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**Analyzing the Fiscal Process Under a
Stochastic Environment: Evidence
From Egypt**

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Analyzing the Fiscal Process Under a Stochastic Environment: Evidence From Egypt

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Abstract

This paper investigates the fiscal sustainability for Egypt, for both stochastic and non-stochastic environments. Both cointegration and multicointegration methodologies were used to evaluate fiscal budgeting processes. It was found that the fiscal budgeting process in Egypt is weakly sustainable.

Keywords: fiscal sustainability and multicointegration

JEL Codes: H60, E62, C32

Analyzing the Fiscal Process Under a Stochastic Environment: Evidence From Egypt

I. Introduction

The intertemporal budget of a government is sustainable if the present discounted value of all current and expected future tax revenues is equal to the present discounted value of all current and expected future spending, plus current outstanding debt, including interest payments on the debt. Such a condition is known as the “no Ponzi” condition. This means that the government must plan to raise sufficient revenue, in present-value terms, to repay its existing debt and finance its planned expenditures. The alternative “Ponzi” scheme is when the government employs a strategy of rolling over an initial debt with interest forever. In that situation, the budget would not be sustainable and the government could be expected to impose high tax rates and to resort to the monetization of debt. This will lead to future inflation and perhaps hyperinflation. In other words, a long sequence of primary deficits has implications for future seigniorage, which will be used to generate the necessary future surpluses. In developing as well as in emerging countries, where debt markets are not fully developed, there is a high possibility of monetization of debt. In general, solvency requires that the government asymptotically cannot have a debt with a positive expected value.

Most existing studies [e.g, Trehan and Walsh (1991), Martin (2000), Cunado *et al.* (2004), Hamilton and Flavin (1986), Wilcox (1989), Hakkio and Rush (1991), Hansen *et al.* (1991), and Gali (1991)], have assumed the discount rate remains positive and constant. The results of these studies vary depending on the sample period and the

methodology used. The cointegration methodology is also used to investigate fiscal sustainability, e.g., Wu (1998), Green *et al.* (2001), Bravo and Silvestre (2002), Hatemi-J (2002), and Goyal *et al.* (2004). However, Luporini (2002) argues that the efficiency of the cointegration analysis is constrained by its assumptions regarding the real interest rate and the stochastic process that drives deficits. Consequently Luporini, as well as Telatar *et al.* (2004), use Bohn's (1998) approach in their sustainability studies, using data from Brazil and Turkey, respectively.

As mentioned by Bohn (1995, 1998) and Ball *et al.* (1998), persistent deficits and the accumulation of debt do not necessarily imply that the debt is unmanageable, and hence, that fiscal processes are unsustainable. It is possible for a government to change the historical pattern it has been following so that it will not continue to borrow and run a "Ponzi" scheme in the future. This implies that the standard approach (cointegration analysis) to testing whether a government adheres to its intertemporal budget constraint, does not provide sufficient criteria for determining whether the fiscal process is truly sustainable.

Leachman (1996), consequently, uses a more encompassing set of criteria under more realistic assumptions for determining whether a country exhibits a sustainable budgeting process. His criteria for sustainability are based on the multicointegration approach first presented by Granger and Lee (1989, 1990). Leachman *et al.* (2005) use the one-step multicointegration approach which was developed by Engsted *et al.* (1997). Multicointegration can ensure that a country's budgeting strategy is also sustainable in 'bad' states of nature, that is, when the rate of economic growth falls short of the real

interest rate on sovereign debt. To the best knowledge of the authors, no such study for Egypt, a MENA (Middle East and North African) country, exists.

The objective of this paper is to develop and test such criteria for Egypt. With more than 90% of its country being desert land, Egypt relies mostly on tourism. The methodology used in this study is purely for a stochastic environment, which is more relevant for Egypt than for developed countries. Finally, contrary to the existing literature, this study incorporates policy regime changes that influence the short-run dynamics of the system. The rest of the paper is organized as follows: Section II formulates the models and explains the methodology. Section III focuses on the data, and on the empirical results and Section IV provides some concluding remarks.

It was found in this study that the fiscal budgeting process in Egypt is weakly sustainable, i.e., it is sustainable only in a non-stochastic environment. The short-run dynamic relationship of the fiscal process in Egypt suggests that spending tends to adjust to divergences from the equilibrium relationship. This result is consistent with Barro's original formulation — that temporary increases in spending will lead to periods of temporary low expenditures so as to generate the surpluses needed to retire the previously issued debt. This appears to be true in Egypt. We also found that adopting a flexible exchange rate was a responsible policy in Egypt.

II. The Model and the Methodology

Under a stochastic environment, uncertainty exists and the discount rate is subjective and time variant. In such a situation, the discount rate is not necessarily always positive. Specifically, the safe real rate of return could be less than the economy's real growth rate. In that case, even if the intertemporal budget balance holds, i.e., deficits and

outstanding debt are cointegrated, the deficit processes would not necessarily be sustainable. Furthermore, as Bohn (1995) shows, in a stochastic environment, if the growth rate of real income is a unit root process that can take on negative values, and there are no lump-sum taxes, running a balanced budget may be unsustainable. This is because there is a positive probability of large income declines that can make the debt-to-income ratio large enough to threaten sustainability, see Walsh (2000).

In a stochastic economy, if investors become sufficiently risk averse, the risk-free rate will fall below the expected growth rate of the economy. This is so because the more risk averse investors become, the higher will be the demand (price) for risk-free assets, which leads to a lower safe-interest rate. Thus, the risk-free rate may fall below the expected growth rate of the economy. In a deterministic steady state, this condition is also associated with dynamic inefficiency, but not necessarily in a stochastic economy, Ljungqvist and Sargent (2000). But in such a case, the transversality (“no-Ponzi”) condition cannot be satisfied and the fiscal process cannot be sustained. This means that, unless investors are risk neutral, the discount rate in a stochastic situation would be subjective and time variant.

Under a constant real safe-rate when the discount rate is subjective (a stochastic environment), utility is time separable, the marginal utility of consumption follows a random walk, and the covariance between the marginal substitution between current and future consumption and fiscal variables [i.e., real government expenditure on goods and services as well as transfer payments, (G), and real government revenues, (R)], is constant. Ahmed and Rogers (1995) prove the existence of a long-run cointegrating relationship between $G'_t (= G_t + r_{t-1}D_{t-1})$ and R_t with the cointegrating vector of (1, -1)

guarantees $\lim_{n \rightarrow \infty} E_t[(1 + r_{t+n})^{-1} D_{t+n} | I_t] = 0$, i.e., a sustainable fiscal process. The variables r

and D are the real interest rate and the outstanding debt at time t , respectively. I_t is current available information. They stressed that the existence of a cointegration relationship between expenditures and revenues is both a necessary and a sufficient condition for the present value “no-Ponzi” condition to hold, even under a stochastic environment.

However, this does not mean that the national debt must eventually be paid off.

Specifically, even if government spending, including interest payments, and revenues are cointegrated, the “Ponzi” scheme (i.e., the possibility of issuing new debt to pay interest on the outstanding debt) is still possible. Furthermore, as Bohn (1995) mentions, in a stochastic setting the government might issue a portfolio of securities that promises a total payoff conditional on the state of the economy at the time of maturity. The new level of government debt, therefore, would change according to the state of the economy. This means that besides the cointegration condition between government expenditures (including interest payments) and revenues, we need to impose an additional condition for the sustainability of fiscal processes. This extra condition would be that the government debt should also be cointegrated with its revenues/expenditures.

Specifically, a fiscal process is sustainable if expenditures and revenues do not drift apart over the long run, and in the meantime the outstanding debt and revenues/expenditures also do not drift apart over the long run, i.e., revenues and spending should be multicointegrated in the sense of Granger and Lee (1989, 1990). This multicointegration condition guarantees the sustainability of fiscal processes in a stochastic environment.

In general, for G'_t and R_t to be multicointegrated, we need first $G'_t - R_t = z_t \sim I(0)$, and then R_t (or G'_t) - $CD_t = Z_t \sim I(0)$, where C is a constant coefficient. Since G'_t , R_t and D_t are generated based on the same information, it is possible to show that the error correction models (ECMs) associated with each of these systems include both Z_t and z_t , see Granger and Lee (1990). Otherwise, the error correction equations will be misspecified. Thus, if G' and R are multicointegrated, they may be considered to be generated by an ECM of the form:

$$\Delta G'_t = \rho_1 z_{t-1} + \rho_2 Z_{t-1} + \text{lagged}(\Delta G'_t, \Delta R_t) + \text{white noise residual}, \quad (1)$$

$$\Delta R_t = \eta_1 z_{t-1} + \eta_2 Z_{t-1} + \text{lagged}(\Delta G'_t, \Delta R_t) + \text{white noise residual}, \quad (2)$$

which is estimated by OLS and the significance of ρ 's and η 's can be tested using standard t -tests.

As an alternative test for multicointegration, one can follow the one-step process of Engsted *et al.* (1997), Haldrup (1998), and Engsted and Haldrup (1999). Specifically,

assume G' and R have a unit root. Then $Y_t = \sum_{i=0}^t G'_{t-i} \sim I(2)$, and $X_t = \sum_{i=0}^t R_{t-i} \sim I(2)$.

Under this assumption, the one-step test for sustainability of fiscal processes in a stochastic environment requires that OLS be run on the following equation:

$$Y_t = C_0 + C_1 X_t + C_2 \Delta X_t \text{ (or } C'_2 \Delta Y_t) + C_3 \text{ trend} + C_4 \text{ trend}^2 + e_t \quad (3)$$

We need to test if in the integral regression (3) e_t follows an $I(0)$ process (the case of multicointegration), an $I(1)$ process (the case of first level cointegration, but no multicointegration) and finally the case of an $I(2)$ process where there is no cointegration amongst variables. Note that in the case of multicointegration, the least squares estimated coefficient, of our $I(1)$ variable (i.e., $G'_t = \Delta Y_t$ or $R_t = \Delta X_t$) is super consistent, and of

I(2) variable (i.e., $X_t = \sum_{i=0}^t R_{t-i}$) is super-super consistent, see Haldrup (1994),

Theorem 1 and Engsted *et al.* (1997).¹

The interpretation of Equation (3) is as follows: if $C_1 > 1$ spending, on average, outpaces revenues. Sustainability requires $C_2 > 1$ (or $C'_2 < 1$) so that revenues rise (or expenditure falls) to accommodate the rising level of debt. If $C_1 < 1$, revenues, on average, outpace spending. Sustainability requires $C_2 < 1$ (or $C'_2 > 1$) so that revenues fall (or expenditure rises) to accommodate the rising level of savings. These conditions ensure neither government nor private agents are involved in a “Ponzi” scheme or gamble. For example, if $C_1 > 1$ and $C_2 < 1$, then the government may be engaged in a “Ponzi” gamble requiring tax increases (or spending cuts) in bad states of nature, see also Leachman *et al.* (2005). If $C_1 = 1$ the budget, on average, is balanced. Then the magnitude of C_2 (or C'_2) is no longer important for sustainability.

III. Data and Sustainability Test Results

The model is tested on annual data for Egypt from 1947 through 2004, since fiscal variables for Egypt are available only on an annual basis. The sample period was chosen because of the availability of the data, which is taken from different sources. The fiscal data from 1947 through 1974 was taken from Scobie (1983). The source of the fiscal data for the period 1975 through 2003 is the *International Financial Statistics* (IFS) online. The data for 2004 was taken from the Ministry of Foreign Trade & Industry, in Egypt. The source of the data on GNP/GDP from 1947 through 1951 is Scobie (1983) and for the remaining of the sample period is IFS online. The CPI was used to convert the

¹ The critical values for the cointegration ADF-test with intercept are given in Haldrup (1998) and with intercept and trends, in Engsted *et al.* (1997).

variables to real terms as a GDP deflator was not available for the entire period. The data for CPI, for the period 1948-2004, was taken from IFS, and for 1947, was taken from Scobie (1983). The 1947 data was adjusted for the base year 2000 to be 100 so as to be consistent with the IFS data. The data for the discount rate is available for the period 1951-2004, and for lending and deposit rates, for the period 1976-2003. Data was taken from IFS online.

We first investigate to see whether the stochastic condition exists during our sample period in Egypt. The average real ex-post safe rate of return (discount rate) is 0.87%, which is less than the average real growth rate of income (4.3%) for the period 1951-2004. However, the discount rate does not fully reflect the rate for the whole economy. Based on the data available for the period 1976-2003, the average real ex-post lending rate and growth rate of real income for this period is, respectively, 2.81% and 4.71%. If we consider the lending rate as the safe rate of interest for the economy, then this situation can be considered a non-stochastic environment, at least for the recent period in Egypt. According to the Augmented Dickey-Fuller (ADF) and Phillips-Perron non-parametric (PP) test results, the growth rate of real income is stationary, but according to Zivot and Andrews' (1992) unit-root test result, it has a unit root. These results are not reported, but are available upon request. Note that Zivot and Andrews' unit-root test allows for unknown breaks in the intercept and slopes. Based on the above results, although the growth rate of real income (GDP) was negative in years 1951-55, 1960, 1966, 1986-87 and 1991, we might conclude that a non-stochastic environment exists in Egypt during the sample period.

Table 1 reports ADF and PP test results as well as multicointegration test results for both a linear and a quadratic time trend. The ADF statistics for the presence of a unit root allow a drift and trend in each series. According to these results, both G' and R are homogenous of degree one. We also used Zivot and Andrews' (1992) unit-root test, which allows for unknown breaks in the intercept and slopes. These test results were consistent with the ADF and PP results, but for the sake of brevity these results are not reported here, though they are available upon request. As for the multicointegration test, according to the ADF test result, reported in Column 9 of the table, government spending and revenues are not multicointegrated in Egypt. Consequently, the conventional cointegration test between spending and revenues implied by Equation (4) should be sufficient for checking the sustainability of fiscal processes in this country.

$$G'_t = \beta_0 + \beta_1 R_t + z_t, \quad (4)$$

where β 's are coefficients and z_t is, as before, the error term.

The bottom of Table 1 reports the results of these tests. However, it should be noted that, as it was shown by Gregory and Hansen (1996), the power of the ADF test in rejecting the null hypothesis of no cointegration will fall sharply in the presence of a regime shift. Of course the government could change its fiscal policy based on wars, recessions, etc. Consequently, we also report in Table 1 Gregory and Hansen's Augmented Dickey-Fuller test (ADF*) when there is a possibility of an unknown break point. ADF* is the Dickey-Fuller statistics at its lowest value where there is a possibility of a break. If this statistics rejects the null hypothesis of no cointegration even with a regime shift, then we will conclude that a long-run relationship between government spending and revenues exists and, therefore, that the fiscal process of the country may be

sustainable in a non-stochastic environment. Then to ensure sustainability also exists in a stochastic environment, we need to conduct Granger and Lee's (1990) two-stage multicointegration test to ensure debt and revenues/spending are also cointegrated. This is due to the fact that the ADF statistics for our multicointegration test may also have a low power in rejecting the null hypothesis of no cointegration. In this case, we need to test whether the error term in Equation (5) or (6), below is stationary, where $Sz_t = \sum_{i=0}^t z_{t-i}$, z being the error term from Equation (4), α 's and δ 's are parameters and u_t and ε_t are the error terms.

$$Sz_t = \alpha_0 + \alpha_1 R_t + u_t, \quad (5)$$

$$Sz_t = \delta_0 + \delta_1 G'_t + \varepsilon_t, \quad (6)$$

Table 1 about here

According to the conventional ADF test results reported in Table 1, government spending and revenues in Egypt are cointegrated. The estimated long-run coefficient is one which indicates that the relationship is characterized by persistently balanced spending relative to revenues, and that spending and revenues share a long-run equilibrium relationship. However, according to the ADF* statistics, spending and revenues do not share a long-run equilibrium relationship, and there might be a break in both slope and intercept in 1979. The former finding of a strong long-run relationship between spending and revenues indicates that the possibility of a break is very weak; see also Gregory and Hansen (1996) for a correct interpretation of the ADF* test result. Moreover, since the estimated coefficient of the revenues (β) is one, we can clearly conclude that the long-run relationship is characterized by a persistently balanced budget

and that the fiscal budgeting process in Egypt is sustainable in only a non-stochastic environment.

We will, consequently, use this estimated result (given in the first row of the bottom panel in Table 1) to analyze the error correction equations. However, as we will see, it is possible that some relevant policy regime changes in the country may affect the short-run dynamics of the system during the sample period. Ignoring this fact may lead to an incorrect conclusion.² To ensure that the ECM is not misspecified and that the lack of multicointegration is not due to structural breaks, we also conducted Granger and Lee's (1990) two-stage test. Specifically, we estimated, using OLS, equations (5) and (6). The result is reported in the last four rows of the first panel of Table 1. As we can see, both conventional ADF and ADF* reject the null hypothesis of multicointegration. Having established that revenues and spending in Egypt are not multicointegrated we estimate the following ECMs:

$$\begin{aligned} \Delta G'_t = & \text{Constant} + \sum_{i=1}^k Cg_i \Delta G'_{t-i} + \sum_{i=1}^k Bg_i \Delta R_{t-i} + \sum_{i=1}^k \psi g_{1i} EC_{t-i} \\ & + \sum_{i=1}^k \psi g_{2i} EC_{t-i}^2 + \sum_{i=1}^k \psi g_{3i} EC_{t-i}^3 + \phi DUM_t + v g_t, \end{aligned} \quad (7)$$

$$\begin{aligned} \Delta R_t = & \text{Constant} + \sum_{i=1}^k Cr_i \Delta G'_{t-i} + \sum_{i=1}^k Br_i \Delta R_{t-i} + \sum_{i=1}^k \psi r_{1i} EC_{t-i} \\ & + \sum_{i=1}^k \psi r_{2i} EC_{t-i}^2 + \sum_{i=1}^k \psi r_{3i} EC_{t-i}^3 + \gamma DUM_t + v r_t. \end{aligned} \quad (8)$$

Cg 's, Bg 's, Cr 's, Br 's, ψg 's and ψr 's are constant coefficients. $EC=z$ is the error correction term from Equation (4). The vector DUM is a column vector of all dummy

² Note that including a linear time trend in the cointegration relationship did not materially change any of the above conclusions; the results are available upon request.

variables which account for policy regime or other exogenous changes during our sample period (see below), and ϕ 's, γ 's are row vectors of coefficients.

During our sample period, there are some policy regime changes which clearly could influence the fiscal process in Egypt over the short run. Figure 1 depicts government expenditure and revenues for our sample period. As we can see, there are some drastic changes in government revenue and expenditure which could be due to these regime changes.

Figure 1 about here

These regime changes include (see *The Middle East and North Africa*, various editions):

(i) All foreign trade was nationalized in 1961. To account for this policy regime change, the dummy variable “national” = 1 for 1961, and zero, otherwise, was created.

(ii) In June 1967, after the war with Israel, losses of revenues from the Suez Canal, tourism, and oil produced in Sinai, amounted to 12.5 million Egyptian pounds per month; about half the Egyptian foreign currency. In July of the same year, an austerity budget was adopted. The dummy variable “bud” = 1 for 1967 and zero, otherwise, was constructed to account for this policy regime change.

(iii) On May 1, 1975, Anwar Sadat announced that all lower paid public sector employees would receive an additional cost of living allowance equal to 30% of their pay. In June of that same year, he announced that the Suez Canal would reopen on the eighth anniversary of the war with Israel, which led to its closure. The dummy variable “suez” =1 for 1967-75 and zero, otherwise, was constructed to account for the period during which the Suez Canal was closed. The dummy variable “costlive” =1 for 1975 and

zero, otherwise, was constructed to account for the cost of living adjustment policy regime change in this year.

(iv) The dummy variable “peace” = 1 for 1979 and zero, otherwise, was used to account for the effect of the peace treaty with Israel on March 26, 1979.

(v) A new sales tax of between 5% and 30% was introduced on most goods and services in May 1991. The dummy variable “price” = 1 for 1991 and zero, otherwise, accounts for a jump in prices for this fiscal policy change.

(vi) In late 1994, price subsidies were eliminated or substantially reduced throughout the public sector, and schedules existed for the removal of the remaining subsidies. This fiscal policy resulted in a hike in the price level in late 1994 and early 1995. The dummy variable “pricesub” = 1 for the period 1994 -1995, and zero, otherwise, accounts for this policy regime change.

(vii) In early 1993, the maximum import tariff of 100 % was reduced to 80%. In July of that year, the government declared its intent to further reduce the maximum tariff from 80% to 50% over a four-year period. In February 1994, the maximum import tariff was actually lowered from 80% to 70%. In January 1996, as part of its drive to stimulate industrial investment, the government cut import tariffs on capital goods, which had ranged from 20%-40%, to 10%. Thirteen free-trade zones were also approved. To account for this policy regime change, the dummy variable “tariff” was constructed. It is zero prior to 1993, and is equal to 0.25 for 1993. It then increases linearly to 1 for 1996, and remains 1 for the rest of the sample period.

(viii) In 1991 a flexible exchange rate was adopted and a new sales tax was introduced. The dummy variable “flex”=1 for 1991 and later years, and zero, otherwise, was constructed to account for these policy changes.

The vector DUM is defined as:

$$\text{DUM} = (\text{national}_t, \text{bud}_t, \text{suez}_t, \text{costlive}_t, \text{peace}_t, \text{price}_t, \text{pricesub}_t, \text{tariff}_t, \text{flex}_t)'$$

Table 2 about here

Note that these policy regime changes can only affect the short-run process. We also included a dummy variable for a potential break in 1979, which was found for the long-run coefficient. To avoid biased results, we allow for a lag profile of four years in the estimated ECMs and, therefore, k in equations (7) and (8) is four. Furthermore, having too many coefficients can also lead to inefficient estimates. To guard against this problem and ensure parsimonious estimations, we selected the final ECMs on the basis of Hendry’s General-to-Specific approach. Table 2 reports the parsimonious estimated ECMs. The specification test results reported in Table 2 in the bottom panel, suggest that the estimated equations are statistically adequate. According to Hansen’s stability L test, all of the coefficients are stable. The joint Hansen stability L_c test result is statistically significant at only 2% for the change in spending. This indicates a weak joint stability, but for the change in revenues the L_c test result is statistically significant at the 24% level of significance.

The estimated coefficient of the error-correction term is negative and statistically significant for only the changes in government spending. This evidence suggests that spending tends to adjust to divergences from the equilibrium relationship. This finding is

consistent with Barro's (1979) tax-smoothing argument.³ The estimated coefficient of the dummy variable "costlive" is positive and statistically significant for both spending and revenues. This indicates that the additional cost of living allowance of 30% for low-paid government employees in 1975, resulted in an increase in government expenditures as well as government revenues, but spending increased by more than revenues, as the magnitude of the coefficient indicates. None of the other dummy variables was found to be statistically significant in the ECM of the changes in government spending.

The estimated coefficient of the dummy variable "tariff" is statistically significant only for revenues. The estimated coefficient is negative, implying that the reduction in tariffs from 80% to 10% during the period 1993-1996, resulted in a reduction in government revenues in Egypt. The estimated coefficient of the dummy variable "flex" is positive and statistically significant for the ECM of revenues, indicating that the adoption of a flexible exchange rate resulted in more government revenues in Egypt.

To summarize, our findings indicate that the fiscal process in Egypt is weakly sustainable in the sense that it is sustainable only in a non-stochastic environment. Furthermore, the adoption of a flexible exchange rate was a responsible policy since it resulted in an increase in government revenues, while having no effect on government expenditures. This effect was probably also due in part to the increase in sales tax during that year.

IV. Implications and Conclusions

In this article, a richer set of criteria is used to assess the sustainability of fiscal budgeting processes, which is based on the more realistic assumption that the discount

³ In Barro's original formulation, temporary increases in spending will lead to periods of temporary low expenditures so that to generate the surpluses needed to retire the previously issued debt.

factor is variable through time. The multicointegration of government spending and revenues is used to test for the sustainability of the fiscal process in a stochastic environment. It has been shown in the literature [see Leachman *et al.* (2005)] that the multicointegration condition is more appropriate for the sustainability test of the fiscal policy, since it implies that both the levels and rates of change of the series are tied together over the long run.

The data for Egypt does not exhibit multicointegration of its system of fiscal variables. A long-run cointegrating relationship between spending and revenues does exist. The result is consistent with the sustainability of the fiscal budgeting process, especially in a non-stochastic environment. The short-run dynamic relationship of fiscal processes in Egypt suggests that spending tends to adjust to divergences from the equilibrium relationship.

Furthermore, the policy change of reducing tariffs in 1993 resulted in lower government revenues without any effect on spending. Moreover, the policy of increasing the cost of living allowance by 30% for low-paid government employees in 1975, resulted in an increase in government expenditures which exceeded the rise in government revenues.

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Table 1: Unit Root Tests: Multicointegration Tests

Variables ¹	ADF τ -Stat(k) ²	PP Z-Stat(k)	Multicointegration-Coefficients ³						
			Stationarity Tests		C ₀	C ₁	C ₂	C ₃	C ₄
	1947-2004: N= 58		-357.51	0.84	1.18	27.86	1.52	-2.74 (4)	0.28
G'	-2.82 (0)	-0.27 (4)	-490.04	0.98	1.16	50.00	-	-2.74 (4)	0.28
R	-0.86 (0)	-0.93 (4)	-	-	-	-	-	-	-
ΔG'	-8.23 ^a (0)	-8.37 ^a (4)	-	-	-	-	-	-	-
ΔR	-6.19 ^a (0)	-6.31 ^a (4)	-	-	-	-	-	-	-
Residual Based Tests ⁶									
Sample Period	β_0	β_1	DW	ADF ⁷ (k)	ADF* ⁸ (k)-Break				
1947-2004	49.48	1.00	1.01	-3.68 ^a (0)	-3.24 (1) - 1979				
-	α_0	α_1			-				
1947-2004	-433.25	0.61	0.15	-1.82(0)	-3.16 (2) - 1988				
-	δ_0	δ_1			-				
1947-2004	-460.77	0.60	0.09	-2.41 (1)	-3.10 (0) - 1989				

1. G' and R are real government spending, including interest payments, and real revenues, respectively. Δ before a variable means its first differences.

2. All tests include constant and trend, and k is the optimal lag length, which was determined by the minimum of AIC and SC. The critical values for Augmented Dickey-Fuller (ADF) τ test [for N=58, is -2.88 at 5% and -3.46 at 1%], and for Phillips-Perron non-parametric (PP) Z test (window size = 4) [for N=58, is -2.91 at 5% and -3.55 at 1%].

3. $Y_t = C_0 + C_1 X_t + C_2 \Delta X_t + C_3 \text{trend} + C_3 (\text{trend})^2 + e_t$, where $Y_t = \sum_{i=0}^t G'_{t-i} \sim I(2)$, and $X_t = \sum_{i=0}^t R_{t-i} \sim I(2)$. The t -values are not shown as the e 's are far from the white noise.

4. The null hypothesis: Residuals are I(1), i.e., all I(2) variables in the model cointegrate into an I(1) relation. The alternative hypothesis: Residuals are I(0) indicating multicointegration. The critical values are from Engsted *et al.* (1997), Table 1, where for $N \geq 50$ these values are: -4.42 for 5% and -5.11 for 1%.

5. $DW > 0.08$ indicates a rejection of residuals to be I(1) at 95% level.

6. $G'_t = \beta_0 + \beta_1 R_t + z_t$, where G' is real government spending, including interest payments, R is real revenues and z is the error term. $Sz_t = \alpha_0 + \alpha_1 R_t + u_t$ and $Sz_t = \delta_0 + \delta_1 G'_t + \varepsilon_t$, where $Sz_t = \sum_{i=0}^t z_{t-i}$, z_t and ε_t are error terms.

7. ADF is the conventional Augmented Dickey-Fuller test statistics and k is the optimal lag length, which was determined by the minimum of AIC, as well as SC. The critical value for ADF τ test is -2.89 at 5% and -3.51 at 1%.

8. ADF* is Gregory and Hansen's (1996) smallest value of t -statistics of ADF. The critical value, when break is on the intercept and slope is -5.5 at 5% and -5.97 at 1%.

a=Significant at 1%.

b=Significant at 5%.

Table 2: Error Correction Model¹

Dependent Variable	$\Delta G'$		ΔR	
	Coef. (SE) ²	$L_i(p)$	Coef. (SE) ²	$L_i(p)$
EC _{t-1}	-0.43 (0.16)	0.31	-	-
costlive	209.06 (73.15)	0.03	152.32 (58.64)	0.90
tarif	-	-	-143.15 (41.47)	0.99
flex	-	-	128.86 (34.82)	0.99
variance	-	0.02	-	0.01
joint-test L _c	-	0.02	-	0.24
Specification		<i>p</i> -value		<i>p</i> -value
\bar{R}^2	0.11	-	0.21	-
DW	2.03	-	1.74	-
Godfrey(5)	0.63	0.71	1.11	0.37
White	0.72	0.98	10.80	0.29
ARCH(5)	6.71	0.24	6.81	0.23
RESET	0.10	0.96	0.27	0.85

1. The sample period is 1947-2004. Δ means the first difference, G' is real government spending, including interest payments, R is real revenues and EC is the error-correction term generated from the long-run relationship. Dummy variables are: *costlive* is equal to 1 in 1975 and zero, otherwise, *tariff* is equal to zero up to 1993, to 0.25 in 1993, then increases linearly to 1 in 1996 and remains 1 for the rest of the period; *flex* is equal to zero up to 1991 and one, otherwise. *White* is White's (1980) general test for heteroskedasticity, *ARCH* is five-order Engle's (1982) test, *Godfrey* is five-order Godfrey's (1978) test, *REST* is Ramsey's (1969) misspecification test, L_i is Hansen's (1992) stability test for the null hypothesis that the estimated coefficient or variance of the error term is constant and L_c is Hansen's (1992) stability test for the null hypothesis that the estimated coefficients as well as the error variance are jointly constant.

2. The estimation method is Least Squared.

Figure 1

