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FURTHER INVESTIGATION INTO THE SUSTAINABILITY OF THE BRAZILIAN FEDERAL DOMESTIC DEBT

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FURTHER INVESTIGATION INTO THE SUSTAINABILITY OF THE BRAZILIAN FEDERAL DOMESTIC DEBT

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SUMÁRIO

Abstract

This paper investigates the sustainability of the Brazilian federal domestic debt using quarterly data from 1981 to 1998. A debt is considered sustainable if the government's budget is intertemporally balanced. Sustainability is tested through the mean-zero stationarity of the discounted debt/GDP ratio with standard unit root tests and the null hypothesis of stationarity. The results indicate that the federal domestic debt have assumed an unsustainable path during the period studied and that the government may indeed have an incentive to reestructure its debt.
Keywords: Federal debt; fiscal consolidation; Brazil.

Resumo

Este artigo investiga a sustentabilidade da dívida mobiliária federal brasileira usando dados trimestrais de 1981 a 1998. Uma dívida é considerada sustentável se a restrição orçamentária governmental é respeitada intertemporalmente. A sustentabilidade da dívida mobiliária federal é testada através da estacionaridade da razão dívida/PIB ao redor da média zero utilizando testes de raíz unitária tradicionais e testando a hipótese nula de estacionaridade. Confirmando diagnósticos previamente obtidos, os resultados indicam que a dívida mobiliária federal assumiu um padrão insustentável durante o período estudado e que o governo tem, de fato, um incentivo para reestruturar sua dívida.
Palavras-chave: Dívida mobiliária federal; consolidação fiscal; Brasil.

1. INTRODUCTION

The Brazilian experience of the 1980s and early 1990s has been characterized by persistent government budget deficits, stop-and-go economic growth and high inflation rates. Since 1994, price stabilization has been achieved and the government has made important efforts to balance its budget. The public debt, particularly the federal government's has increased, however, to unprecedented levels reaching 35.5 per cent of the Brazilian GDP in November of 1998. According to the Central Bank, this performance resulted mainly from the combination of high domestic real interest rates and the sterilization of the inflow of foreign reserves. The price stabilization plan implemented in 1994 was anchored on a fixed exchange rate regime. A tight control of the monetary policy was then necessary to keep a positive real rate of interest domestically in order to stimulate foreign capital inflows. The need to prevent an expansion of the monetary base along with increasing interest payment outlays resulted in the increments of the debt/GDP ratio observed after 1995. Although the size of the Brazilian federal domestic debt relative to GDP is not particularly large when compared to other countries, the pattern of its growth has raised the question of whether the Brazilian government is running a Ponzi scheme against the public and whether the federal domestic debt is on a sustainable path.

A debt is considered sustainable when the government satisfies an intertemporal budget constraint and its debt can, therefore, be offset by expected primary surpluses of equal present-value [Hamilton and Flavin, 1986]. A government does not have to keep its budget balanced all the time in order to have a sustainable debt, but it cannot run permanent interest-exclusive budget deficits [McCallum, 1984]. The reason is that optimizing individuals will not keep buying financial claims from a government that does not intend to pay its debt. Moreover, an unsustainable domestic debt may threaten price stability in an institutional setting where the monetary authority does not act independently and set the monetary targets in accordance to a pre-stablished fiscal budget.

Elsewhere, the sustainability of the Brazilian federal domestic debt was tested using annual observations from 1966 to 1996 [Luporini, 1998]. The results indicated that, although the federal domestic debt was sustainable until the end of the 1970s, it has assumed an unsustainble path after 1981. From an econometric point of view, the debt is sustainable if the series, appropriately discounted, is mean-stationary (presence of a unit root). Some economic series might take long, however, to revert to their mean and the result of an unsustainable federal debt after 1981 might have resulted from the small data set used in the tests.

The purpose of this paper is to further investigate the non-sustainable path assumed by the federal domestic debt after 1981, using quarterly observations and two more years of available data. Besides allowing for a better understanding of the dynamics of the domestic debt, this new data set has enough degrees of freedom to test the sustainability under the null of stationarity [Kwiatkowski, Phillips, Schmidt and Shin, 1992]. Hypothesis tests are designed to reject the null unless there is strong evidence against it. Standard unit root tests have the presence of a unit root as the null hypothesis and fail to reject the null in several economic series.

2. THE GOVERNMENT'S BUDGET CONSTRAINT

Consider the following budget constraint for the government expressed in per capita nominal terms at time t:

$$B_t - B_{t-1} + M_t - M_{t-1} = G_t - T_t + i_{t-1}B_{t-1} \qquad (1)$$

where

$B_t - B_{t-1} + M_t - M_{t-1} = G_t - T_t + i_{t-1}B_{t-1}$ is the dollar amount of the net interest-bearing government debt held by the public at period t;

$B_t - B_{t-1} + M_t - M_{t-1} = G_t - T_t + i_{t-1}B_{t-1}$ is the change in the money stock;

i is the *ex post* nominal interest rate, interpreted as the holding-period return on the stock of debt outstanding[1];

P_t is the price level at time t;

G and T are government expenditures and tax revenue respectively.

The real government deficit can be defined as the change, in real terms, of the government debt over time. The government budget constraint must be adjusted for inflation so that changes in its components do not reflect price variations. Moreover, it is important to adjust the budget constraint for real changes in the income level or economic growth.

The government's budget constraint in real terms and as a ratio to income can be written as:

$$b_t - b_{t-1} + m_t - m_{t-1} = -s_t + (r_{t-1} - g_{t-1})b_{t-1} - (\pi_{t-1} + g_{t-1})m_{t-1} \qquad (2)$$

where

s is the non-interest primary surplus (*-s* denotes the government primary deficit, that is, the diference between expenditures exclusive of interest payments on the government's debt and tax revenues);

$r \equiv i - \pi$ stands for the real rate of interest and *g* denotes the rate of income growth.

Rewrite (2) to obtain:

$$b_t - b_{t-1} = -\bar{s}_t + (r_{t-1} - g_{t-1})b_{t-1} \qquad (2')$$

[1] Note that it is not necessary to assume that the government issues only one-period bonds.

where $-\bar{s}_t = -s_t - (m_t - m_{t-1}) - (\pi_{t-1} - g_{t-1})m_{t-1}$ is the negative surplus inclusive of seignorage collection[2].

Let $\alpha_t \equiv (r_t - g_t)$ and rewrite equation (2') to obtain:

$$b_t = -\bar{s}_t + (1 + \alpha_{t-1})b_{t-1} \qquad (3)$$

Define $Q_t = \prod_{j=0}^{N-1} (1 + \alpha_j)^{-1}$; $Q_0 = 1$. Multiplying equation (3) throughout by Q_t gives:

$$Q_t b_t = Q_{t-1} b_{t-1} - Q_t \bar{s}_t \qquad (4)$$

Rewrite (4) and obtain a version of equation (3) discounted back to period zero:

$$B_t = B_{t-1} - \bar{S}_t \qquad (5)$$

Applying recursive forward substitution to (5), we obtain the government intertemporal budget constraint, which now involves the market value of the government's debt at its present-value of the initial date:

$$B_t = B_{t+N} + \sum_{j=1}^{N} \bar{S}_{t+j} \qquad (6)$$

The debt is sustainable if the government's budget is balanced in expected present-value terms. Thus, the relevant question is what creditors expect to happen to B_{t+N} as N gets large.

Taking expectations as of time t of equation (6) and applying the limit as N goes to infinite yields equation (7):

$$B_t = \lim_{t \to \infty} E_t B_{t+N} + E_t \sum_{j=1}^{N} \bar{S}_{t+j} \qquad (7)$$

---

[2] Inflation tax is the total capital loss that inflation inflicts on holders of real money balances ($\pi_t . \frac{M_t}{P_t}$). Seignorage equals inflation tax proceeds plus the change in the economy's real money holdings, that is $\left(\pi_t . \frac{M_t}{P_t}\right) + \left(\frac{M_t}{P_t} - \frac{M_{t-1}}{P_{t-1}}\right)$. Seignorage represents the real revenue the government acquires by using newly issued money to buy goods and nonmoney assets.

The government's budget is balanced in expected present-value terms when its debt can be offset by the sum of expected future discounted primary surpluses. According to equation (7), this is the case when $\lim_{N\to\infty} B_{t+n} = 0$. If $\lim_{N\to\infty} B_{t+n} < 0$, the expected discounted future primary surpluses exceeds the present value of the government's debt by an amount that does not converge to zero. The government is accumulating tax revenues which could be translated into higher disposable income for households and, therefore, increased consumption level at all periods.

In the opposite case, $\lim_{N\to\infty} B_{t+n} > 0$, the present-value of the government's debt exceeds expected primary surpluses. This implies that the government is continually borrowing to meet interest payments on its debt which will grow, *ceteris paribus*, at the rate of interest and that economic agents are providing the government with "free" resources. When $\lim_{N\to\infty} B_{t+n} = 0$ the government is asymptotically using the resources allowed by its budget constraint, no more and no less. It is assumed that the amount of seignorage collected by the government is consistent with a non-accelerating rate of inflation.

3. SUSTAINABILITY OF THE FEDERAL DOMESTIC DEBT

The data set consists of quarterly observations from 1981:IV to 1998:III. The government debt at par value is the series "Dívida Mobiliária Interna Federal fora do Banco Central" or federal domestic debt held by the public published monthly by the Brazilian Central Bank. Quarterly values are the published stock of debt at the end of each quarter (values of March, June, September and December).

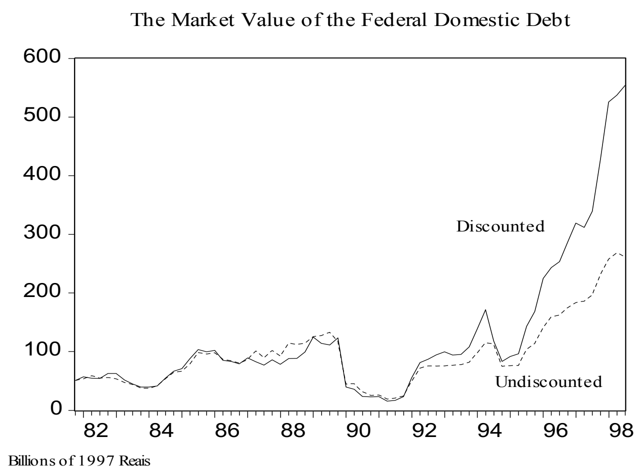
In order to calculate the debt/GDP ratio, quarterly values for the GDP are needed. The current values for the Gross Domestic Product measured quarterly are not published by the IBGE (Instituto Brasileiro de Geografia e Estatística), however. In its *Anuário Estatístico do Brasil*, the IBGE publishes a quarterly GDP index "Produto Interno Bruto Real Trimestral", which was used to obtain quarterly values of the GDP. The index was scaled so that 1997:I = 1 and multiplied by the GDP value for the first quarter of 1997 (R$ 206605 millions of 1997, IPEA "Indicadores Conjunturais"), giving a series with quarterly values of the GDP at constant prices of 1997.

Nominal debt was converted into Millions of Reais and divided by the General Price Index (IGP), internal supply (1997:I = 1). Following the metodology used by IPEA, to avoid distortions due to collection lags, the debt/GDP ratio for, say, 1997:I, was calculated as

$$\frac{DEBT_{1997I}}{GDP_{1997I} + GDP_{1996IV} + GDP_{1996III} + GDP_{1996II}}.$$

The real rate of interest was calculated as $r = \frac{(1+i)}{(1+\pi)} - 1$, where r is the *overnight* real rate of interest for the quarter (monthly values compounded over the quarter) and π is the inflation rate also accumulated over the quarter, that is, $\pi_{1996:I} = \dfrac{IGP_{Mar\,96} - IGP_{Dec\,95}}{IGP_{Dec\,95}}$. This definition of the real rate of interest is equivalent to the standard definition $r = i - \pi$ when the inflation rate is low. The market value of the debt/GDP ratio is the ratio divided by *(1+r)*.

Figure 1 shows the undiscounted and discounted values of the federal domestic debt in Billions of 1997 Reais, for the period 1981:IV to 1998:III. The market value is the par value of the debt multiplied by *1/(1+r)*, where *r* is the real rate of interest; the discounted value of the debt is its market value multiplied by the discounting factor *Qt* . The value of *Qt* is normalized to unity in the beginning of the sample. Although the debt/GDP ratio has increased, the graph shows that the market value of the government's debt in the last quarter of 1994 was roughly the same as it was in 1981 (*Qt= 1.026)*.



Both the discounted and the undiscounted debt increased steadily during the first half of the sample and declined in the beginning of the 1990s when the government intervened in the securities'market. Starting in 1992, however, the two series resume its previous level indicating that the intervention did not represent a default in the government's debt. Both values of the debt assume a strong upward trend. At the end of the sample, the undiscounted value of the debt has more than doubled in relation to its original value in 1981; a policy of consistently positive real rate of interest implemented by the government since the second quarter of 1994 results in the more rapid increase of the discounted value of the debt. The observed behaviour of the two series seems to indicate non-compliance to an interterporally balanced budget constraint. Formal sustainability tests are presented in the next section.

3.1. Unit Root Tests

The first step in testing the series for the presence of a unit root is to select the appropriate lag lengh of the autoregressive model proposed.

Although the data set consists of quarterly observations, the correlogram of the mean-discounted debt (not reported) does not seem to indicate any seasonal components in the series. It is important, nonetheless, to entertain the possibility of a lag lengh no shorter than 4 quarters in the unit root tests and check for their significance levels. The equation $\Delta b_t = \gamma b_{t-1} + \sum_{i=2}^{12} \beta_i \Delta b_{t-i+1} + \varepsilon_t$ is estimated and the significance of the lag coefficients evalutated, starting with lag 12 or 3 years of data.

The t statistics for the 12th and the 8th lags, important candidates for seasonal components, indicate that these lags are not significantly different from zero (0.178 and 0.116, respectively). The 4th lag seems to be the first important lag with a t statistic of -1.245. The residuals of the regression was plotted and its autocorelation function examined (not reported). There seems to be no indication of serial correlation and a 4-lag seems the appropriate equation to use in the unit root tests.

Since the actual data process generating the mean-adjusted discounted debt is not known, the second step is to determine the regression equation. We start with the least restrictive model, which includes a trend and a drift terms. The results are reported in Table 1. The critical values for the Augmented Dickey-Fuller and Phillips-Perron tests reported are based on MacKinnon (1991)'s estimation of response surface regressions which allow for the calculation of critical values for any sample size.

The results indicate that the null hypothesis of a unit root can not be rejected at the 5 percent confidence interval for the mean-adjusted discounted debt (ADF of -1.26). The Augmented Dickey-Fuller test is sensitive to the regression equation used to test for the presence of a unit root. The test may fail to reject the null because of a misspecification of the deterministic part of the regression. Since the null was not rejected, it is necessary to test for the significance of the trend term under the null of a unit root. The t statistics for the trend coefficient of the mean-adjusted discounted debt is 1.65, which compared to the Dickey-Fuller critical value of 2.79 indicate that the trend term is not significantly different from zero at a 5 percent confidence interval and that the unit root test should be carried without a trend.

The mean of the adjusted debt series is zero by construction and we should not expect, therefore, that a constant term be included in the regression model for the unit root test. The model is reestimated with an intercept term and, in fact, this term is statistically insignificant (t value of 0.792). The ADF statistics (-0.598) once again does not reject the null hypothesis of a unit root.

Given the results presented above, the stationarity of the mean-adjusted discounted debt should be tested regressing a model with no trend or intercept. This model, not surprisingly, is also selected by the Schwarz criterion.

The Augmented Dickey-Fuller test fails to reject the null a unit root in the mean-adjusted discounted debt series. The calculated ADF statistics (–0.786) is far above the reported critical value of –1.946 at the 5 percent confidence interval. The Phillips-Perron unit root test corrects the statistics for serial correlation and possibly heteroskedastic error terms. The calculated statistics of –0.695 also indicates the presence of a unit root in the series. The results indicate, therefore, that the mean-adjusted discounted debt is non-stationary and that, therefore, the Brazilian federal domestic debt has indeed assumed an unsustainable path after 1981.

3.2. A Stationarity Test

Standard unit root tests as the ones developed by Dickey-Fuller and Phillips-Perron are designed to reject the null hypothesis unless there is strong evidence against it. The null hypothesis is, in general, that there exists a unit root in the series being tested. As a result, standard tests fail to reject the null of a unit root (non-stationarity) in several economic series. Kwiaatkowski, Phillips, Schmidt and Shin (1992), herein KPSS, developed a procedure that allows us to directly testing the null hypothesis of stationarity (absence of a unit root).

Elsewhere, this procedure was used to test for the sustainability of the Brazilian federal domestic debt from 1966 through 1996 and the null of stationarity could not be rejected. The sample was then divided in two sub-samples. Standard unit root tests have indicated that the federal domestic debt assumed an unsustainable path after 1981. Having used annual data, the KPSS procedure could not be applied to the two samples due to too few degrees of freedom to implement the test. Therefore, it was not possible to rule out the possibility that the non-stationarity of the debt series after 1981 was not, in fact, a result of the null being specified as the presence of a unit root. The data set used here allows enough degree of freedom to further investigate the non-sustainability of the federal domestic debt after 1981 using the KPSS procedure.

The KPSS Procedure

The test for level stationarity is based on the statistic $\hat{\eta}_\mu = T^{-2}\dfrac{\sum_{t=1}^{T} S_t^2}{s^2(l)}$, where $S_t = \sum_{i=1}^{t} e_i$, $t=1,2,\ldots T$ is the partial process of the residuals from the regression $y_t = \bar{y} + e_t$; $s^2(l) = T^{-1}\sum_{t=1}^{T} e_t^2 + 2T^{-1}\sum_{s=1}^{l} w(s,l)\sum_{t=s+1}^{T} e_t e_{t-s}$ is a consistent estimator of the error variance; $w(s,l)= 1 - s/(l+1)$ is a weighting function which guarantees the nonnegativity of $s^2(l)$; and l is the lag truncation parameter. A zero truncation lag ($l=0$) implies no correction for autocorrelation.

The results are presented in Table 3. The larger the truncation lag l, the larger must be the sample size in order for assymptotic results be relevant and, unfortunately, the values of the test statistic decreases as the lag truncation increases. An adequate truncation lag can be obtained by using the integer of the value $\left(T/100\right)^{0.25}$, where T is the number of observations. A sample of 68 observations gives a truncation lag of 1. The critical values at 5 and 10 percent levels are 0.463 and 0.347, respectively. In this case, the null hypothesis of stationarity is rejected at the 5 percent level. For the truncation lag of 1, the KPSS test clearly indicates that the federal domestic debt has assumed an unsustainable path after 1981, a result consistent with those previously obtained.

CONCLUDING REMARKS

This paper analyzed the sustainability of the federal domestic debt in Brazil and was motivated by a result previously obtained [Luporini, 1998] that the Brazilian debt had assumed an unsustainable path after 1981. The diagnostic of the cited study might have resulted from the small sample size used for the econometric tests. The new data set obtained allowed for further investigation of the sustainability of the federal domestic debt after 1981.

The debt is considered sustainable when the government is following an intertemporally balanced budget constraint. Econometrically, the condition for sustainability is the stationarity of the appropriatelly discounted debt series. The path of the federal domestic debt was analyzed both by standard unit root tests and by the procedure developed by Kwiatkowski, *et al.*(1992). The Augmented Dickey-Fuller and Phillips-Perron procedures test the null hypothesis of a unit root while Kwiatkowski test the null of stationarity. The results by both sets of tests indicated that the federal domestic debt has assumed an unsustainable path after 1981, confirming the previously obtained diagnostic. The federal government seems to be indeed heading to excessive debt accumulation which threatens the government's ability to continue financing itself.

A possibility for yet further inquiry on the nature of the federal domestic debt accumulation is to test whether the government's intervention in the *overnight* market in 1990 has constituted a structural break in the debt series, which could acount for the results obtained here.

REFERENCES

Ahmed S. & Rogers J. Government budget deficits and trade deficits: are present value constraints satisfied in long-term data? *Journal of Monetary Economics* 36:351-374, 1995.

Banco Central do Brasil, Departamento Econômico, *Boletim do Banco Central do Brasil.*

Banco Central do Brasil, Departamento Econômico, *Relatório Anual.*

Blanchard, O. & Fischer S. *Lectures on Macroeconomics.* Cambridge: The MIT Press, 1989.

Bohn, H. The sustainability of budget deficits with lump-sum and with income-based taxation. *Journal of Money, Credit, and Banking* 23(3):581-604, 1991.

-----. The sustainability of budget deficits in a stochastic economy. *Journal of Money, Credit, and Banking* 27(1)(February):257-71, 1995.

Carvalho, C. Liquidez e choques inflacionários. In: Belluzzo, L. & Batista Jr., P. (eds.) *A luta pela moeda nacional: ensaios em homenagem a Dilson Funaro*. São Paulo, Paz e Terra Editora, 1992.

Dickey, D. & Fuller, W. Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association* 74:427-31, 1979.

-----. Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica* 49:1057-72, 1981.

Hakkio, C. & Rush, M. Is the budget deficit 'too large'? *Economic Inquiry* 39 (July):429-445, 1991.

Hamilton, J. & Flavin, M. On the limitations of government borrowing: a framework for empirical testing. *The American Economic Review* 76(4):809-19, 1986.

Instituto Brasileiro de Geografia e Estatística. *Anuário Estatístico do Brasil.*

Isller, J. V. & Lima, L.R. Public debt sustainability and endogenous seignorage in Brazil: time-series evidence from 1947-92. Ensaios Econômicos da EPGE, 306, 1997.

Kremmers, J. U.S. federal indebtedness and the conduct of fiscal policy. *Journal of Monetary Economics* 23:219-38, 1989.

Kwiatkowski, D.; Phillips, P.; Schmidt, P., & Shin, Y. Testing the null
hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics* 54:159-78, 1992.

Luporini, V. Central bank independence and the federal domestic debt: a study of the Brazilian case, 1966-1996. *Ph.D. Thesis.* The City University of New York, 1998.

Maddala, G. and I. Kim. *Unit roots, cointegration, and structural change.* Cambridget, Cambridge University Press, 1998.

McCallum, B. Are bond-financed deficits inflationary? A Ricardian analysis. *Journal of Political Economy* 92(1):123-35, 1984.

Pastore, A. Déficit público, a sustentabilidade das dívidas interna e externa, seignoriagem e inflação: uma análise do regime monetário brasileiro. *Revista de Econometria*, 14(2), 1995.

Phillips, P. e Pierron, P. Testing for a unit root in time series regression. *Biometrika* 75:335-46, 1988.

Tanner E. & Liu, P.. Is the budget deficit 'too large'? Some further evidence. *Economic Inquiry* 32 (July):511-518, 1994.

Trehan, B. & Walsh, C. Testing intertemporal budget constraints: theory and applications to U.S. federal budget and current account deficits. *Journal of Money, Credit, and Banking* 23(2):206-23, 1991.

Uctum, M. & Wickens, M. Debt and deficit ceilings, and sustainability of fiscal policies: an intertemporal analysis. *Mimeographed*. New York, Brooklyn College and the Federal Reserve of New York, 1996.

Wilcox, D. The sustainability of government deficits: implications of the present-value borrowing constraint. *Journal of Money, Credit, and Banking* 21(3):291-306, 1989.

TABLES

TABLE 1

Discounting Factor and Quarterly Data for GDP

obs	Qt	GDP (Millions of 1997 Reais)
1981:4	1.000000	139841.5
1982:1	0.983000	139964.4
1982:2	0.862000	155545.0
1982:3	0.919000	153224.8
1982:4	1.042000	144512.6
1983:1	1.082000	135600.6
1983:2	1.008000	149322.0
1983:3	0.945000	147923.7
1983:4	0.971000	143083.6
1984:1	0.993000	141516.3
1984:2	0.913000	156559.1
1984:3	0.938000	155913.8
1984:4	0.948000	153701.2
1985:1	0.989000	150996.8
1985:2	1.032000	165133.1
1985:3	0.976000	170080.8
1985:4	0.963000	168697.9
1986:1	0.962000	162060.0
1986:2	0.904000	177686.7
1986:3	0.913000	183848.3
1986:4	0.914000	180775.2
1987:1	0.955000	174582.9
1987:2	0.756000	189825.5
1987:3	0.798000	184877.8
1987:4	0.783000	180713.7
1988:1	0.788000	174690.4
1988:2	0.713000	189087.9
1988:3	0.732000	189180.1
1988:4	0.803000	176703.3
1989:1	0.921000	169804.2
1989:2	0.828000	195602.9
1989:3	0.777000	199137.0
1989:4	0.969000	188657.7
1990:1	0.828000	174506.0

1990:2	0.735000	177640.6
1990:3	0.696000	191607.9
1990:4	0.836000	177333.3
1991:1	0.829000	161940.7
1991:2	0.755000	183136.5
1991:3	0.749000	190089.7
1991:4	0.888000	179828.0
1992:1	1.034000	168929.3
1992:2	1.044000	179969.5
1992:3	1.066000	183490.3
1992:4	1.161000	178748.7
1993:1	1.218000	174661.7
1993:2	1.136000	189417.4
1993:3	1.132000	193132.8
1993:4	1.222000	188904.3
1994:1	1.309000	182924.2
1994:2	1.376000	195273.6
1994:3	0.970000	204845.4
1994:4	1.026000	206720.8
1995:1	1.118000	201996.8
1995:2	1.167000	207782.3
1995:3	1.276000	206968.5
1995:4	1.370000	206349.2
1996:1	1.478000	199148.3
1996:2	1.415000	212453.2
1996:3	1.443000	218061.8
1996:4	1.516000	216150.9
1997:1	1.611000	206650.0
1997:2	1.552000	220998.7
1997:3	1.598000	223688.0
1997:4	1.715000	220503.3
1998:1	1.888000	211360.4
1998:2	1.851000	225216.0
1998:3	1.963000	225992.1

TABLE 2

Unit Root Tests

$$\Delta B_t = \alpha_1 + \gamma B_{t-1} + \alpha_2 t + \sum_{i=2}^{4} \delta_i B_{t-i+1} + \varepsilon_t$$

	(1)	(2)	(3)
B_{t-1}	-0.093	-0.040	-0.051
	(0.074)	(0.067)	(0.065)
ΔB_{t-1}	0.062	0.058	0.078
	(0.137)	(0.139)	(0.136)
ΔB_{t-2}	0.208	0.204	0.225
	(0.139)	(0.141)	(0.138)
ΔB_{t-3}	0.116	0.099	0.119
	(0.141)	(0.143)	(0.140)
ΔB_{t-4}	-0.165	-0.187	-0.172
	(0.141)	(0.142)	(0.141)
α	-0.927	0.262	
	(0.792)	(0.033)	
T	0.033		
	(0.020)		
ADF Stat	-1.263	-0.597	-0.786
ADF (5%)	-3.481	-2.908	-1.946
PP Stat			-0.695
PP (5%)			-1.945

Standard Errors in parenthesis.

TABLE 3

Stationarity Test

$$\hat{\eta}_\mu = T^{-2} \frac{\sum_{t=1}^{T} S_t^2}{s^2(l)}$$

l = 0	2.081
l = 1	1.111
l = 2	0.465
l = 3	0.336
l = 4	0.364
l = 8	0.144
η_μ critical values	0.463 (5%)
	0.347 (10%)

Upper tail critical values, level stationarity, KPSS (1992), p.156.