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# TESTING BRAZILIANS' IMPORTS AND EXPORTS CO-INTEGRATION WITH MOTHLY DATA FOR 1996-2005

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# SUMÁRIO

## SINOPSE

O objetivo deste trabalho é testar o modelo de Husted e inspecionar a sustentabilidade de longo prazo das contas correntes brasileiras em um período muito específico de tempo (1996-2005) por meio do uso de dados mensais. Foi realizado teste da condição de restrição orçamentária inter-temporal (IBC) via teste de raiz unitária com quebra estrutural e co-integração pelo método de Gregory-Hansen em séries (117 pontos) nominais, normalizadas pelo PIB e normalizadas pelo índice de preços ao consumidor norte-americano (CPI). Os resultados indicam que a condição IBC pura não se sustenta para a economia brasileira, mas há co-integração entre as séries utilizadas, indicando que o equilíbrio de contas é sustentável.

## ABSTRACT

The goal of this paper is to test the Husted model and to inspect the long-run sustainability of Brazilian current account in a very specific period of time (1996-2005) by the use of monthly data. We have tested the inter-temporal budget constraints (IBC) condition via unit root test with structural break and co-integration through Gregory-Hansen test in a 117 long nominal, GDP normalized and CPI normalized series for the Brazilian economy. The results indicated that the pure IBC condition does not hold for the Brazilian economy. However, there is co-integration among the series used in this work and the balance of accounts is sustainable.

# 1 INTRODUCTION

The Brazilian economy seems to be a hard test for any economic reasoning. One possible explanation for this perception arises from its fiscal fragility; other could come up from frequently changes in its public policies. Moreover, the vulnerability to foreign crisis is also reported as a problem, as well as the current account balance, an important issue for any undeveloped country like Brazil.

The goal of this paper is to test the Husted model and to inspect the long-run sustainability of Brazilian current account in a very specific period of time (1996-2005) by the use of monthly data.

The balance between imports and exports is a common subject in international trade literature and there are several studies concerning developed and undeveloped countries. (Trehan & Walsh: 19911 and Otto: 1992,[2] Narayan & Narayan: 2005)[3] and references therein).

Husted (1992)[4] and Fountas & Wu (1999)[5] examined the problem, with different conclusions, using quarterly data, for the USA in the period 1967-1989 and 1967 and 1994, respectively.

The issue was also focused by several studies for OECD in developed countries (e.g. Wu (2000),[6] Wu *et al* (2001).[7] Liu and Tanner, E. (1996)[8] and Holmes (2003)).[9] In this sense, Arize (2002)[10] reported 35 indications of co-integration on 50 OECD countries and developing countries, with quarterly data, for the period 1973-1998.

Recently, Narayan & Narayan (2005)[11] have reported an extensive investigation regarding the long-run relationship between imports and exports for 22 countries least developed and found out evidence of co-integration for only six countries.

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1. Trehan, B. and Walsh, C. (1991), "Testing Intertemporal Budget Constraints: Theory and Applications to USA Federal Budget Déficit and Current Account Déficit", Journal of Money, Credit and Banking, May, 206-23
2. Otto, G. (1992), Testing a Present Value Model of the Current Account: Evidence from US and Candian Time Series", Journal of International Money and Finance, October, 414-30
3. Narayan, P. K., Narayan, S.. (2005) Are exports and imports cointegrated? Evidence from 22 least deloped countries, Applied Economic Letters, 2005, **12**, 375-378
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5. Fountas, S. and Wu, J. L. (1999) Are the US current account deficit really sustainable?, International Economic Journal, **13**, 51-8
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8. Liu, P., and Tanner, E. (1996), "International Intertemporal Solvency in Industrialised Countries: Evidence and Implications", Southern Economic Journal, 62, 3, 739-49.
9. Holmes, M.J., "How Sustainable are OECD current account in the long run?", Working Paper, Department of Economics, Loughborough University, Sept. 2003.
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11. Narayan, P. K., Narayan, S.. (2005) Are exports and imports cointegrated? Evidence from 22 least deloped countries, Applied Economic Letters, 2005, **12**, 375-378

Bahmani-Oskooee and Rhee (1997)[12] using quarterly data, found a co-integrated relationship between Koreans' exports and imports.

To the best of our knowledge there are no studies performed with monthly data for the Brazilian case.

For this purpose, this investigation first conducts an unit root test with structural break on Brazil current account balances and a co-integration test with structural break for Brazilians' exports and imports.

In the second section we introduce the theoretical framework. The data are presented in the third section and the econometric methodology is shown in the fourth section. In the fifth section, we present the results and, finally, the conclusions are in the last section.

## 2 BACKGROUND

Husted (1992)[4] established the simplest theoretical framework for the current account long-run sustainability. The author considered a small country with open economy and without government. In this model, the consumers are subject to budget constraints, maximize their utility function and obtain a long-run relationship between exports-imports.

$$C_t = Y_t - B_t - I_t - (1+r_t)B_{t-1} \quad (1)$$

where $C_t, Y_t, B_t, I_t$ *and* $r_t$ refer to current consumption, income, borrowing , investment and $r$ is the one-period world interest rate and $B_{t-1}$ is the initial debt size. The last equation is a necessary constraint for consumption, outcome, investment and debt size. In addition, the amount a country borrows in international markets equals:

$$B_t = \sum_{t=1}^{\infty} l_t (X - M)_t + \lim_{m \to \infty} l_m B_{tm}$$

Which is the present value of the trade balance where $l_{tt} = 1/(1+r_t)$.

Considering further assumptions such a stationary world interest rate and that exports and imports follow a non-stationary processes, the model is tested by:

$$X_t = a + b*(M_{tt} + r_t B_{t-1}) + e_t \quad where \ e_t \approx N(0, s)$$

If *b=1* in the last equation is said that inter-temporal budget constraints (IBC) condition is hold for the country and a co-integration relationship between exports ($X_t$) and imports of goods and services plus net transfers and net interest payments takes place ($MM_t = M_{tt} + r_t B_{t-1}$). Moreover, if there is co-integration but *b<1* we say that this economy is not sustainable and the budget constraints condition fails.

12. Bahmani-Oskooee, M. and Rhee, H-J. (1997) "Are Exports and Imports of Korea cointegrated?", International Economic Journal, 11, 109-14.

## 3 DATA

We took monthly data, in dollars, from January 1996 to September 2005 (117 data points) for the Brazilians' imports and exports. The Foreign Trade Secretary of the Ministry of Development, Industry, and Foreign Trade provided the data.

Furthermore, the debt payments series was built from the balance of payments supplied by the Brazilian central bank, considering the amortization and debt services registered.

The study was performed with three sets of data. The first one is composed by the nominal series (NEXP and NMM). In the second set, we test GDP normalized series (namely GDPEXP and GDPMM). For the last one, we deal with the exports and imports series deflationed by the Consumer Price Index (CPI): CPIEXP and CPIMM.

FIGURE 1
**Nominal exports and nominal imports normalized by 1996 mean**

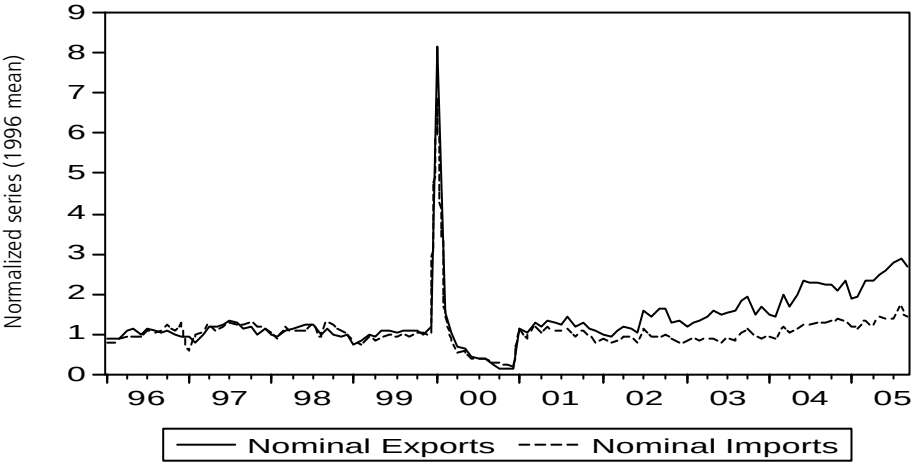



FIGURE 2
**Exports and imports normalized by GDP**

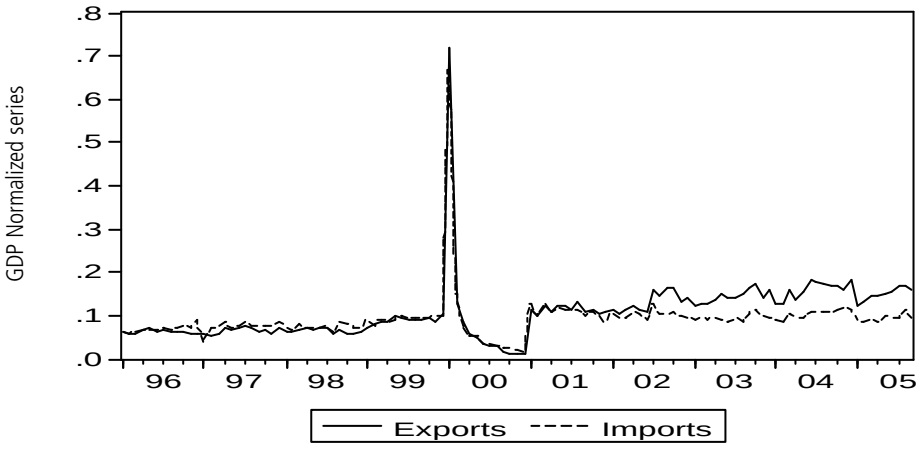
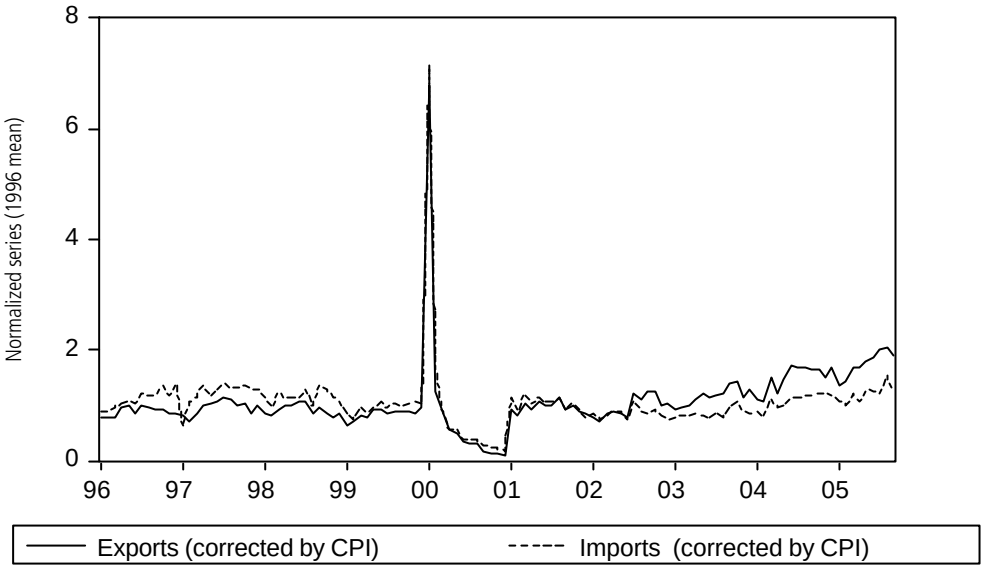


FIGURE 3
**Exports and imports deflationed by CPI and normalized by 1996 mean**




## 4 ECONOMETRIC METHODOLOGY

A process is assumed first order integrated, namely I(1), if its first difference is a stationary process. A Philips-Perron test (1988)[13] with trend and intercept may be performed in order to assure that the exports and imports series are I(1) as well as if the IBC condition is hold.

The major difficulty of Philips-Perron unit root test is concerning the existence of structural break points which can make our analyze vulnerable. In fact, Perron (1989)[14] reported that ignoring the break point might lead accepting an inexistent unit root. In reality, in view of the several changes of Brazilian public policies in the last years, it is quite unlikely there are not structural breaks in these series.

On the other hand, Perron (1989) assume that the break point is known what is quite restrictive. Zivot and Andrews (1992),[15] in contrast, assume an ADF approach with structural break and no previous knowledge about the break point position. In this sense, the break point is endogenously built and it is chosen in order to assure the least probability of a unit root on a t-statistics criteria.

Similarly,[16] Vogelsang and Perron (1998)[17] suggested a unit root with an endogenously break point determined. Summarily, they consider a break point data ( $T_B$ ) and the general model :

13. Phillips, PCB and Perron, P. (1988), Testing for a unit root in time series regression, Biometrika, 75(2), 335–346.
14. Perron, P. (1989). "The Great Crash, the Oil Price Shock and the Unit Root Hypothesis." Econometrica 57, 1361-1401.
15. Zivot, Eric and Donald W.K. Andrews (1992). "Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis." Journal of Business and Economic Statistics 10(3),251-272.
16. Nunes, L. C. (2004)"A Practitioner's Guide To Unit Root Testing With Trend Breaks", Faculdade de Nova Lisboa, Lecture.
17. Vogelsang, T.J. and P. Perron (1998). "Additional tests for a unit root allowing for abreak in the trend function at an unknown time," International Economic Review, 39(4), 1073-1100.

$$y_t = m + bt + \Theta DU_t + gDT_t + u_t$$

*where* :

$$DU_t = \begin{cases} 0 & if\ T \le T_B \\ 1 & if\ T \ge T_B + 1 \end{cases}$$

$$DT_t = \begin{cases} 0 & if\ T \le T_B \\ t - T_B & if\ T \ge T_B + 1 \end{cases}$$

Where the innovation is an ARMA process providing there's no unit root. So, depending on the coefficients it is possible to test for a break in the intercept ($\gamma$=0) (Model 1), for both a shift in the intercept and slope (Model 2) and for a smooth shift in the slope ($\Theta$=0) by requiring the two segments of the broken trend to be joined (Model 3). If there is no unit root in the innovation, $\Delta y_t$ is stationary and the following equation can be tested:

$$\Delta y_t = b + \Theta D_{tt} + gDT_t + v_t$$

*where* :

$$DU_t = \begin{cases} 0 & if\ T \le T_B \\ 1 & if\ T \ge T_B + 1 \end{cases}$$

$$D_{tt} = \begin{cases} 0 & if\ T \ne T_B + 1 \\ 1 & if\ not \end{cases}$$

Additionally, when the breakpoint date is unknown, Vogelsang and Perron (1998) propose choosing the break date that maximizes significance of a t-statistic of one or more of the break parameter, or, depending of the model, a *F*-statistic.

For the unit test the series is previously detrended and the residues are used in the following regression:

$$\bar{y}_t = a\ \bar{y}_{t-1} + \sum_{i=0}^{k} w_i D_{t-1} + \sum_{i=0}^{k} c_i \Delta\bar{y}_{t-1} + e_t \qquad (Models\ 1,2)$$

$$\bar{y}_t = a\ \bar{y}_{t-1} + \sum_{i=0}^{k} c_i \Delta\bar{y}_{t-1} + e_t \qquad (Models\ 3)$$

or alternatively a simpler version :

$$\Delta\bar{y}_t = (a-1)\,\bar{y}_{t-1} + \sum_{i=0}^{k} w_i D_{t-1} + \sum_{i=0}^{k} c_i \Delta\bar{y}_{t-1} + e_t \qquad (Models\ 1,2)$$

$$\Delta\bar{y}_t = (a-1)\ \bar{y}_{t-1} + \sum_{i=0}^{k} c_i \Delta\bar{y}_{t-1} + e_t \qquad (Models\ 3)$$

Where an information criteria (BIC, AIC, etc) is used for controlling the correlation by choosing the lag number.

Afterward, this same course of action can be used concerning the IBC condition as a simple co-integration test with the co-integration parameter equal to one.

Moreover, if the inter-temporal budget constraints condition fails, a general cointegration test may be performed searching for the value of the parameter b with the purpose of examining the balance account sustainability. On this ground, we may apply a Gregory and Hansen (1996) test for co-integration where the structural break is also tested.

Naturally, once the unknown break points are identified, traditional co-integration tests can be carried out on each interval and we may follow the Engle-Granger (1987)[18] and methodology developed in Johansen (1991, 1995a).[19]

As before mentioned, Gregory and Hansen (1996) tested a single unknown structural break in co-integration analysis where the break point is endogenously determined and it is allowed to have a level break, a full structural break, or a trend with a level break. Namely:

$$Model\ A: Level\ Shift: y_t = m_0 + m_1 j_t + a x_t + u_t$$

$$Model\ B: Level\ Shift\ with\ Trend: y_t = m_0 + b t + m_1 j_t + a_1 x_t + u_t$$

$$Model\ C: \text{Re}\,gime\ Shift: y_t = m_0 + b t + m_1 j_t + a_1 x_t + a_2 x_t j_t + u_t$$

$$where:$$

$$j_t = \begin{cases} 0 & if\ \ t > T_B \\ 1 & otherwise \end{cases}$$

The residues obtained from the above models are then employed in a ADF test. The break point is unknown and determined by finding the minimum value for the ADF statistic. The number of lags of the change in the residual used in computing the ADF statistic can either be input, or can be selected automatically using AIC, BIC or general-to-specific pruning by t-tests. In this paper, we adjusted by BIC.

# 5 RESULTS

## 5.1 INTEGRATION ORDER OF THE SERIES

In order to guarantee that the exports and imports Series are *I(1)* and considering the existence of an unknown break point the Vogelsang and Perron test (Model 2) is performed on 117 long monthly series (1996:01-2005:09).

All the export series are I(1) and display a time trend with no unit root, utilizing Perron (1989),[20] at least 1% of significance and a break point estimated to be February of 2000.[21] Similarly, all the imports series are I(1) and exhibit a time trend with no unit root with, at least 1% of significance and a break point estimated to be also in February of 2000, in fact two months after the change of exchange regime in January of 2000.

18. Engle, Robert F. and C.W.J Granger (1987, March). "Co-intergration and Error Correction: Representation, Estimation, and Testing." Econometrica 55(2), 251-276.

19. Johansen, Soren (1991, November). "Estimation and Hypothesis Testing of Cointergration Vectors in Gaussian Vector Autoregressive Models." Econometrica 59(6), 1551-1580.

20. Perron, P. (1989). "The great crash, the oil price shock, and the unit root hypothesis," Econometrica 57(6), 1361-1401.

21. Perron, P. (1989). "The great crash, the oil price shock, and the unit root hypothesis," Econometrica 57(6), 1361-1401.

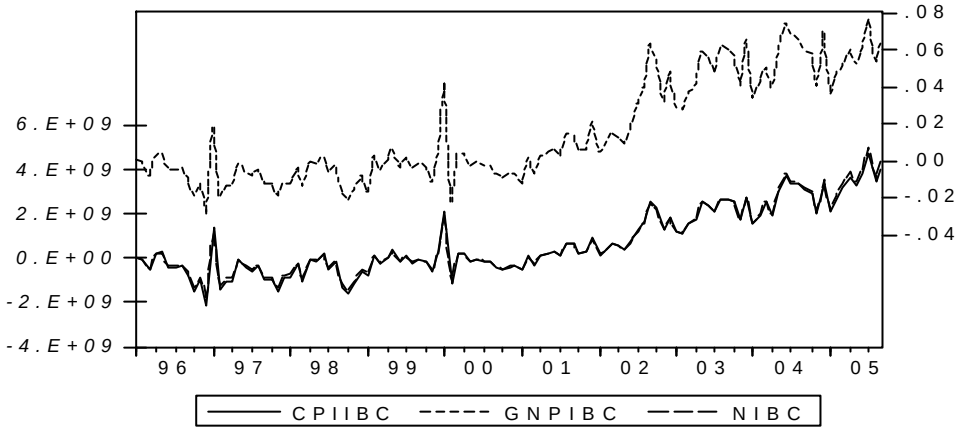
## 5.2 COINTEGRATION TEST

The Vogelsang and Perron unit root test was applied on the nominal series, GDP normalized series as well as on the CPI normalized series in order to examine if the IBC condition holds, namely $X_t - (M_{t_t} + r_t B_{t-1})_t \approx N(0, s)$. The point to be analyzed is if the IBC is a stationary series, *I(0)*.

All three IBC series presented linear broken trend and no unit root up to 1% of significance. Two series, namely GDPIBC and CPIIBC, presented broken time in June 2002, and the nominal series presented optimal broken time in August 2000. We have concluded all three series analyzed are trend stationary (I(1)).

FIGURE 4

**The CPIIBC and the NIBC are referenced in left axis; the GDPIBC is referenced in right axis**




In order to search if any other co-integration relationship holds, we performed the Gregory-Hansen co-integration test, specifically, the level shift model and regime shift.

TABLE 1

**The results are relatives to BIC adjustments of lags**

| | Series | Nominal | | GNP Normalized | | CPI Normalized | |
|---|---|---|---|---|---|---|---|
| | Models | Level shift | Regime Shift | Level shift | Regime Shift | Level shift | Regime Shift |
| ADF Test | t-statistic | -3,72 | -5,31 | -3,87 | -5,14 | -8,18 | -8,21 |
| | Break-Point | 0,692 | 0,692 | 0,649 | 0,658 | 0,658 | 0,658 |
| Philips Test | Zt | -5,80** (0,66) | -8,99* (0,66) | -8,49* (0,66) | -8,57* (0,66) | -6,29** (0,66) | -8,733* (0,66) |
| | Za | -50,33$^{NS}$ (0,66) | -90,35* (0,66) | -88,47* (0,66) | -89,39* (0,66) | -56,31$^{+}$ (0,66) | -91,38* (0,66) |

Note: The standard errors are inside parenthesis.

* The means 1% of significance.

** The means 2,5% of significance, the '+' means 10% of significance. The test statistics were extracted from Gregoryand Hansen (1996)[22]

22. Gregory A. and Hansen, B. (1996). "Tests for cointegration in models with regime and trend shifts". Oxford Bulletin of Economics and Statistics, 58, 3.

The table 1 shows that the nominal series presented break point in May 2002 and the GDP normalized series and CPI deflationed series in September of the same year, but do not reject, robustly, the null hypothesis of co-integration (see the table) at several levels of significance. So, despite of the IBC condition doesn't hold there is co-integration between exports and imports plus net debt service payments.

Remarkably, the regime shift presented more robust (or stable) levels of significance, showing a smoother structural change.

## 6 CONCLUSIONS

We have tested the inter-temporal budget constraints (IBC) condition via unit root test with structural break and co-integration through Gregory-Hansen test in a 117 long nominal, GDP normalized and CPI normalized series for the Brazilian economy.

The results indicated that the pure IBC condition does not hold for the Brazilian economy. However, there is co-integration among the series used in this work and the balance of accounts is sustainable.

We found two data break points. Concerning this, it is interesting to make some comments. The first break point in the series occurred in February 2000 due to changes in Brazilian exchange regime. The second happened in May 2002. A possible explanation for this phenomenon should be given by the uncertainty atmosphere lived by the economical agents at this moment because of Brazilian's Presidency elections.

In May 2002, the stronger candidate and future winner, Luis Ignacio Lula da Silva, who represented at this point – for electors and financial sector – possible changes in macroeconomic policies, released an "open letter", where he explained his government wouldn't change the current policies followed by the Brazilian government since 1994. This event coincides with the second break point found in this paper.

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