pp.95-96). The present article is not concerned with balance of payments constraints on Brazilian economic growth, but aims to show the existence of a demand-led growth regime in Brazil. The econometric tests will therefore not use “Thirlwall’s Law”.

III

Demand-led growth in Brazil?

Some empirical tests

This section reports econometric tests of the hypothesis that growth is driven by aggregate demand in the Brazilian economy. It firstly shows that certain aggregate demand variables play a key role in explaining the growth of the Brazilian economy in the period 1991-2005.⁵ In particular, exports and government current consumption are exogenous variables in long-run growth, thus corroborating the demand-led growth model described in Section II. It is also shown that the natural growth rate of the Brazilian economy is endogenous, and determined by the dynamics of the current growth rate driven by aggregate demand. This means that supply conditions do not impose a binding constraint on economic growth. The estimates made for this article —based on quarterly data on unemployment and the growth of the Brazilian economy in the period 1980-2002— show that the

natural growth rate can vary from 5.2% per year to 8% in boom periods.

1. Testing the hypothesis of demand-led growth

This subsection uses the Atesoglu (2002) methodology to test the hypothesis that growth in the Brazilian economy is driven by aggregate demand. This involves measuring the relationship between real GDP (Y) and the following variables: real level of exports (X); the real level of investment (I);⁶ real government consumption (G); and the real money supply ($M2$ deflated).⁷

⁶ Public and private.

⁷ The reason for using a money-supply variable instead of a long-term interest rate as a proxy for the effects of monetary policy on long-run growth in Brazil needs to be explained. Firstly, the implementation of monetary policy by setting the short-term interest rate only began in 1999 after the establishment of an inflation-targeting regime. Prior to 1999, the Central Bank of Brazil used other operational targets for monetary policy, such as money-supply growth (1994-1995) and the nominal exchange rate (1996-1998). Secondly, Brazil does not have a long-term interest-rate “market” because government bonds (*Letras*

⁵ The Brazilian Geographical and Statistical Institute (IBGE) replicated GDP calculations for the years 1995-2006. As the analyzed series is quarterly and the period of analysis of this study spans from 1991 to 2005, the data used in the estimates are those obtained under the old IBGE methodology.

The data on real GDP, real exports, real investments and real government consumption were obtained from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA). The money-supply series was obtained from the Central Bank of Brazil. All series were deflated by the general price index (IGP-DI) calculated by the Getúlio Vargas Foundation (FGV). All variables were transformed to set their 1991 values equal to 100 (1991 = 100), and natural logarithms⁸ were applied to these rates. As a result, the estimated coefficients represent the elasticities between

the variables in question. The study period spans 60 quarters, from the first quarter of 1991 to the fourth quarter of 2005.

The following unit-root tests were used to check for stochastic trends in the variables: augmented Dickey-Fuller (ADF, t-test), Phillips-Perron (PP, z-test) and the trend-adjusted Dickey-Fuller (DF-GLS test), along with the KPSS stationarity test, proposed by Kwiatkowski, Phillips, Schmidt and Shin (1992).⁹ The decision on whether to include the constant or trend, or both, in addition to the number of lags for each series, was made using the Schwarz (sc) and Newey-West (NW) information criteria, supported by the statistical significance of the estimated parameters and the usual diagnostic tests, always starting with the general model and moving to the particular (initial lag = 10). The results, set out in table 1, show that all variables are integrated of order one, or I(1), and are therefore not stationary.

Financieiras do Tesouro) – are indexed to the short-term interest rate. This eliminates the possibility of capital losses caused by an increase in the short-term interest rate, which means that the *duration* (the sensitivity of bond prices to changes in the interest rate) of such bonds is zero, making them perfect substitutes for bank reserves. This specific institutional feature of the Brazilian economy results in a “contamination” of monetary policy by public debt, creating a *horizontal yield curve*; in other words, a situation where debts of different maturities have the same interest rate, namely the interest rate on loans in the inter-bank market (see Barbosa, 2006).

⁸ An L placed before the name of each variable indicates its logarithmic form while DL denotes the first difference of the logarithms.

⁹ Following Maddala (2001), confirmatory analysis was used and a significance level of 10% was adopted. In the event of conflicting results, the unit-root test was preferred.

TABLE 1

Unit-root and stationarity tests

Variable	ADF				PP			
	Def.	Set terms	Test	Critical value 10%	Def.	Set terms	Test	Critical value 10%
LY	1	N	0.70	-1.61	2	CT	-3.15	-3.17
D(LY)	0	N	-10.78	-1.61	11	N	-11.76	-1.61
LX	2	N	1.64	-1.61	18	N	1.56	-1.61
D(LX)	1	N	-9.52	-1.61	21	N	-8.45	-1.61
LI	0	N	0.59	-1.61	57	N	1.25	-1.61
D(LI)	0	N	-7.77	-1.61	57	N	-12.88	-1.61
LG	4	N	0.82	-1.61	15	N	1.41	-1.61
D(LG)	3	N	-3.21	-1.61	28	N	-15.62	-1.61
LM2	0	CT	-2.31	-3.17	0	CT	-2.31	-3.17
D(LM2)	1	N	-3.02	-1.61	2	N	-6.42	-1.61

Variable	DF-GLS				KPSS			
	Def.	Set terms	Test	Critical value 10%	Def.	Set terms	Test	Critical value
LY	1	C	-0.59	-1.61	5	CT	0.20	0.12
D(LY)	0	CT	-7.74	-2.87	48	C	0.39	0.35
LX	2	CT	-1.46	-2.87	5	CT	0.23	0.12
D(LX)	1	CT	-8.60	-2.87	18	C	0.15	0.35
LI	0	CT	-2.44	-2.86	5	CT	0.22	0.12
D(LI)	0	CT	-5.62	-2.87	58	CT	0.50	0.12
LG	4	CT	-1.78	-2.88	5	CT	0.21	0.12
D(LG)	3	CT	-2.21	-2.88	15	C	0.14	0.35
LM2	0	CT	-1.14	-2.86	6	CT	0.23	0.12
D(LM2)	1	C	-2.61	-1.61	3	C	0.42	0.35

Source: Prepared by the authors using data from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA) and “Boletim do Banco Central do Brasil”.

Notes: N = None; C = Constant; and CT = Constant and linear trend. In the ADF and DF-GLS tests, the initial number of lags for each series is defined according to the Schwarz information criterion. The Newey-West selection was applied for the PP and KPSS tests.

An L placed before the name of each variable indicates its logarithmic form.

The letters DL denote the first difference of the logarithms.

As all series are I(1), there are no problems of spurious correlation between the dependent and independent variables in the results, when the regression is estimated using variables expressed as first-differences, as shown in table 2.

All non-deterministic variables have the expected signs and are significant at the 5% or 1% levels, including jointly (F-statistic). The diagnostic tests performed on: the model specification (Ramsey RESET), the presence of structural change (Chow) and the existence of multicollinearity (Variance Inflation Factor), together with the traditional selection criteria (Akaike-AIC and Schwarz-SIC) validate the chosen parameterization. Tests on the residuals to check for problems of autocorrelation (Durbin-Watson and Breusch-Godfrey), heteroscedasticity (White, Breusch-Pagan and ARCH) and normality (Doornik-Hansen) showed no evidence of the respective problems. The variables on the right-hand side of the regression equation explain about 47% of the variation in GDP, with the money supply having the greatest impact: a 1% increase in the money supply raises GDP by 0.33%.

The analysis of short-run dynamics shown in table 2 —having removed trends in variables via differentiation— provided important information on the long run. Since all the variables involved are I(1),

cointegration is possible. Thus, short-run dynamics and short-run balances are integrated on the basis of the theory developed in Granger (1981) and Engle and Granger (1987).

The regression of the static variables expressed as levels (table 3) is part of the two-stage Engle-Granger (EG) procedure to test cointegration. If the variables are cointegrated (the residual is stationary or I(0)), then it is possible to obtain consistent long-run parameters and the error correction term for the short-run regression.

Although the long-run model is validated by the diagnostic tests performed, the residuals may display autocorrelation, so the standard errors (and t-statistics) shown are corrected by the consistent covariance matrix, and the White autocorrelation and heteroscedasticity test (HAC). The LX and LI variables, significant at 5%, will be significant at 1%, while LG is significant at 1% and LM2 is not significant, in both cases (with or without correction).¹⁰

To overcome the problem of residual autocorrelation, a long-run dynamic regression was estimated for an

¹⁰ Evidence of autocorrelation is less severe in this case.

TABLE 2

Model using first differences

Dependent variable: DLY						Observations: 59
Method: Ordinary least squares (OLS)						
Variable	C	DLX	DLI	DLG	DLM2	
Coefficient	-0.0054	0.1753	0.3228	0.2087	0.3312	
Standard error	0.0076	0.0579	0.1151	0.0556	0.1537	
t-stat	-0.7094	3.0296	2.8038	3.7564	2.1547	
Variance inflation factor		1.0270	1.0060	1.1810	1.1690	
R ²	0.4658	Durbin-Watson			2.3652	
Adjusted R ²	0.4262	Breusch-Godfrey		Lags: 2	3.2573	
Standard error (eq.)	0.0547			Lags: 4	3.2877	
Log-probability	90.3107	ARCH test		Lags: 1	2.3725	
Akaike criterion	-2.9618			Lags: 2	3.4820	
Schwarz criterion	-2.7158			Lags: 4	4.0796	
F-stat	11.7699	White test			15.4668	
Chow test	3.0986	Breusch-Pagan test			4.3934	
Ramsey RESET test	1.8084	Doornik-Hansen test			4.7683	

Source: Prepared by the authors using data from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA) and "Boletim do Banco Central do Brasil".

Notes:

Durbin-Watson and Breusch-Godfrey tests detect autocorrelation problems.

White and Breusch-Pagan tests detect heteroscedasticity problems.

Ramsey RESET is a diagnostic test performed on the model specification.

ARCH test detects problems of autoregressive conditional heteroscedasticity.

Doornik-Hansen test detects autocorrelation and normality problems.

Chow test is a diagnostic test on the presence of structural change.

The letters DL denote the first difference of the logarithms.

C: Constant.

TABLE 3

Long-run (eg)^a model

Dependent variable: LY Method: Ordinary least squares (OLS)		Observations: 59 (ADL) and 60 Static regression				
Variable	C	LX	LI	LG	LM2	
Static regression						
Coefficient	0.6599	0.0687	0.3172	0.4134	0.0533	
Standard error	0.5207	0.0278	0.1193	0.0680	0.0543	
t-stat	1.2674	2.4735	2.6598	6.0805	0.9818	
Standard error (HAC)	0.4864	0.0239	0.0847	0.1067	0.0634	
t-stat (HAC)	1.3569	2.8783	3.7428	3.8758	0.8397	
Variance inflation factor		1.7170	2.3850	3.4210	4.6910	
Autoregressive distributed lag						
Coefficient	1.1726	0.0389	0.0793	0.5966	0.0316	
Wald test (F-stat)	3.7628	1.5588	3.1683	10.9340	0.1173	
R ²	0.8743	Durbin-Watson			1.9849	
Adjusted R ²	0.8513	Breusch-Godfrey		Lags: 2	1.2114	
Standard error (eq.)	0.0468			Lags: 4	1.9216	
Log-probability	102.3642	ARCH test		Lags: 1	0.0837	
Akaike criterion	-3.1310			Lags: 2	0.4808	
Schwarz criterion	-2.7789			Lags: 4	0.7408	
F-stat	37.8855	White test			57.9920	
Chow test	0.2095	Breusch-Pagan test			11.1197	
Ramsey RESET test	1.9947	Doornik-Hansen test			14.1386	

Source: Prepared by the authors using data from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA) and "Boletim do Banco Central do Brasil".

Notes: The diagnostic statistics refer to the ADL model with 1 lag. Durbin-Watson and Breusch-Godfrey tests detect autocorrelation problems. White and Breusch-Pagan tests detect heteroscedasticity problems. Ramsey RESET is a diagnostic test performed on the model specification. ARCH test detects problems of autoregressive conditional heteroscedasticity. Doornik-Hansen test detects autocorrelation and normality problems. Chow test is a diagnostic test on the presence of structural change. ADL: Autoregressive distributed lag model. HAC: Heteroscedasticity and autocorrelation test (White). C: Constant.

^a EG: Two-stage procedure developed by Engle-Granger to test cointegration.

autoregressive distributed lag (ADL) model.¹¹ This model passes the diagnostic tests. In terms of parameter significance, LX, LI, LG are still significant (at least at 10%) but LM2 is not.

To ensure the estimated relationships are not spurious, the variables in question need to co-integrate. The next step in the Engle-Granger procedure is to check whether the residuals in the long-run relationship are stationary, using the adf test. Nonetheless, it is not advisable to use the values of the traditional tables to test this hypothesis. As these tables are not prepared for the estimated values, we use the adjusted table for estimated values and for

the sample size proposed in MacKinnon (1990). The statistical test value (-4.68) rejects the presence of a unit root with 99% confidence, thus pointing to the existence of a long-run relationship between variables.

The existence of cointegrated variables means the error correction model (ECM) can be used. This connects short-run dynamic aspects and long-run ones; in other words, it makes it possible to combine the advantages of modeling with variables expressed as differences and as levels.

As Table 4 shows, the variables under study are differentiated, so they are stationary (they originally had a unit root). For the equation to be balanced in the sense of being at the same level of integration, the error correction term (ECT) needs to be I(0). Thus, the

¹¹ In the static model with the Cochrane-Orcutt and Prais-Winsten transformations, the significance of the parameters is unchanged.

TABLE 4

Short-run (eg)^a model

Dependent variable: DLY							Observations: 59
Method: OLS							
Variable	C	DLX	DLI	DLG	DLM2	TCE(-1)	
Coefficient	-0.0030	0.1600	0.3438	0.2727	0.1965	-0.5972	
Standard error	0.0062	0.0587	0.0996	0.0305	0.0960	0.1044	
t-stat	-0.4912	2.7233	3.4532	8.9286	2.0465	-5.7199	
Variance inflation factor		1.0310	1.0080	1.2780	1.2250	1.1140	
R ²	0.6248		Durbin-Watson			1.9008	
Adjusted R ²	0.5894		Breusch-Godfrey		Lags: 2	0.5993	
Standard error (eq.)	0.0463				Lags: 4	1.8900	
Log-probability	100.7344		ARCH test		Lags: 1	0.1385	
Akaike criterion	-3.2113				Lags: 2	0.1474	
Schwarz criterion	-3.0001				Lags: 4	0.1624	
F-stat	17.6509		White test			10.1296	
Chow test	0.7125		Breusch-Pagan test			2.8016	
Ramsey RESET test	2.1170		Doomik-Hansen test			17.6178	

Source: Prepared by the authors using data from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA) and “Boletim do Banco Central do Brasil”.

Notes:

Durbin-Watson and Breusch-Godfrey tests detect autocorrelation problems.

White and Breusch-Pagan tests detect heteroscedasticity problems.

Ramsey RESET is a diagnostic test performed on the model specification.

ARCH test detects problems of autoregressive conditional heteroscedasticity.

Doomik-Hansen test detects autocorrelation and normality problems.

Chow test is a diagnostic test on the presence of structural change.

The letters DL denote the first difference of the logarithms.

C: Constant.

^a EG: Two-stage procedure developed by Engle-Granger to test cointegration.

cointegration between the variables in the sense proposed in Engle and Granger (1987) requires the existence of an ecm, and vice-versa. The elasticities are all significant (at the 5% level at least), and close to the values obtained with the usual model expressed in first-difference form. Nonetheless, the coefficient of ECT—which measures the distance of X and Y from the long-run equilibrium and thus reports the speed of adjustment of variables to occasional disequilibria—is about 60%.¹²

For a more robust analysis, the approach described in Johansen (1988 and 1991) and Johansen and Juselius (1990) was used to verify the existence of cointegration and existing relations for the long-run balance. The Johansen procedure is a more general maximum likelihood method that uses a system of dynamic equations, specifically a vector autoregression model (VAR). Johansen’s systemic approach is able to identify not only the presence of cointegration but, if confirmed, the number of cointegrating vectors and their specification.

The number of lags was determined according to the modified maximum likelihood (LR), final prediction error (FPE), Akaike (AIC), Schwarz (SIC) and Hannan-Quinn (HQ) criteria, while the decision to include deterministic terms was based on a visual analysis of the series and the Pantula principle. To test for cointegration and, at the same time, whether the number of vectors exists, the trace and maximum eigenvalue statistics are used (table 5).

As both tests suggest the existence of a cointegration vector, the vector error correction (VEC) can be estimated. The long-run elasticities obtained from the cointegration vector are shown in equation (2):

$$\begin{aligned}
 LY = & 1.1972 + 0.1099LX + 0.7067LI + \\
 & \quad (0.0420) \quad (0.2856) \\
 & \quad [-2.6175] \quad [-2.4714] \\
 & 0.4052LG + 0.0322LM2 \\
 & \quad (0.1490) \quad (0.1045) \\
 & \quad [-2.7197] \quad [-0.3077]
 \end{aligned} \tag{2}$$

Sample: 1992:3-2005:4; Lags: 1 to 5; There is a deterministic trend in the data.

¹² The negative sign is expected to ensure that any disequilibrium is offset by an opposite movement in the variable being explained.

TABLE 5

Cointegration tests

Trace Test			
Hypothesized no. of EC(s)	Eigenvalue	Trace statistics	0.05 Critical value
None	0.4969	76.9029	69.8189
At most 1	0.3780	39.8108	47.8561
At most 2	0.1523	14.1673	29.7971
At most 3	0.0903	5.2455	15.4947
At most 4	0.0025	0.1336	3.8415

The maximum eigenvalue test			
Hypothesized no. of EC(s)	Eigenvalue	Maximum eigenvalue statistic	0.05 Critical value
None	0.4969	37.0921	33.8769
At most 1	0.3780	25.6435	27.5843
At most 2	0.1523	8.9218	21.1316
At most 3	0.0903	5.1119	14.2646
At most 4	0.0025	0.1336	3.8415

Source: Prepared by the authors using data from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA) and "Boletim do Banco Central do Brasil".

The parameter estimates in equation (2) are the standard co-integrating coefficients; the values in parentheses are standard errors and the t-statistics are in brackets. All elasticities have the signs expected in the theory and are statistically significant (5%), except, once again, LM2.

Table 6 summarizes the results obtained from VEC, including each equation's error-correction term and the basic diagnostics of the model as a whole. The figures indicate the long-run equilibrium adjustment coefficients obtained from each of the five VEC multiple equations. The significance of the error correction term in each equation indicates that the dependent variable adjusts in response to an imbalance between the dependent variable and the independent variables, thus indicating endogeneity.

The statistics of the VEC test reject the presence of autocorrelation, heteroscedasticity and non-normality in the residuals. In the adjustment matrix, only the error correction terms in the Product and Investment equations are significant (up to 5%), which is evidence for the (weak) exogeneity of exports and government expenditures in the model. Although the money supply does not adjust to long-run disequilibria, it is not significant in the long-run equation.

The analysis of short run-disequilibria and their interaction with the long-run dynamics, provided by the Engle-Granger methodology and the Johansen procedure, provide some interesting conclusions. The

signs suggested by the theory are observed empirically for the Brazilian economy in the period examined; and the explanatory variables exports, investment, and government expenditure are all significant in the short and long runs. The money supply is significant only in short-run dynamics, so *it seems unlikely that monetary policy has persistent effects on economic growth in Brazil*. This is because monetary changes, broadly defined, do not have a statistical influence on the behavior of real GDP in the long run.

According to the estimated coefficients of regression equation (2), for each 1% increase in real government consumption, real GDP grows by 0.40%. Thus, assuming that tax revenues in the three spheres of government represent approximately 40% of GDP, an increase in current consumption by government on the order of 1% would generate an increase in tax revenues of approximately 0.16%, thereby worsening the public-sector deficit. Given the high tax burden currently prevailing in the Brazilian economy (about 40%) and the high public-debt/GDP ratio (also around 40%), under current conditions, the government cannot permanently stimulate economic growth by increasing its current consumption. Exports represent the only "autonomous" source of demand that could induce a growth acceleration. In other words, the Brazilian economy needs adopt an export-led growth model.

Apart from the money supply, the results reported in this section are very similar to those found by

TABLE 6

Summary of vec^a results

	D(LY)	D(LX)	D(LI)	D(LG)	D(LM2)
ECT	-0.7540	0.9970	0.4946	-0.7177	-0.2112
Standard error	(0.2490)	(0.5846)	(0.2423)	(0.3805)	(0.2156)
t-stat	[-3.0285]	[1.7053]	[2.0379]	[-1.8858]	[-0.9794]
Adjusted R ²	0.6757	0.4361	0.4121	0.8157	0.4696
Standard Error (eq.)	0.0405	0.0952	0.0411	0.0620	0.0351
LM stat (Autocor.)	24.2728				
White (Heterosc.)	801.1020				
Lutkepohl (Norm.)	2.8940				

Source: Prepared by the authors using data from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA) and "Boletim do Banco Central do Brasil".

^a Vector error correction.

Atesoglu (2002). The causality relations support the Keynesian approach discussed in the previous section, in which exports and government consumption are the key sources of economic growth in the long run. Nonetheless, given the severe fiscal crisis in Brazil, it does not seem possible to boost economic growth through a policy to expand the government's current consumption. A resumption of rapid growth in the Brazilian economy requires the adoption of an export-led growth model.

2. Is the natural growth rate of the Brazilian economy endogenous?

Subsection 1 showed that the observed growth rate of the Brazilian economy is determined by the growth of aggregate demand. This subsection takes the reasoning a step further by showing that the natural rate of growth¹³ also adjusts to the economy's actual growth rate in the long term. This means that aggregate-demand growth determines not only the dynamics of the actual growth rate of the Brazilian economy, but also the dynamics of the natural growth rate, which is conventionally linked to technological progress and growth of the labour force.

This subsection is based on a study by Ledesma and Thirlwall (2002). Using the concept defined by Okun (1962 cited by Ledesma and Thirlwall 2002), the

natural rate of growth (g_n) is what keeps the level of unemployment constant. Okun (1962 cited by Ledesma and Thirlwall 2002) uses the following specification for the change in the percentage unemployment rate:

$$\Delta\%U = a - b(g) \quad (3)$$

where U is the level of unemployment, g is the rate of growth of output and a and b are two constants. From equation (3), when $\Delta\%U = 0$, the natural rate of growth is defined by a/b .

As some people do not seek work when economic growth is subdued, it is possible that the coefficient a is underestimated. In this case, the natural rate of economic growth would also be underestimated. Moreover, in periods of rapid economic growth, part of the additional work needed to increase production comes from labour that was previously underused, and also from overtime. Thus, b is underestimated, which leads to an overestimation of the natural rate of growth. Accordingly the natural rate of growth may be either under- or overestimated depending on which of two effects predominates.

In an attempt to circumvent these problems a different approach to estimating the natural rate of growth was developed by Thirlwall (1969):

$$g = a_1 - b_1(\Delta\%U) \quad (4)$$

In equation (4), when the variation in the unemployment rate is zero, we have:

$$g = a_1 \quad (5)$$

Thus, the natural rate of growth is defined by the intercept of the regression equation. The problem of using equation (4) is that the natural rate of growth is endogenous, so the estimated coefficients are biased.

¹³ In the old neoclassical growth models, represented by Solow (1956), the natural growth rate was exogenous and determined by supply factors including the rate of technological progress and growth of the labour force. In the "new growth theory" which originated in seminal papers by Romer (1986) and Lucas (1988), the natural growth rate is made an endogenous variable in the sense that the rate of technological progress is determined by the model itself. Nonetheless, this is not the meaning of the term "endogenous" as used in this article. Here the term "endogenous natural growth rate" means a real output growth rate that is determined by the rate of growth of aggregate demand in the long term. For a similar interpretation of the term "endogenous" see Libanio (2009).

Once the natural rate of growth is estimated, a dummy variable can be created that takes the value 1 (one) when actual economic growth exceeds the natural rate estimated by equations (3) or (4), and 0 (zero), otherwise. The introduction of the dummy variable gives the following regression equation:

$$g = a_2 + b_2D + c_2(\Delta\%U) \quad (6)$$

where D is the dummy variable. In specifying equation (6), two natural rates of growth are estimated. The first is estimated for periods in which the growth rate is above the natural rate given by equation (4). In this case, the natural rate of growth is equal to $a_2 + b_2$. The second is estimated for the periods in which the observed growth rate is below the natural rate given by equation (4). In this case, the natural rate is a_2 .

A “natural rate” would be expected not to vary when the actual growth rate changes. If this is true, the coefficient of the dummy variable should not be statistically different from zero. Otherwise, the natural rate of growth (g_n) is endogenous and responds to changes that may occur in the actual growth rate (g).

The database used to perform the regression analysis in this study contains GDP and unemployment variables. The level of unemployment is taken from the IBGE Monthly Employment Survey (PME), with the original monthly figures being transformed into quarterly data by calculating the arithmetic mean of the three months in each quarter.¹⁴ The chain index of GDP is based on the

System of National Accounts obtained from IBGE (IBGE/SNA).¹⁵ The period of analysis spans the first quarter of 1980 to the last quarter of 2002.¹⁶ As both variables were transformed into growth rates, the first observation in each series was lost, leaving 91 observations for the empirical analysis.

Using the quarterly data series, estimates of the natural rate of growth obtained from equations (3) and (4) are shown in table 7.

The growth rates reported by each of the equations are very similar, which suggests that the estimated natural rate of growth (NRG) is robust, despite the potential problems mentioned above.

A natural rate of growth of around 0.60% per quarter gives an annualized rate close to 2.50%. Thus, the regression equations used suggest that the growth rate that would have kept Brazilian unemployment constant between 1980 and 2002 was close to 2.50%.

Table 8 shows the empirical results obtained from regression equation (6). The symbol MA means that the GDP growth rate is a three-quarter moving average.

The results of regression (6) indicate that the natural rate of growth responds to the economy's real growth rate. The figures in the first line of table 8 suggest that in periods of rapid economic growth the natural rate is around 8%, while in periods of weak economic growth or recession the natural rate is actually negative, at around -3.5 %.

It should be remembered that the data are quarterly so the range of variation is large. One advantage of using moving averages is that they smooth the fluctuations, as

¹⁴ Using the monthly data, each year was divided into four quarters, by adding together the unemployment figures for the three months and dividing by three. 1st quarter unemployment rate (January + February + March) / 3; 2nd quarter unemployment rate (April + May + June) / 3; 3rd quarter unemployment rate (July + August + September) / 3; 4th quarter unemployment rate (October + November + December) / 3.

¹⁵ Seasonally adjusted chained series of the quarterly mobile index, average 1990 = 100.

¹⁶ The period of analysis ends in 2002 because a methodological change was made to the Monthly Employment Survey database in 2003, making it impossible to extend the econometric tests to the most recent period.

TABLE 7

Estimation of the natural rate of growth using the Okun and Thirlwall equations

	Method	Intercept	Slope	DW	R ² Aj.	NRG
Equation (3)	RR	1.61 (0.99)	-2.70*** (3.49)	2.32	0.11	0.60
Equation (4)	OLS	0.59*** (2.99)	-0.053*** (4.12)	1.89	0.15	0.59

Source: Prepared by the authors using data from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA).

Notes: *** Significant at 1%. ** OLS: ordinary least squares; RR is the robust regression method used to correct problems of non-normality of residuals and heteroscedasticity; DW is the value of the Durbin-Watson test for first-order autocorrelation; R² Aj. is the adjusted R²; and NRG is the natural rate of growth.

TABLE 8

**Estimation of the natural rate of growth using the Okun
and Thirlwall equations with a dummy variable**

	Method	Intercept	Dummy coefficient	Slope	DW	R ² Aj.	NRG ($g < g_n$)	NRG ($g > g_n$)
Equation (6)	OLS	-0.84*** (-4.40)	2.85*** (10.40)	0.03*** (-3.35)	2.28	0.61	-0.84	2.01
Equation (6) MA	PWER	-0.26* (-1.66)	1.56*** (10.26)	0.011** (-2.14)	1.82	0.54	-0.26	1.3

Source: Prepared by the authors using data from the System of National Accounts provided by the Brazilian Geographical and Statistical Institute (IBGE/SNA).

Notes: *** Significant at 1%; ** Significant at 5%; * Significant at 10%. OLS: ordinary least squares; PWER is the method of Prais-Winsten with robust errors to correct problems of autocorrelation and heteroscedasticity; DW is the value of the Durbin-Watson test for first-order autocorrelation; R² Aj. is adjusted R²; NRG is the natural rate of growth; and MA is the regression equation using three-quarter moving averages.

can be seen from the results shown in the second row of table 8. In this case, the natural rate of annual growth in “good times” would be around 5.2%, while in “bad times” it would be close to -1%.

The tests show that the natural rate of growth of the Brazilian economy is an endogenous variable and can therefore be affected by the demand conditions

prevailing in the economy. Estimates for the natural rate of growth in “good times” vary between 5.2% and 8% per year, which suggests that the Brazilian economy could grow at annual rates well above 3.5% without generating inflationary pressures. The empirical results provide evidence that economic growth in Brazil is not constrained by supply side, but by demand.

IV

An empirical analysis of the relation between the real exchange rate and the income-elasticity of exports

Section III showed that the observed and natural growth rates in the Brazilian economy are both determined by the growth of aggregate demand. It was also noted that aggregate-demand growth is driven by the growth of exports and government expenditures (since investment is endogenous); but a growth regime led by fiscal expansion is not feasible in Brazil owing to the fiscal crisis. This means that growth in Brazil can only be driven by a continuous expansion of exports.

What conditions need to be satisfied for a strong and continuous expansion of exports in Brazil, or in other capitalist economies? In the long run, the rate of growth of exports in a country or region is determined by the worldwide income-elasticity of exports multiplied by the rate of growth of income in the rest of the world. The income-elasticity of exports captures the influence that non-price factors —such as the technological content

of exported products, the degree of differentiation of exported products compared to their competitors on the international market, the value added to these products, and so forth— have on the country’s external competitiveness. The higher is the income-elasticity of exports, the higher will be a country’s growth rate of exports for a given rate of growth of world income. This is the channel through which supply factors can influence, but not determine, the growth rate of real output in the long run.¹⁷

¹⁷ The inclusion of supply factors in the analysis of this article does not diminish the role of aggregate demand as the ultimate cause of economic growth. The growth rate of real output in the long term is determined by the growth rate of autonomous demand, which is influenced —although not determined— by supply-side factors. Moreover, the inclusion of supply factors in the analysis makes it

Countries on the so-called “technological frontier” should generally have a higher income-elasticity of exports than less developed countries. That is because countries that are closer to the “technological frontier” tend to export products of higher value-added and with greater technological content than countries that are further from the frontier. Thus the “technological gap” will be an important determinant of the income-elasticity of exports and, hence, of the long-run growth rate of exports (Dosi, Pavitt and Soete, 1990, p. 26).

The theoretical and empirical literature on the determinants of the income-elasticity of exports has, however, neglected the role of the real exchange rate as one of its determinants. In fact, empirical work on the variables affecting export performance has been limited to estimating the price-elasticities of exports; and price-elasticity estimates have either shown the opposite sign to that predicted by the theory or have been non-significant.

No attempt has been made to assess the existence of a relationship between the income-elasticity of exports and the real exchange rate. The literature seems to support the hypothesis that the real exchange rate can only influence long-run economic growth through its effect on the willingness of domestic and foreign consumers to spend their income on domestic or foreign goods. The literature neglects the impacts the real exchange rate can have on the economy’s productive structure and, hence, on the income-elasticity of exports.

On a purely theoretical level, a relationship can be established between the level of real exchange rate and the income-elasticity of exports, using the Ricardian model of international trade expounded in Dornbusch, Fischer and Samuelson (1977). Based on this model, the degree of productive specialization of an economy—in other words the number of different types of goods produced by the domestic economy—is determined by the ratio between the domestic real wage and real wages paid worldwide.

The higher the real wages paid in the domestic economy compared to the rest of the world, the greater will be the country’s degree of productive specialization, or the smaller the number of different types of goods produced in the domestic economy. The greater the degree of productive specialization, the lower will be

possible to identify a precise channel through which the real exchange rate can influence export growth in the long run. The conclusion of the analysis, set out in the following paragraphs, is that a robust and continuous expansion of exports (which is a necessary condition for Brazil to achieve high rates of growth in the long run) requires the real exchange rate to be kept undervalued.

the rate of export growth generated by a given rate of world income growth—in other words, the lower will be the income-elasticity of exports.

The real exchange rate affects the degree of productive specialization in the economy by directly impacting on real wages. An appreciation of the real exchange rate generally causes real wages to rise, thereby increasing production costs in the country relatively to those prevailing in the rest of the world. This process forces productive activities undertaken in the domestic economy to migrate abroad, resulting in deindustrialization of the domestic economy, with adverse repercussions on its export capacity.

To assess whether the income-elasticity of exports is affected by the real exchange rate and the technological gap,¹⁸ 30 developed and developing countries¹⁹ were analysed using a two-step regression methodology. Firstly the values of the selected countries’ income-elasticities of exports were estimated for the period 1995-2005; then the relationship between a country’s income-elasticity of exports and its real exchange rate level and technological gap was estimated.

The equation estimated in the first stage is as follows:

$$X_i = c_0 + c_1Q + c_2Y^* + \varepsilon_i \quad (7)$$

where X_i is the real dollar-value of exports by country i , Y^* is the real dollar-value of the rest of the world’s GDP, Q is an index of the real exchange rate, taken as an average from the period 1995-2005 (1995 = 100), c_0 is a constant, ε_i is the error term, c_1 represents the exchange-rate elasticity of exports, and c_2 represents the income-elasticity of exports, in other words, the response of each country’s exports to changes in the world GDP.²⁰ All series use quarterly data.

Estimation of the second-stage equation aimed to capture any effects exerted by the real exchange rate and technological gap on the income-elasticity of exports. To this end, an OLS regression was estimated of the values of the income-elasticities of exports estimated

¹⁸ The technological gap concept is due to Fagerberg (1988).

¹⁹ Argentina, Australia, Austria, Brazil, Canada, Chile, Czech Republic, Denmark, France, Germany, Hungary, Indonesia, Italy, Malaysia, Mexico, Netherlands, New Zealand, Norway, Portugal, Republic of Korea, Russian Federation, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom and United States.

²⁰ Of the 30 countries reviewed, 24 did not present any problem in the estimation of c_2 in level terms. In the cases of Chile, Denmark, New Zealand, Norway, Portugal and the United Kingdom, exports and world GDP do not cointegrate, so it is impossible to estimate the correct level of the income-elasticity of exports. In two other countries, Austria and Mexico, the real-exchange-rate index in level terms is stationary.

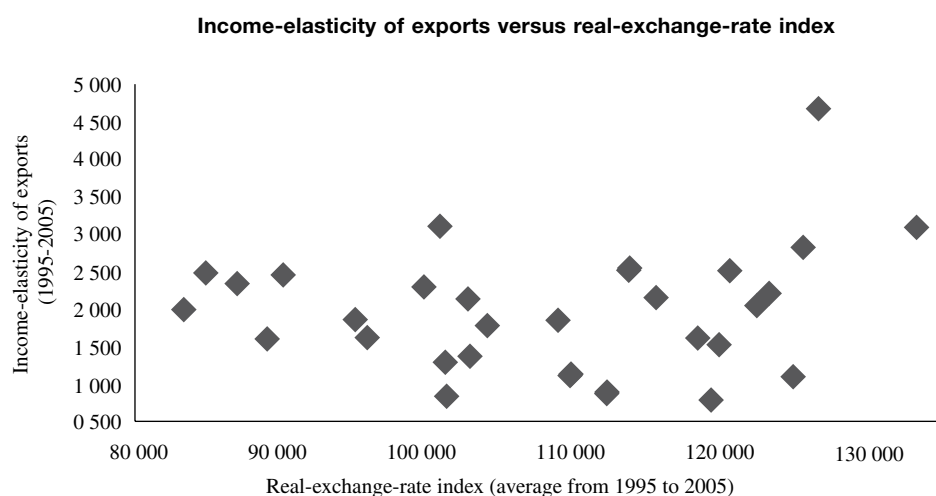
in the first stage against the real-exchange-rate and technological gap indices for the selected countries in the period 1995-2005. The model specification allows for an interaction between the real exchange rate and the technological gap in determining the income-elasticity of exports. Introducing this interaction makes it possible to analyze whether the effect of real-exchange-rate variations on the income-elasticity of exports is affected by the technological gap. Countries with a larger technological gap in relation to the United States could be expected to offset their technological disadvantage through currency depreciation. For countries closer to the technological frontier the opposite result is expected: a higher level of non-price competitiveness allows these countries to maintain an appreciated currency and thus higher real wages.

The real-exchange-rate index was calculated using quarterly data on the nominal exchange rate and consumer price indices obtained from *International Financial Statistics* (IFS), and normalized to 100 in 1995. Figure 1 below shows the dispersion of the income-elasticity of exports and the real-exchange-rate index.

Figure 1 reveals the existence of a nonlinear relationship between the income-elasticity of exports and the real exchange rate across the selected countries. For lower levels of the real exchange rate, there appears to be a negative relation between the two variables. At higher levels of the real exchange rate, however, the relation is positive.

The results of the econometric model are shown in table 9.

FIGURE 1



Source: Prepared by the authors on the basis of data from *International Finance Statistics* (IFS).

TABLE 9

**Selected countries: Results of the econometric model
for the income-elasticity of exports (1995-2005)**

Variable	Coefficient	Standard error	t-statistic	Probability
RER	0.027719	0.013431	2.063739	0.0492
GAP	0.203742	0.112411	1.812469	0.0815
RERGAP	-0.001963	0.001019	-1.926045	0.0651
Constant	-0.919443	1.427213	-0.644222	0.5251
R ²	0.226110			
Durbin-Watson stat	2.116491			
Probability (F-statistic>0)	0.078975			

Source: Prepared by the authors.

Note: (i) White Heteroscedasticity-Consistent Standard Errors & Covariance; (ii) RER is the real-exchange-rate index; (iii) GAP is the ratio between the per-capita income of the country in question relative to the United States; and (iv) Durbin-Watson stat refers to the Durbin-Watson test for detecting autocorrelation between residuals. For a thorough interpretation of the tests, see Asteriou (2006) and Hamilton (1994).

The real-exchange-rate and technological-gap indices have the expected signs and are statistically significant at 5% and 10% respectively. This means that a depreciation of the real exchange rate will increase the income-elasticity of exports, thereby raising domestic export growth for a given growth rate of world income. This result is consistent with the notion that an economy's degree of productive specialization depends critically on the real exchange rate; so the real exchange rate and the long-run growth rate are linked.

It can also be seen that a reduction in the technological gap (represented by a rise in the technological-gap index) will increase the income-elasticity of exports, thus confirming the hypothesis that a higher technological level is associated with exports of higher technology content, thus increasing the country's income-elasticity of exports.

Lastly, there is a small, but statistically significant, negative interaction between the real exchange rate and the technological gap, which confirms the hypothesis that the effect of real-exchange-rate variations on the income-elasticity of exports depends on the size of the technological gap. The negative sign of this variable in the regression estimates is a reflection of the weight of developed countries in the sample. In these countries,

the technological gap is smaller, so their external competitiveness enables them to maintain appreciated currencies relative to those in developing economies.

The econometric tests show that countries which are further from the "technological frontier" cannot base their growth strategy on a low real exchange rate. In these countries, appreciation of the real exchange rate will eliminate their only means of competing with developed countries, namely an undervalued currency. Developed countries can compensate for a lower real exchange rate with technologically superior products.

There is also a clear positive relationship between the income-elasticity of exports and the level of the real exchange rate for all countries in the sample. This means that, regardless the size of the technological gap, a real-exchange-rate devaluation can raise the long-run growth rate of an economy by increasing its income-elasticity of exports, thereby boosting export growth for a given rate of growth of world income. The real exchange rate is thus a fundamental variable in any country's growth strategy.²¹

²¹ For a survey of the literature on the real exchange rate and growth, see Gala (2008).

V Conclusions

This article has used the demand-led growth model to address two fundamental issues: (i) why the growth rate of the Brazilian economy slowed in the last two decades of the period 1950-1980; (ii) what policies are needed to speed up sustainable growth in the Brazilian economy.

The answer to the first question is based directly on demand-led growth theory. The econometric tests reported in section III show that 85% of Brazil's real GDP growth in the period 1990-2005 is explained by aggregate-demand variables, thus supporting the hypothesis of demand-led growth in the Brazilian economy. Then the methodology developed by Ledesma and Thirlwall (2002) was used to show that the natural rate of growth in the Brazilian economy is endogenous and rises significantly in boom periods. Accordingly, there does not seem to be any supply-side constraint preventing more rapid economic growth.

From this perspective, the early-1980s growth slowdown in the Brazilian economy reflected an exhaustion

of the pattern of aggregate-demand growth that had prevailed since 1964, namely an expansion of spending on durable or luxury goods facilitated by the increasing concentration of income in the middle- and upper-income groups. The semi-stagnation of the Brazilian economy is thus explained by the current absence of a consistent pattern of aggregate-demand expansion.

The econometric tests also showed that the government current-consumption multiplier is approximately 0.40%, so a 1% increase in the government's current consumption will generate an increase of 0.37% in Brazil's real GDP. Assuming an average tax rate of about 40% of GDP, it follows that a 1% increase in the government's current consumption will raise tax revenues by just 0.15% of GDP. In the fiscal crisis currently prevailing in Brazil, which involves a combination of a high public debt/GDP ratio, high taxation and low levels of public investment in infrastructure works, it is impossible to stimulate growth

in the Brazilian economy by increasing the government's current consumption. The only alternative is to adopt an export-led growth model.

What conditions need to be satisfied for a robust and continuous expansion of exports in Brazil or other capitalist economies? The econometric tests reported in section III show that countries which are further from the "technological frontier" cannot base their growth strategy on a low real exchange rate. In these countries, appreciation of the real exchange rate will eliminate their only means of competing with developed countries, namely an undervalued currency. In contrast, developed countries can compensate for a lower real exchange rate with technologically superior products.

There is also a clear positive relationship between the income-elasticity of exports and the level of the real exchange rate for all countries in the sample. This

means that, regardless the size of the technological gap, a devaluation of the real exchange rate can raise an economy's long-run growth rate by increasing its income-elasticity of exports, thereby boosting export growth for a given rate of world-income growth. The real exchange rate is thus a fundamental variable in any country's growth strategy.

As a corollary of these results, developing countries, such as Brazil, may try to offset the international-competitiveness effects of their technological disadvantage by devaluing the real exchange rate against those of developed countries. This means that the adoption of an export-led growth model in Brazil — a necessary condition for Brazil to achieve high long-run growth rates of — requires an exchange-rate policy that can sustain an under-valued real exchange rate in the long term.

(Original: English)

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