Sustainability of the Fiscal Process in Developing Countries - Egypt, Iran and Turkey: A Multicointegration Approach

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Abstract

This paper investigates the fiscal sustainability of three developing countries — Egypt, Iran and Turkey — for both stochastic and non-stochastic environments. Both cointegration and multicointegration methodologies were used to evaluate fiscal budgeting processes in these countries. A model for testing the sustainability of a fiscal policy, based on Barro’s tax smoothing, was also developed to test the Iranian fiscal policy. It was found that the fiscal budgeting process in Egypt and Turkey is weakly sustainable, but not in Iran. However, the Iranian fiscal policy, as far as oil and gas income is concerned, is a responsible, but not a fully responsible policy.

Keywords: fiscal sustainability, multicointegration and tax smoothing

JEL Codes: H60, E62, C32
1. Introduction

The credibility of a government is extremely important for its ability to borrow both domestically and internationally. This is particularly true for the government of developing countries who also, at times, needs to rely intensively on international lenders. Governments, like individuals, are constrained in their ability to borrow. In fact, this constraint limits the government’s choices in issuing debt, imposing taxes or printing money to finance deficits. However, government budgets tend to move between balance, surplus, and deficit. These fluctuations result from the fact that all too often a government makes financial decisions in one year that have implications for spending commitments and revenue streams a number of years down the road. Thus, a responsible government budgeting process involves examining the budget position over time, that is, engaging in an intertemporal budgeting.

The intertemporal budget 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 on the debt. Such a condition is known as “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 is when the government is borrowing and running a Ponzi scheme. In such a case, financial trading strategies of the government involve rolling over an initial debt with interest forever. Then why should any investor, domestic or foreign, buy the debt of such a government.
Consequently, agents run Ponzi game against the government. In such a situation, the government’s budget is not sustainable and the government is expected to impose high tax rates and to resort to the monetization of debt which, by itself, means 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 emerging countries, where debt markets are not fully developed, there is a high possibility of monetization of debt.

Sustainability, in general, concerns current and expected future policies. If economic agents do not expect current and future policies to lead to an intertemporal budget constraint then the fiscal process would be unsustainable and government insolvency would be possible. In such a case, the government is not able to stop agents to play Ponzi schemes/game against it. This means an asymptotically negative expected present value of a debt is possible. Furthermore, solvency requires that the government asymptotically cannot leave a debt with a positive expected value. A government is insolvent if it cannot, both politically and economically, impose a tax set and generate seignorage plans that permit the outstanding stock of debt to be serviced.

Most of the empirical work in this area focuses on the time-series behavior of tax revenues and expenditures as well as debt series to investigate if the behavior of these series is consistent with the intertemporal budget balance. Specifically, an intertemporal budget balance holds if the stock of debt and the flow of deficits are cointegrated. The empirical results of the existing literature vary depending on the sample period and the methodology used. For example, Trehan and Walsh (1991), Martin (2000) and Cunado et al. (2004) failed to reject intertemporal budget balance for the United States while
other studies, including Hamilton and Flavin (1986), Wilcox (1989) and Hakkio and Rush (1991) rejected it. These studies, similar to Hansen et al. (1991) and Gali (1991) have assumed the discount rate remained positive and constant.

Using the cointegration methodology on the data of other countries, for instance, Wu (1998) finds the fiscal policy of Taiwan is sustainable as did Green et al. (2001) for Poland’s fiscal policy. Furthermore, Bravo and Silvestre (2002) find the fiscal process in Austria, France, Germany, Netherlands and the UK is sustainable, while the process is unsustainable in Belgium, Denmark, Finland, Ireland, Italy and Portugal. Hatemi-J (2002) finds that Sweden did not violate its intertemporal budget constraint and Goyal et al. (2004) find the fiscal policy of the Centre and State Governments in India is individually unsustainable, but for all states together is sustainable.

Luporini (2002) argues that the efficiency of cointegration analysis is constrained by its assumptions on real interest rate and the stochastic process that drives deficit. Luporini applied Bohn’s (1998) approach to investigate the response of Brazil’s budget surplus to its variation of debt-income ratio and found Brazil had an unsustainable fiscal structure, in contrast to the result found earlier by Issler and Lima (1997) who adopted a cointegration approach. Telatar et al. (2004) also follow Bohn’s (1998) approach, but use Bayesian Gibbs sampling simulation to observe changes in the behavior of the Turkish government period by period. They found that the relationship between primary surpluses and government total liabilities might be unstable in Turkey as the intention of the government towards the sustainability of fiscal policy has been changing.

A more serious problem with the cointegration analysis, as mentioned by Bohn (1995, 1998) and Ball et al. (1998), is that persistent deficits and the accumulation
of debt do not necessarily imply that the debt is unmanageable and, hence, fiscal processes are unsustainable. It is possible for the government to change the historical pattern, it has been following and so it will not borrow and run a Ponzi scheme in the future. This implies that the standard approach to testing whether government adheres to its intertemporal budget constraint — a cointegration analysis — 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 author, no such study for developing countries, particularly MENA (Middle East and North African) countries, exists.

The objective of this paper is to develop and test such criteria for Egypt, Iran and Turkey. Egypt, with more than 90% of the country being desert land, relies mostly on tourism, Iran, on oil exports and Turkey, on agricultural products. The heterogeneity of these countries makes the study unique. Furthermore, the methodology used in this study is purely for a stochastic environment, which is more relevant for these countries than developed countries. By extending Barro’s (1979, 1986) tax-smoothing model, a model which is capable to analyze the sustainability of fiscal processes of an energy-producing
country like Iran was also developed. 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 2 formulates the models and explains the methodology. Section 3 focuses on data, and the empirical results. The final section provides some concluding remarks.

It was found in this article 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. In Iran, the fiscal budgeting process is unsustainable in both stochastic and non-stochastic environments. It was found that the Iranian fiscal policy, as far as oil and gas income is concerned, is a responsible, but not a fully responsible fiscal policy. In Turkey, the fiscal budgeting process is unsustainable in a stochastic environment, but is weakly sustainable.

II. The Model and the Methodology

The intertemporal budget balance holds when deficits and outstanding debt are cointegrated. This implies that deficit processes are sustainable. The bulk of the existing literature assumes the discount rate remains positive and constant. A positive discount rate means the safe real rate is higher than the sum of the population growth rate and the growth rate of real per capita output, Walsh (2000). This situation guarantees the transversality condition as well as dynamic efficiency. However, the safe real rate of interest has been lower than the economy’s average growth rate in most countries, e.g., in the United States, a situation that can arise in a stochastic environment.
Furthermore, relying on safe interest rates as discount factors when assessing the sustainability of the fiscal policy would be justified only if future government surpluses were uncorrelated with future marginal utilities of consumption. But, as mentioned by Ljungqvist and Sargent (2000), this condition is trivially true in a non-stochastic economy or if agents are risk neutral. However, in practice, it is difficult to imagine a tax and spending policy that is uncorrelated with the difference between aggregate income and government spending that determines the marginal utility of consumption. Bohn (1995) shows that in a stochastic environment, in the absence of lump-sum taxes, even seemingly prudent fiscal policies such as running a balanced budget may be unsustainable.

Specifically, if the growth rate of real income is a unit root process that can take on negative values, then fiscal policies, which run a balanced budget, may be unsustainable. In this case, there is a positive probability of large income declines that can make the debt-to-income ratio large enough to threaten sustainability. Consequently, studies under the condition of certainty are too simple to be realistic. Under stochastic conditions, uncertainty exists. In this situation, higher risk averse agents attach a higher value to sure claims to future consumption. This implies a higher demand for government bonds, which itself tends to increase the bond price and so to lower the risk-free (safe) rate of interest.

The more risk averse agents are, the lower the safe-interest rate will be. Therefore, there is a negative relationship between the degree of risk aversion and safe rates of interest. Thus, when uncertainty is sufficiently large and agents are sufficiently risk averse, the risk-free rate falls below the expected 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, transversality (no-Ponzi) condition cannot be satisfied and the fiscal process cannot be sustainable. This means that, unless agents are risk neutral, the discount rate in a stochastic situation should be subjective and time variant. In other words, the rate should be a function of the probability distribution of future debt, and the marginal rate of substitution between present and future consumption should be zero. This correct discounting is critical in economies where the rate of growth has been higher than the real interest rate.

Therefore, we need to use criteria that correctly assess whether the behavior of each of our developing countries, over the sample period, is consistent with sustainable budgeting policies, regardless of economic performance while ruling out default or inflation. Consequently, following Ahmed and Rogers (1995), among others, I assume the discount rate $\beta_t$, $0 < \beta_t < 1$, is subjective, utility is time separable and marginal utility of consumption follows a random walk. Furthermore, assume 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. In other words, all risk premia are time-invariant. The current government budget constraint, when there is no inflationary finance, is given by:

$$G_t - R_t + r_{t-1} D_{t-1} = D_t - D_{t-1},$$ (1)
where $r$ and $D$ are the real interest rate and the outstanding debt at time $t$, respectively. Substituting forward for $D_t$ in Equation (1) and denoting $E$ as expectations operator, conditional on all available information at time $t$, and rearranging we will have:

$$(1 + r_{t-1}) D_{t-1} = G_t - R_t + E_t[(1 + r_t)^{-1} (G_{t+1} - R_{t+1}) + (1 + r_t)^{-1}(1 + r_{t+1})^{-1} (G_{t+2} - R_{t+2})$$

$$+ \ldots + (1 + r_t)^{-1}(1 + r_{t+n})^{-1} \ldots (1 + r_{t+n})^{-1} (G_{t+n} - R_{t+n}) \ldots | I_t]$$

$$+ \lim_{n \to \infty} E_t[(1 + r_{t+n})^{-1} D_{t+n} | I_t].$$

In Equation (2) $I_t$ is the information available at time $t$, including the state of the economy. This equation is the standard intertemporal government budget constraint in expected value terms. In other words, it implies that, given all available information, the current value of government debt is equal to the expected present value of all future primary surpluses, plus a limiting term representing the asymptotic expected present value of the government debt. Solvency requires that the government, asymptotically cannot leave a debt with a positive expected value, and since it should not allow anybody to run Ponzi schemes against it, an asymptotically negative expected present value of a debt is not allowed either. This means $\lim_{n \to \infty} E_t[(1 + r_{t+n})^{-1} D_{t+n} | I_t] = 0$. Such a condition immediately implies that the government should satisfy its intertemporal budget constraint. Namely, the sum of the current primary budget surplus and the expected present discounted value of future primary surplus, given $I_t$, should be equal to the amount needed to repay the principal and interest on the initial debt, Ahmed and Rogers (1995).

The above condition generates a sustainable fiscal process. Under some necessary and sufficient conditions, Ahmed and Rogers 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 \( \lim_{n \to \infty} \mathbb{E}_t[(1 + r_{t+n})^{-1} D_{t-n} | I_t] = 0 \), i.e., a sustainable fiscal process.\(^1\) They assume expectations are rational, the real rate of return is constant and

\[
\Delta G'_{t+n} = a_{G'} + v_{G't+n}, \quad (3)
\]

\[
\Delta R_{t+n} = a_R + v_{Rt+n}, \quad (4)
\]

where \( \Delta \) is the first difference operator, \( a_{G'} \) and \( a_R \) are constant parameters, \( v_{G'} \) and \( v_R \) are zero-mean stationary processes. They stressed that cointegration between expenditures and revenues is both necessary and sufficient conditions for the government’s present value 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. In general, the agents who purchase safe-government issued bonds rather than invest in risky assets are logically risk averse individuals. In stochastic economies when uncertainty exists, these individuals’ subjective discount rate will increase when the initial debt relative to the income is high. When the outstanding debt at its maturity is rolled over, it will be priced low and while the safe rate of return increases, there is a need for more debt (i.e., new issues) to be marketed to replace the initial debt. Consequently, debt can grow as government roll over the old debt with new issues, which has a lower market value or a higher rate of return. Furthermore, as Bohn (1995) also mentions, in a stochastic setting the government might issue a portfolio of securities that promises a total payoff conditional on the state of the

\(^1\) For the proof, see Ahmed and Rogers (1995), Appendix A2.
economy at the time of maturity. The new level of government debt, therefore, will 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 to be multicointegrated in the sense of Granger and Lee (1989, 1990). In other words, government revenues and expenditures or government revenues and outstanding debt can deviate from each other over the short run, but market forces and/or fiscal policy bring them back together over the long run. This multicointegration condition guarantees the sustainability of fiscal processes in a stochastic environment.

Note that if G’\_t and R\_t are both I(1) and are cointegrated, then the government deficit series, i.e., z\_t = G’\_t - R\_t, will be I(0). In this case, the outstanding government debt, 

\[ D\_t = \sum_{i=0}^{t} z\_t-i \] will be I(1). We know D\_t is a function of G’\_t, R\_t and their lags. If the government’s fiscal process does not allow D\_t and G’\_t, or D\_t and R\_t to drift apart over the long run and so be cointegrated, then G’\_t and R\_t will be said to be multicointegrated. In this case, the government considers both the change and the rate of change in economic conditions in formulating its fiscal policy. To demonstrate it formally, let us follow Leachman et al. (2005) and assume G’\_t and R\_t are cointegrated with the long-run parameter set (1, -1). Then the government’s response policy will be determined by the
standard common factor representations of $G'_t = AW_t + x_1t$ and $R_t = W_t + y_1t$, where $A$ is equal to one by assumption, $W_t$ is I(1) and both $x_t$ and $y_t$ are I(0) processes. $W_t$ may be thought of as a state variable, which summarizes economic conditions at time $t$. Since $G'_t$ and $R_t$ are cointegrated they have $W_t$ as a component. Furthermore, in order for $D_t = \sum_{i=0}^{t} z_{t-i} - \sum_{i=0}^{t} G'_{t-i} - \sum_{i=0}^{t} R_{t-i}$ to be cointegrated with $G'_t$ (or $R_t$), it is necessary for this variable to have $\Delta W_t$ as a component, see Granger and Lee (1990). In other words, sustainability exists if, at time $t$, government spending and revenues as well as outstanding government debt depend on the same information variable. This will occur if full decompositions are $G'_t = W_t + x_1t + \alpha_1 \Delta W_t$, and $R_t = W_t + \alpha_2 \Delta W_t + y_2t$, where $x_2t$ and $y_2t$ are both I(-1) and since $A=1$, it was dropped. Furthermore, these two decompositions should give $D_t = CW_t + \Delta^{-1} \sum_{i=0}^{t} x_{2t-i} - \Delta^{-1} \sum_{i=0}^{t} y_{2t-i}$, where $C = \alpha_1 - \alpha_2 \neq 0$, $\Delta^{-1} \sum_{i=0}^{t} x_{2t-i} - \Delta^{-1} \sum_{i=0}^{t} y_{2t-i}$ is I(0) and $\Delta^{-1}$ is the accumulation of I(-1) variables. It follows that:

$$R_t - C^{-1} D_t = Z_t - I(0), \quad (5)$$

Note that the same relationship holds for $G'_t$ and $D_t$. In general, for $G'_t$ and $R_t$ to be multicointegrated we need first:

$$G'_t - R_t = z_t \sim I(0), \quad (6)$$

and then (5) will be satisfied. Since $G'_t$, $R_t$, and $D_t$ are generated based on the same information, it is possible to show the error correction models (ECMs) associated with each system of (5) or (6) 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:

$$\Delta G'_t = \rho_1 z_{t-1} + \rho_2 Z_{t-1} + \text{lagged}(\Delta G'_t, \Delta R_t) + \text{white noise residual}, \quad (7)$$

$$\Delta R_t = \eta_1 z_{t-1} + \eta_2 Z_{t-1} + \text{lagged}(\Delta G'_t, \Delta R_t) + \text{white noise residual}, \quad (8)$$
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) as well as Engsted and Haldrup (1999). To obtain the one-step test of multicointegration, substitute for $D_t$ in (5) to get:

$$R_t - C^{-1}\left[ \sum_{i=0}^{t} G'_{t-i} - \sum_{i=0}^{t} R_{t-i} \right] = R_t - C^{-1}Y_t + C^{-1}X_t \sim I(0), \quad (9)$$

where $Y_t = \sum_{i=0}^{t} G'_{t-i} \sim I(2)$, and $X_t = \sum_{i=0}^{t} R_{t-i} \sim I(2)$. Noting that $\Delta X_t = R_t$ we will have:

$Y_t = X_t + C \Delta X_t + e_t$, where $e_t \sim I(0)$. We can also replace $\Delta X_t$ by $\Delta Y_t$. If $e_t$ is not stationary, then multicointegration does not exist. In such a case, one can test for the cointegration relationship between expenditures and revenues. If a cointegration relationship exists, then the corresponding error-correction model for $\Delta G_t$ or $\Delta R_t$ will not be misspecified. The basic one-step test procedure for sustainability is to consider

$Y_t = X_t + C \Delta Y_t + e_t$, and check if $e_t \sim I(0)$, but since each series may potentially have a drift, it is necessary to include deterministic components like a linear and/or quadratic trend in the auxiliary regression. Furthermore, as mentioned by Engsted et al. (1997), when a drift is absent in the series, it is sufficient to include a time trend to account for the initial conditions. In sum, our one-step test for sustainability of fiscal processes in a stochastic environment is to run OLS on the following equation:

$$Y_t = C_0 + C_1 X_t + C_2 \Delta X_t \text{ (or } C'_2 \Delta Y_t) + C_3 \text{ trend} + C_4 \text{ trend}^2 + e_t \quad (10)$$

We need to test if in the integral regression (10) $e_t$ 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., \( G' = \Delta Y_t \) 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).2

The interpretation of Equation (10) 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 cut) 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.

It should be noted that since Iran is an oil-producing country, we need an extra
assumption in order to use equations (5) and (6) or Equation (10) to test the sustainability
of the Iranian fiscal process. In order to use these equations, we need to assume the
Iranian reserve of oil lasts forever. This assumption is somehow artificial as Iranian oil
resources, based on BP’s latest Statistical Review of World Energy and on the country’s
current production would last only 89 years, see IRNA Report, London, June 2005.
Unless we further assume that government will be able to effectively diversify revenue

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2 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).
and/or enormously cut expenditure when oil resources are exhausted, the use of the above criteria for a sustainable fiscal process is unrealistic. Let us impose these assumptions and investigate if the fiscal policy in Iran, using equations (5) and (6) and Equation (10) is sustainable. If the fiscal process under these assumptions is not sustainable, then, clearly, it cannot be sustainable under more restrictive assumptions. If, on the other hand, we find the fiscal policy in Iran is sustainable, then we need also a forward-looking criteria to evaluate our result. In this case, I will extend Barro’s (1979, 1986) tax smoothing model for an energy producing country.

In Barro’s approach, the government faces the exogenous deterministic stream of real expenditures, other than interest payments, as given by $G_t$. The base of real taxable income is the deterministic amount $y_t$, which is a fixed fraction of real GDP and generally depends on the path of tax rates. In contrast to Barro’s model, I assume GDP to be also a function of energy (oil and gas) income of the country, i.e., $y_t=f[e^{EN_t}, Z_t]$, where $f$ is a fixed function, $Z_t$ is a set of other factors of production and $EN_t$ is the real energy income at time $t$. Following Barro (1986), let $\tau_t$ be the average tax rate at time $t$ so that the real tax revenue be $\tau_t y_t$. However, in this model, variable $R_t$ in Equation (1) is now equal to the sum of $\tau_t y_t$ and $EN_t$. The government’s budget constraint, Equation (2), in a continuous form and with constant real interest rate, $r$, and when the country has the energy income, will be

$$E[ \int_0^\infty \tau_t ye^{-rt} dt + \int_0^m ENte^{-rt} dt | I_t ] = E[ \int_0^\infty Gte^{-rt} dt | I_t ] + D_0. \quad (11)$$

3 Note that, only for the sake of simplicity, it is assumed that the real interest rate is constant as none of the following analyses would change if we replace constant $r$ by $r_t$. 

\[ E[ \int \tau_t ye^{-rt} dt + \int ENte^{-rt} dt | I_t ] = E[ \int Gte^{-rt} dt | I_t ] + D_0. \quad (11) \]
Note that the time when the country energy resources will be exhausted is assumed to be known at \( t=m \) and \( D_0 \) is the outstanding debt at \( t=0 \). The model, contrary to Barro’s model is also stochastic, but similar to his model, is based on a Ramsey-type optimal-taxation perspective. Specifically, it is assumed the allocative effects from taxation depend on the average marginal tax rate \( (\tau^m_t) \) for each period. In other words, it is assumed people’s incentive to work, produce and consume at time \( t \) depends on the average tax rate. In such an environment, the tax rate depends on the state of the economy at each period. Following Barro (1986), I assume that the government plans for equal average marginal tax rates in each period. Furthermore, the average marginal tax rate for any period has a time invariant and stable relationship with that period’s average tax rate, \( \tau_t \), so that the stabilization of average marginal tax rates entails the stabilization of average tax rates. Similar to Barro (1986), let \( \tau \) denote the constant value of the average tax rate. Substitute \( \tau \) for \( \tau_t \) in (11) to get

\[
\tau = \left[ E\left[ \int_0^\infty \int_0^m G(\tau) e^{-nt} dt \right] + D_0 - \int_0^m E[N(\tau) e^{-nt} dt | I_t] \right] + D_0/\left[ E\left[ \int_0^\infty y(\tau) e^{-nt} dt | I_t] \right] \right].
\]

(12)

Similar to Barro, but in a non-deterministic economy, assume the real government expenditure, \( G_t \), and the real tax base \( y_t \) are expected to fluctuate around trend values that grow at the common rate \( n \) so that the time paths \( G^*_t = G^*_0 e^{-nt} \) and \( y^*_t = y^*_0 e^{-nt} \). This implies that \( G^*_t \) and \( y^*_t \) have the same expected present values as the actual time paths \( G_t \) and \( y_t \). These assumptions, as mentioned by Barro (1986), rule out any drift in the ratio of the government expenditure and real GDP.\(^4\) Then the current normal values, \( G^*_0 \) and \( y^*_0 \), satisfy the conditions:

\(^4\) Over the long run, this drift would be subject to the bound \( 0 < G^*_t/y^*_t < 1 \).
\[ G^*_0 = (r-n) \int_0^\infty Ge^{-rt} \, dt | I_0 \] (13)  
\[ y^*_0 = (r-n) \int_0^\infty ye^{-rt} \, dt \, | I_0 \] (14)

I also assume the expected present value of the energy income is the current value of the energy income, i.e.,

\[ E N_t = E \int_0^m ENe^{-rt} \, dt \, | I_t \]. (15)

This means that the government and private agents expect the energy revenue to stay at the current level for the remaining life of the resources. Substituting (13), (14) and (15) in (12) yields:

\[ \tau = \frac{[G^*_t + (r-n) D_0 - (r-n) E N_t]}{y^*}. \] (16)

Equation (16) is similar to the stabilized average tax rate of Barro (1986), except that here we have an extra term which accounts for the (expected present value of) energy income. As this income goes up, the average tax rate will fall. For countries like Saudi Arabia or Kuwait where EN relative to \( y^* \) is large, \( \tau \) is equal to zero or negative (i.e., \( \tau \) is the average subsidy rate). Let \( S \) be the primary real surplus. Then, we can write

\[ S_t = \tau y_t + E N_t - G_t - r D_{t-1} = [G^*_t + (r-n) D_{t-1} - (r-n) E N_t] \frac{y_t}{y^*} + E N_t - G_t - r D_{t-1}. \] (17)

After rearranging terms this expression becomes:

\[ S_t = -n D_{t-1} - [G^*_t + (r-n) D_{t-1}] (1 - \frac{y_t}{y^*}) - (G_t - G^*_t) + E N_t [1 - (r-n) \frac{y_t}{y^*}] \]. (17)

For empirical purposes, let us divide both sides of (17) by GDP and then we can write

\[ S_t = - (G_t - G^*_t) - G^*_t (1 - \frac{y_t}{y^*}) - r D_{t-1} (1 - \frac{y_t}{y^*}) + n D_{t-1} (1 - \frac{y_t}{y^*}) - n D_{t-1} + E N_t [1 - (r-n) \frac{y_t}{y^*}]. \] (17)

\[ S_t = - (G_t - G^*_t) - G^*_t (1 - \frac{y_t}{y^*}) - r D_{t-1} (1 - \frac{y_t}{y^*}) + n D_{t-1} (1 - \frac{y_t}{y^*}) - n D_{t-1} + E N_t [1 - (r-n) \frac{y_t}{y^*}] \]
\[ s_t = \alpha_0 + \alpha_1 d_t + \alpha_2 YVAR_t + \alpha_3 GVAR_t + \alpha_4 ENERGY_t + \varepsilon_t, \]  

where \( s \) is the primary surplus, excluding interest payments, per GDP at the end of the period, \( d \) is the outstanding government debt per GDP (or \( y \)) at the beginning of the period, \( YVAR_t = (1 - y_t / y^*_t)(G_t / y_t) \), \( GVAR_t = (G_t - G^*_t) / y_t \), \( ENERGY_t = EN_t / y_t \) and \( \varepsilon \) is an error term. Following Barro (1986), I assume \( (r - n) D_{t-1} \) relative to the size of the government expenditure is empirically too small, which can be ignored. I also assume this is true for \( (r - n) y_t / y^*_t \). The temporary government spending is measured by \( (G_t - G^*_t) \) and the temporary shortfall of output is measured by \( (1 - y_t / y^*_t) \). Note that variables can be measured in either real or nominal terms since price cancels out in ratios.

Everything else being constant, considering equations (16) and (17), the outstanding real debt increases at the rate of \( n \), which is the trend growth rate of the economy. If debt did not grow (\( S \) did not fall) with the economy, interest payments would fall over time relative to GNP. This result would be inconsistent with stabilizing the average tax rate. Hence, as debt grows, from Equation (16), the optimum-welfare average tax rate (\( \tau \)) should increase which leads to a rise in revenues (surplus). Consequently, the sustainability of fiscal processes requires a positive relationship between primary surplus and the outstanding debt, i.e., \( \alpha_1 \) should be positive. To evaluate the sustainability of U.S. fiscal processes, Bohn (1998) also uses this relationship when \( EN_t \) is zero.

Everything else being equal, the coefficients of \( YVAR, GVAR \) and \( ENERGY \) reflect the behavior of the government in different situations. As for the coefficient of \( YVAR_t \), when \( y_t / y^* < 1 \), the output is below normal and tax revenues fall in proportion to the fall in output. Debt will rise (surplus will fall) implying \( \alpha_2 < 0 \). However, when tax

\[ = - (G_t - G^*_t) - [G^*_t + (r - n) D_{t-1}] (1 - y_t / y^*) - n D_{t-1} + EN_t [1 - (r - n) y_t / y^*]. \]
rates are stabilized over time, the coefficient of the countercyclical variable \( YVAR_t \) will be unity. Alternatively, if the government were to set relatively low tax rates during recessions, then it would have to increase tax rates during the expansion to respond to deficit, then \( \alpha_2 \) would be more than 1 in the absolute value term.

The coefficient of temporary abnormal government expenditure mostly depends on unusual cases, like wars or when the government has to increase expenditure above normal. The surplus will fall (or debt will increase) when \( G>G^* \) as Equation (17) indicates. In these cases, the government avoids increasing taxes to deal with the rise of debt. This means a negative unitary coefficient on \( GVAR_t \) variable in Equation (18) indicates that the government desires to equalize tax rates during war/unusual-time and peace/normal-time periods. If, alternatively, tax rates positively change with variable \( GVAR_t \), the coefficient on this variable would be less than one in the absolute value term, i.e., \( |\alpha_3|<1 \).

Again, other things being equal, as oil and gas revenue increases, surplus/debt will increase/fall if the government acts responsibly by using the income to reduce the debt and/or invest it for future generations. Consequently, \( \alpha_4 \geq 1 \) indicates a fully responsible fiscal policy. Note also that since we assumed \( y_t=f[e^{EN_i},Z_t] \) the tax revenue will also increase through a rise in GDP if energy revenue is used responsibly to create capital. Specifically, if the government considers energy revenues as a temporary income, invests them for future generations and only spends the return on that investment, then \( \alpha_4>1 \) since the revenue will also go up through the GDP-effect of energy income. The coefficient of \( \alpha_4 \leq 0 \) reflects that all energy revenue is allocated to government spending, implying an irresponsible policy. Furthermore, if \( \alpha_4<0 \), spending rises more than the
energy revenue in anticipation of future energy or tax revenues (a Ponzi game), implying an even more irresponsible policy.

III. Data and Sustainability Test Results

The model is tested for three developing countries: Egypt (1975Q1-2002Q4), Iran (1970-2003) and Turkey (1967-2001). The sample periods as well as the frequency of the observations for each country are chosen according to the availability of the data. The sources of data, unless specified, are the *International Financial Statistics* (IFS) online. Fiscal variables for Egypt were available on an annual basis, but since the number of observations were not sufficient for the regression, the quarterly observations were interpolated, using the statistical process developed by RATS. This procedure keeps the final value fixed within each full period. For Egypt and Turkey, CPI was used to make the variables in real terms as GDP deflator was not available for the entire period. For Iran, the GDP deflator was used.

Table 1 reports augmented Dickey-Fuller (ADF) and Phillips-Perron non-parametric (PP) test results as well as multicointegration test results for each country 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. I also used Zivot and Andrews’s (1992) unit-root test which allows for unknown breaks in intercept and slopes. The test results were consistent with those of ADF’s and PP’s, but for the sake of brevity these results are not reported, but 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 for any of these countries. Consequently, the conventional
A cointegration test between spending and revenues implied by Equation (19) should be sufficient for checking the sustainability of fiscal processes in these countries.

\[ G'_t = \beta_0 + \beta_1 R_t + z_t, \quad (19) \]

where \( \beta \)'s are coefficients and \( z_t \) is, as before, the error term.

Table 2 reports the results of these tests. However, it should be noted that, as it was shown by Gregory and Hansen (1996), the power of ADF test in rejecting the null of no cointegration will fall sharply in the presence of a regime shift. It is possible that the government changes its fiscal policy according to some circumstances, e.g., wars, recessions, etc. Consequently, I also reported in Table 2 Gregory and Hansen’s (1996) 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 break. If this statistics rejects the null 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, 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 of no cointegration. In this case, we need to test if the error term in Equation (20) or (21), below is stationary, where \( S_{zt} = \sum_{i=0}^{t} z_{t-i} \), \( z \) being the error term from Equation (19), \( \alpha \)'s and \( \delta \)'s are parameters and \( u_t \) and \( \varepsilon_t \) are the error terms.

\[ S_{zt} = \alpha_0 + \alpha_1 R_t + u_t, \quad (20) \]

\[ S_{zt} = \delta_0 + \delta_1 G'_t + \varepsilon_t, \quad (21) \]
(A) Egypt

According to the conventional ADF as well as ADF* test results for Egypt reported in Table 2, the government spending and revenues are cointegrated. The estimated long-run coefficient is less than one which indicates the relationship is characterized by persistently lower spending relative to revenues while spending and revenues share a long-run equilibrium relationship. However, according to ADF* statistic result, there might be a break in both slope and intercept in 1979Q4. According to the estimation result for period 1980Q1-2002Q4, both ADF and ADF* test results indicate that the cointegration relationship does not hold for this period, but the latter test result indicates a possibility of a break in 1985Q3. The estimated ADF and ADF* statistics for 1985Q4-2002Q4 also imply the lack of a long-run relationship for the last sub-period.

However, as it was shown, a long-run relationship between spending and revenues strongly exists for the whole sample period even when a possible break is considered, see the ADF* result for the entire sample. Note that the shorter sub-samples may not be long enough for ADF and ADF* to have sufficient power for testing the existence of long-run relationships. Furthermore, finding a strong relationship between these variables for the whole sample period indicates that the possibility of break is very weak; see also Gregory and Hansen (1996) for a correct interpretation of ADF* test result. Moreover, since the estimated coefficient of the revenues ($\beta$) is less than one, we can clearly conclude that the long-run relationship is characterized by persistently lower spending relative to revenues and that the fiscal budgeting process in Egypt is sustainable in only a non-stochastic environment.
We will, consequently, use the result for the whole sample period to analyze the error correction equations. However, as we will see, it is possible that some relevant policy regime changes in the country affect the short-run dynamics of the system during the sample period. Ignoring this fact, as it was done in this literature, may lead to an incorrect conclusion. To ensure the ECM is not misspecified and the result in Table 1 (the lack of multicointegration) is not due to structural breaks I also conducted Granger and Lee’s (1990) two-stage test. Specifically, I estimated, using OLS, equations (20) and (21). The result is reported in the last four rows of the first panel of Table 2 for Egypt. As we can see, both conventional ADF and ADF* reject the null of multicointegration.

During our sample period, there are some policy regime changes which clearly could influence the fiscal process in Egypt over the short run. Specifically, consider three major regime/institutional changes (see *The Middle East and North Africa*, 2004):

(i) A new sales tax of between 5% and 30% was introduced on most goods and services in May 1991. Dummy variable ‘price’ = 1 for 1991Q2, and = 0 otherwise, accounts for a jump in price for this fiscal policy change.

(ii) 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 price level in late 1994 and early 1995. Dummy variable ‘pricesub’ = 1 for the period 1994Q4 and 1995Q1, and = 0 otherwise, accounts for this policy regime change.

(iii) In July 1993, the government’s declared aim was to reduce Egypt's maximum import tariff from 80% (to which the maximum tariff had been

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6 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.
cut from 100% earlier in 1993) 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 from 20%-40% to 10%, and thirteen free-trade zones were approved. To account for this policy regime change, dummy variable ‘tariff’ was constructed. It is zero up to 1993Q1 and is equal to 0.25 in 1993Q2, increases linearly to 1 in 1996Q1 and remains 1 for the rest of the period.

Table 3 about here

Note that these policy regime changes can only affect the short-run process. I also included a dummy variable for a potential break in 1979Q1, which was found for the long-run coefficient. The estimated coefficient was not statistically significant and so it was dropped. Table 3 reports ECM for Egypt. According to the specification test results in the last row of the table the error is heteroskedastic in ARCH sense for the ECM of government spending and autocorrelated (at 5% level) for the ECM of government revenues. I, therefore, used Newey and West’s (1987) robusterror for 5-order moving average to correct standard errors for heteroskedasticity and autocorrelation. Other specification test results reported in the table suggest that the estimated equations are statistically adequate. According to Hansen’s stability L₁ and Lₐ test results, all of the coefficients, individually and jointly with the variance of the estimation, are stable.

The estimated coefficient of the error-correction term is negative for both the changes in spending and revenue, but it is only statistically significant for the 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. The estimated coefficient of the dummy variable tariff is not statistically significant for both spending and revenues, implying that the reduction in tariff did not change the short-run fiscal process in Egypt. The estimated coefficient of dummy variable pricesub is negative and statistically significant for both spending and revenues, indicating tariff reduction lowered the government revenues, but spending was also lowered even more, as the magnitude of the coefficient indicates. Interestingly, the estimated coefficient of the dummy variable price is negative for both models, but only statistically significant for spending. This finding implies that the introduction of new sales tax did not cause any increase in revenues for the government. This could be because demand for these goods are highly elastic and the jump in the price (as a result of an additional sales tax) resulted in a lower sale so that tax revenue was not affected. However, the government also reduced its spending based on perhaps estimating lower revenues. In sum, in this section, we found the fiscal process in Egypt is weakly sustainable and the short-run fiscal policy of tariff reduction was a responsible fiscal policy in the sense that government expenditure fell even more in reaction to the lower revenue.

(B) Iran

Since spending and revenues are not multicointegrated (see Table 1), the fiscal process in Iran is unsustainable in a stochastic environment. According to the conventional ADF as well as ADF* test results for Iran reported in Table 2, government spending and revenues are not cointegrated over the whole sample as well as sub-sample

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7 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.
periods. This result implies that the fiscal process in Iran, an energy producing country, is not sustainable in the sense that the government spending and revenues do not move together over the long run even in a non-stochastic environment. These fiscal variables can deviate from each other without any market force or government action to bring them back together. It should be noted that Iran has also witnessed several changes in policy regimes and undergone numerous exogenous shocks during the past two and a half decades. These changes include: the oil price shock in 1975, the revolution of April 1979, the first formal U.S. sanctions against Iran ordered by President Carter in April 1980, following the break in diplomatic relations between the two countries, and the Iraq-Iran war over the period 1980-1988.

These changes could easily affect both government revenues and spending in Iran. The results given in Table 2 clearly entail these shocks. The first break is in 1975 when the oil price shock brought a positive shock to revenues. The second break is associated with the revolution, U.S sanctions and the war of 1980-88 which happened all during the same period. To ensure the lack of cointegration is not due to these breaks, I followed Saikkonen and Lütkepohl’s (2000) two-stage test for cointegration. In the first stage, using a feasible generalized least-squares (GLS) approach, I adjusted the variables for the breaks. In the second stage, I used the adjusted series to obtain LR-type statistics developed by Saikkonen and Lütkepohl (1997) as well as Lütkepohl and Saikkonen (2000) to test the cointegration relationship between G’ and R.

For the first stage, I constructed and used the following dummy variables. Oil=1 for the period of 1974-1975 and zero, otherwise, San=1 since 1980 and=0, otherwise, War=1 for the period 1980-1988, and =0, otherwise. The dummy variables Oil, San and
War account, respectively, for the oil price shock, the U.S. sanctions and Iraq-Iran war. These three events clearly could affect both Iranian government expenditures and revenues. Table 4 reports the estimation results. As the stationary test results indicate, the adjusted series are homogeneous of degree 1. As both the result of $LR_{\text{Max}}$ and $LR_{\text{trace}}$ indicates there is a cointegration relationship between $G'$ and $R$, that is, $G' = 1.138 * R + 7.14$. This cointegrating relationship (the estimated $\beta$ being more than one) implies that although spending and revenues share a long-run relationship, that relationship is characterized by persistently higher spending relative to revenues which means deficits and the accumulation of the debt is the norm in the Iranian fiscal process. The evidence suggests that the Iranian fiscal policy is only weakly sustainable in a non-stochastic environment.

Table 4 about here

However, I could not find any significant ECM for using both adjusted and original data. While the error-correcting term was found to be negative in ECM for spending, the estimated coefficient was not statistically significant. The coefficient of the error-correcting term in ECM for revenues was found to be positive, but again not statistically significant. To ensure the ECMs are not misspecified, I also estimated both $LR_{\text{Max}}$ and $LR_{\text{trace}}$ for second stage of Granger and Lee (1990), i.e., Equation (21). None of the statistics was found to be significant and so the possibility of multicointegration is again, similar to the result in Table 1, ruled out. Furthermore, I constructed error correction terms for sub-periods 1970-80, 1981-87 and 1988-2002, which are associated with the breaks in the long-run relationship, reported in Table 2. Then I estimated both the ECM for spending and revenues by including these error-correction terms and found
again none of the error correction term to be statistically significant. This finding confirms the earlier result that no ECM exists for spending or revenues.\(^8\) Consequently, the earlier conclusion that the Iranian fiscal policy is only weakly sustainable in a non-stochastic environment may be misleading.

The above result is not, of course, surprising for an energy producing country like Iran and since, to the best of my knowledge, there is no study of this sort on fiscal sustainability of any energy producing country, the finding itself is a contribution to this literature. Specifically, finding a cointegration relationship between government spending and revenues (reported in Table 4) is due to the fact the transversality condition should be satisfied for such an economy since no agent can expect a publicly-owned oil producing country to fail in its debt. The country can simply sell its oil and pay the debt without resorting to printing money or imposing taxes.

Furthermore, spending and revenues move together, without causing each other, as the country sells oil to finance its expenditure in excess of its tax revenues. These two facts explain seemingly a cointegrating relationship between revenues and spending. The lack of an ECM is due to the fact that the oil price and world demand for oil determine most of the revenues of the country while spending is determined by the size of the government. In fact, these two fiscal variables in Iran are independent. Specifically, in estimating changes of real spending on its lagged value and a lagged value of changes in real revenue, a Wald test of 0.14 with \(p\)-value of 0.70 cannot reject that the changes in government spending cause the changes in spending. At the same time, a Wald test of 2.37 with \(p\)-value 0.13 also cannot reject the null hypothesis that changes in real revenues do not Granger cause changes in spending. Furthermore, a Wald test of 0.01 with \(p\)-value

\(^8\) For the sake of brevity, none of the above results are reported, but are available upon request.
of 0.93 cannot reject the null hypothesis that changes in real government spending do not Granger cause changes in real revenues and a Wald test of 0.60 with p-value of 0.54 also cannot reject the null hypothesis that changes in revenues are not affected by their lagged values. This evidence clearly indicates that government revenues and spending are independent from each other. In sum, from the above evidence, we cannot clearly conclude that the fiscal process in Iran is sustainable.

The above results were based on the assumption that Iran’s energy resources are expected to last forever or the Iranian government will be able to effectively diversify revenue and/or enormously cut expenditure when oil resources are exhausted. Under these somehow artificial assumptions, we could not find clear-cut evidence for or against sustainability of the fiscal process in Iran. I, therefore, will use the tax smoothing model (18), which is relevant for an energy producing country to further investigate the sustainability of the fiscal process in Iran. Moreover, with this model, I can investigate how responsible the government is in spending energy income.

For normal or trend GDP, i.e, $y^*$ [see Equation (18) and the definition of YVAR] and government expenditures, i.e. $G^*$ [see Equation (18) and the definition of GVAR], I used a 10-year moving average, as both of these series are available from 1960. The outstanding debt for Iran is not available. I, therefore, constructed this data. Furthermore, since the International Financial Statistics (IFS) provides data on the volume of oil and gas exports only in an index form, I took and constructed oil and gas revenues from

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9 The debt is calculated based on the following formula:
Debt_t = Debt_{t-1}[1 + (interest rate on debt)_{t-1}] + (government spending on goods and services and transfer payments)_t - (government revenues)_t - (change in monetary base).
I used ADF, PP and Zivot and Andrews’ (1992) unit tests to investigate the stationarity properties of the variables in Equation (18). All of these variables are homogeneous of degree one.\footnote{Data on the volume of Iranian oil and gas exports, in an index form, the world oil price in $US and the official Rial-$US exchange rate are taken from IFS. The data on oil and gas exports, in $US, since 1991, is taken from \textit{Economic Trends}, published by the Central Bank of Iran. The latter data was converted from the Iranian to the Gregorian calendar and was divided by the oil price to get the actual volume of exports for the 1991-2003 period. The resulting data as well as the index on the volume of exports were used to construct the volume of exports for the entire period. The data on oil price in Rials, using the official exchange rate and the world oil price in $US, was calculated. Then, using the actual volume of exports and the price, the data on oil and gas revenues was calculated.} Assuming variables $YVAR_t$, $GVAR_t$ and $ENERGY_t$ are weakly exogenous in Equation (18). I used Trace and $\lambda_{\text{max}}$ tests developed in Johansen and Juselius (1992) to check if variables $s_t$ and $d_t$, conditional on the weakly exogenous variables $YVAR_t$, $GVAR_t$ and $ENERGY_t$, are cointegrated. I used the Lagrange Multiplier (LM) testing procedure to ensure that the lag profiles used in the tests are sufficiently long to yield residuals which are not autocorrelated. I also adjusted the resulting test statistics to correct for potential finite-sample biases, Cheung and Lai (1993).

Table 5 reports the result of the $\lambda_{\text{max}}$ and Trace tests for a lag length of one year. According to diagnostic tests reported in the table, there is no autocorrelation and the error is normally distributed. Both $\lambda_{\text{max}}$ and Trace tests reject $r$ (cointegration rank)$=0$ at 5\% level and none of these test results can reject $r \leq 1$, implying that $r=1$. Consequently, we can conclude the primary surplus and debt, both per GDP, and conditional on the temporary shortfall of output ($YVAR$) and the temporary government spending ($GVAR$) as well as energy income per GDP ($ENERGY$), are cointegrated. The long-run

\footnote{The test results are not reported, but they are available upon request.}
relationship, normalized on the primary surplus per GDP, is given in Equation (22),
where \( p \)-value on \( \chi^2 \) test on the exclusion of each variable is given below each coefficient.

\[
s_t = - 0.07 - 0.63 d_t - 2.19 \text{YVAR}_t - 1.78 \text{GVAR}_t + 0.48 \text{ENERGY}_t \tag{22}
\]

\( \chi^2 \) (p-value) \( (0.14) \) \( (0.00) \) \( (0.00) \) \( (0.02) \) \( (0.01) \)

Except for the constant term, all estimated coefficients are statistically significant at a conventional level. The estimated coefficient of debt variable is negative (-0.63) and highly significant, implying that the optimum-welfare average tax rate will not increase as debt per GDP rises and so revenues (surplus) will fall. This result is an indication of an unsustainable fiscal process in Iran. An estimated negative and highly significant coefficient (-2.19<-1) for the cyclical variable YVAR indicates a strong counter-cyclical behavior of deficits in Iran. Specifically, the evidence suggests that, on average, the government sets relatively low tax rates during recessions and increases tax rates during the expansion to respond to deficit, i.e., a Keynesian prescription. This result contradicts the finding of Talvi and Vegh (2005) who claim that the fiscal policy in developing countries is highly procyclical although they did not include Iran in their study.

The estimated coefficient of temporary government abnormal expenditure GVAR is negative (-1.78<-1) and statistically significant only at more than 2% level. Furthermore, the estimated coefficient of more than unitary (in an absolute value term) reflects that the government does not desire to equalize tax rates during war/unusual-time and peace/normal-time periods. It actually reduces tax rates during war/unusual-time periods.

The estimated coefficient of variable ENERGY (oil and gas income per GDP) is positive (0.48) and statistically significant only at more than 1% level. A positive, but less than unit, and statistically significant coefficient for ENERGY indicates some, if not
all, of energy income is used for investment and debt reduction, a responsible, if not fully responsible fiscal policy. In sum, this section provides evidence that the fiscal policy in Iran is unsustainable, but the fiscal policy is partially responsible in terms of energy income.

(C) Turkey

According to the result given in Table 1, the fiscal process in Turkey is unsustainable in a stochastic environment. However, the conventional ADF test results for Turkey reported in Table 2 indicate that government spending and revenues are cointegrated over the whole sample period. Furthermore, as the result of ADF* statistics indicate, there are breaks in 1973 and 1986. Note that again, as it was found by Gregory and Hansen (1996), the power of ADF test in rejecting the null of no cointegration will fall sharply in the presence of a regime shift. Despite this fact, the conventional ADF test result rejects the null of no cointegration for Turkey. We can, therefore, conclude that government spending and revenues are cointegrated over the whole sample period. However, the estimated long-run coefficient $\beta$ is more than one implying that although spending and revenues share a long-run equilibrium relationship, that relationship is characterized by persistently higher spending relative to revenues. In other words, deficits and debt accumulation have been the norm in Turkey, but the fiscal process is weakly sustainable only in a non-stochastic environment.

As before, to ensure the ECM is not misspecified and the result in Table 1 (the lack of multicointegration) is not due to structural breaks, I also conducted Granger and Lee’s (1990) two-stage test. The result is reported in the last four rows of the third panel of Table 2 for Turkey. As we can see, both conventional ADF and ADF* reject the null
of multicointegration. Finding that the lack of multicointegration is not due to structural breaks, we should note that during the sample period there is a policy regime change which clearly could influence the fiscal process in Turkey over the short run. In 1984, the government introduced a value-added tax to replace the previous unwieldy system of production taxes. To incorporate the impact of this policy regime change, I constructed dummy variable $\text{vtax}=1$ since 1984 and $=0$, otherwise.

In the first round of the estimation of ECMs, I found the error-correction term was not statistically significant in any equation. This could be due to the structural breaks in the long-run relationship over the entire period. Note that we found a strong cointegrating relationship between our fiscal variables for Turkey as the conventional ADF (with its low power due to structural breaks) test result rejects the null of no-cointegration. But, we may need to consider three error-correction terms for our three sub-sample periods which were determined by ADF* test results. Table 6 reports the ECM for both changes in spending and revenues for Turkey. The specification test results reported in the table suggest that the estimated equations are statistically adequate. According to Hansen’s stability $L_1$ and $L_c$ tests results, all of the coefficients, individually and jointly with the variance of the estimation, are stable.

Table 6 about here

The variables EC67-73, EC74-86 and EC87-01 are error correction terms associated with the long-run relationship for periods 1967-73, 1974-86 and 1987-2001, respectively. The coefficient of all of these error terms is negative for the change in spending, but is statistically significant only for the 1974-86 period indicating that spending tends to adjust to divergences from the equilibrium relationship. This result is
consistent with Barro’s (1979) tax-smoothing argument and is confirmed by Telatur et al. (2004) who find the intention of the Turkish government for the sustainability of the fiscal process changed in the 1980-2004 period. As for the error correcting term for the change in revenues, none of the coefficient is statistically significant. Finally, the estimated coefficient of vtax is positive for both the change in government expenditure and revenues but is only statistically significant for the change in government expenditure. This implies that while revenues did not systematically respond to this policy regime change, government spending has been increased. The overall result of this policy regime change was a higher deficit and perhaps an accumulation of debt in the country. In sum, it was found, in this section, that the fiscal process in Turkey is weakly sustainable and deficit and debt accumulation have been the norm.

**IV. Implications and Conclusions**

In this article, a richer set of criteria under the more realistic assumption that the discount factor is variable through time for assessing the sustainability of fiscal budgeting practices is used. 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 this literature [i.e., Leachman et al. (2005)] that the multicointegration condition is more appropriate for the sustainability test of the fiscal policy as it implies that both the levels and rates of change of the series are tied together over the long run. I also developed and used a model which provides criteria for the sustainability of the fiscal policy in an energy producing country and for a responsible fiscal policy when exhaustible resources are involved. I then applied the sustainability criteria to the fiscal system of Iran.
As it is common in this literature, our results confirm that intertemporal budgeting strategies vary from country to country. None of the three countries exhibits the multicointegration of its system of fiscal variables. In Egypt, a long-run cointegrating relationship between spending and revenues exists. The result is consistent with the sustainability of fiscal budgeting, 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 tariff in 1993 resulted in lower government revenues, but spending was lowered even more. Moreover, the introduction of a new sales tax in 1991 did not cause any increase in revenue for the government. However, the government also reduced its spending based on perhaps estimating lower revenues.

In Iran, the fiscal budgeting process is unsustainable in both stochastic and non-stochastic environments. Furthermore, deficits and debt accumulation are the norm in the country’s fiscal processes and the policy response is inappropriate given the budget situation. The evidence in this article suggests that the government spending and revenues in Iran are independent. Furthermore, if these two fiscal variables move together, they do not cause each other.

In general, it was shown in this article that the government of Iran sets on average relatively low tax rates during recessions and increases tax rates during the expansion to respond to deficit. Furthermore, the government does not desire to equalize tax rates during war/unusual-time and peace/normal-time periods. It actually reduces tax rates during war time. It was found that the Iranian fiscal policy, as far as oil and gas income is
concerned, is a responsible policy in the sense that some, if not all, of the energy income is used for investment and the reduction of debt, but is not a fully responsible fiscal policy.

In Turkey, the fiscal budgeting process is unsustainable in a stochastic environment, but it is weakly sustainable as government spending and revenues are cointegrated. However, deficits and debt accumulation have been the norm in Turkey. The introduction of the value-added tax in 1984 resulted in a rise in revenues, but not significantly. However, the government spending in response to this policy regime change has been increased, implying the policy regime change generated a higher deficit and perhaps the accumulation of debt in Turkey.
References


Table 1: Unit Root Tests and Multicointegration

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF τ-Stat(k)</th>
<th>PP Z-Stat(k)</th>
<th>Multicointegration-Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stationarity Tests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Egypt</td>
<td>1975Q1-2002Q4: N=112</td>
<td>-22871</td>
<td>0.86</td>
</tr>
<tr>
<td>G'</td>
<td>-1.83 (1)</td>
<td>-1.62 (4)</td>
<td>-30750</td>
</tr>
<tr>
<td>R</td>
<td>-3.04a (4)</td>
<td>-1.07 (4)</td>
<td>315</td>
</tr>
<tr>
<td>ΔG'</td>
<td>-5.04a (4)</td>
<td>-7.32a (4)</td>
<td></td>
</tr>
<tr>
<td>ΔR</td>
<td>-3.51a (3)</td>
<td>-7.29a (4)</td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td>1970-2003: N=34</td>
<td>200.59</td>
<td>0.93</td>
</tr>
<tr>
<td>G'</td>
<td>-1.22 (0)</td>
<td>-1.72 (4)</td>
<td>940.32</td>
</tr>
<tr>
<td>R</td>
<td>-1.46 (0)</td>
<td>-1.92 (4)</td>
<td></td>
</tr>
<tr>
<td>ΔG'</td>
<td>-3.17b (0)</td>
<td>-3.24b (4)</td>
<td></td>
</tr>
<tr>
<td>ΔR</td>
<td>-4.01a (0)</td>
<td>-4.14a (4)</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>1967-2001: N=35</td>
<td>86018</td>
<td>1.43</td>
</tr>
<tr>
<td>G'</td>
<td>-2.36 (0)</td>
<td>3.47b (4)</td>
<td>85300</td>
</tr>
<tr>
<td>R</td>
<td>0.36 (0)</td>
<td>0.82 (4)</td>
<td></td>
</tr>
<tr>
<td>ΔG'</td>
<td>-5.38a (0)</td>
<td>-5.71a (4)</td>
<td></td>
</tr>
<tr>
<td>ΔR</td>
<td>-4.84a (1)</td>
<td>-7.41a (4)</td>
<td></td>
</tr>
</tbody>
</table>

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=112, is -2.88 at 5% and -3.46 at 1%], [for N=34 is -2.93 at 5% and -3.58 at 1%], and for Phillips-Perron non-parametric (PP) Z test (window size = 4) [for N=112, is -2.88 at 5% and -3.45 at 1%, [for N=34, is -2.95 at 5% and -3.63 at 1%].
3. Y_t = C_0 + C_1 X_t + C_2 ΔX_t + C_3 trend + C_4 (trend)^2 + e_t, where Y_t = \sum_{i=0}^{t} G'_{t-j} ~ I(2), and X_t = \sum_{i=0}^{t} R_{t-j} ~ I(2). The τ-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 ≥ 100 these values are: -4.26 for 5% and -4.85 for 1%, for N ≥ 25 they are -4.71 for 5% and -5.60 for 1%.
5. DW > 0.08 indicates a rejection of residuals to be I(1) at 95% level.
a=Significant at 1%.
b=Significant at 5%. 
<table>
<thead>
<tr>
<th>Country</th>
<th>Sample Period</th>
<th>$\beta_0$</th>
<th>$\beta_1$</th>
<th>DW</th>
<th>ADF$^2$ (k)</th>
<th>ADF*3(k)-Break</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>1975Q1-2002Q4</td>
<td>277</td>
<td>0.69</td>
<td>0.29</td>
<td>-4.58$^a$ (1)</td>
<td>-5.72$^a$(1) - 1979Q4</td>
</tr>
<tr>
<td>1980Q1-2002Q4</td>
<td>173</td>
<td>0.82</td>
<td>0.23</td>
<td>-2.80 (5)</td>
<td>-4.04 (3) - 1985Q3</td>
<td></td>
</tr>
<tr>
<td>1985Q4-2002Q4</td>
<td>175</td>
<td>0.81</td>
<td>0.18</td>
<td>-2.41 (5)</td>
<td>-4.00 (2) - 1986Q2</td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td>1970-2003</td>
<td>250.41</td>
<td>0.91</td>
<td>0.82</td>
<td>-2.69 (0)</td>
<td>-4.45 (0) - 1975</td>
</tr>
<tr>
<td>1976-2003</td>
<td>204.15</td>
<td>0.98</td>
<td>0.83</td>
<td>-2.63 (0)</td>
<td>-4.53 (0) - 1980</td>
<td></td>
</tr>
<tr>
<td>1981-2003</td>
<td>271.26</td>
<td>0.87</td>
<td>0.72</td>
<td>-2.57 (0)</td>
<td>-3.60 (0) - 1987</td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td>1967-2001</td>
<td>-25419</td>
<td>1.47</td>
<td>1.41</td>
<td>-3.87$^a$ (0)</td>
<td>-4.84 (0) - 1973</td>
</tr>
<tr>
<td>1974-2001</td>
<td>-42964</td>
<td>1.55</td>
<td>1.80</td>
<td>-4.51$^a$ (0)</td>
<td>-5.38$^a$ (0) - 1986</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1967-2001</td>
<td>62320</td>
<td>-0.45</td>
<td>0.36</td>
<td>-0.90 (0)</td>
<td>-3.56 (1) - 1978</td>
</tr>
<tr>
<td></td>
<td>50086</td>
<td>-0.28</td>
<td>0.47</td>
<td>-1.10(0)</td>
<td>-3.17 (0) - 1979</td>
<td></td>
</tr>
</tbody>
</table>

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

2. 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 $\tau$ test is -2.88 at 5% and -3.46 at 1%.

3. 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 -4.95 at 5% and -5.47 at 1%.

$a$=Significant at 1%.

$b$=Significant at 5%. 

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Table 3: Error Correction Model for Egypt\textsuperscript{1}

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>$\Delta G'$</th>
<th>Coef. (SE)\textsuperscript{2}</th>
<th>$L_1 (p)$</th>
<th>Coef. (SE)\textsuperscript{2}</th>
<th>$L_1 (p)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>2.78 (3.79)</td>
<td>1.00</td>
<td>3.54 (3.00)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>$\Delta R_{t-1}$</td>
<td>-0.33 (0.14)</td>
<td>1.00</td>
<td>0.41 (0.12)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>$\Delta G'_{t-1}$</td>
<td>0.60 (0.15)</td>
<td>1.00</td>
<td>-0.05 (0.10)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>$EC_{t-1}$</td>
<td>-0.27 (0.07)</td>
<td>1.00</td>
<td>-0.11 (0.06)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>tariff</td>
<td>0.71 (5.29)</td>
<td>1.00</td>
<td>-1.15 (5.17)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>pricesub</td>
<td>-47.02 (20.89)</td>
<td>1.00</td>
<td>-40.15 (7.11)</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>price</td>
<td>-15.74 (4.44)</td>
<td>0.06</td>
<td>-5.53 (5.10)</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>variance</td>
<td>-</td>
<td>0.02</td>
<td>-</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>joint-test $L_c$</td>
<td>-</td>
<td>0.17</td>
<td>-</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specification</th>
<th>$p$-value</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$</td>
<td>0.28</td>
<td>0.18</td>
</tr>
<tr>
<td>DW</td>
<td>2.05</td>
<td>2.00</td>
</tr>
<tr>
<td>Godfrey(5)</td>
<td>0.19</td>
<td>2.34</td>
</tr>
<tr>
<td>White</td>
<td>0.06</td>
<td>17.26</td>
</tr>
<tr>
<td>ARCH(5)</td>
<td>0.00</td>
<td>5.00</td>
</tr>
<tr>
<td>RESET</td>
<td>0.29</td>
<td>0.91</td>
</tr>
<tr>
<td>Normality</td>
<td>0.60</td>
<td>2.81</td>
</tr>
</tbody>
</table>

1. The sample period is 1975Q1-2002Q4. $\Delta$ 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: tariff is equal to zero up to 1993Q1, to 0.25 in 1993Q2, then increases linearly to 1 in 1996Q1 and remains 1 for the rest of the period; pricesub is equal to 1 from 1994Q4 to 1995Q1 and to zero, otherwise; price is equal to 1 in 1991Q2 and is zero 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, Normality is Jarque and Bera’s (1987) normality statistic, $L_1$ 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, where, using Newey and West’s (1987) robust error, standard errors are adjusted for heteroskedasticity.
### Table 4: Cointegration Tests for Two-Dimensional System (G', R) For Iran

<table>
<thead>
<tr>
<th>Adjusted Series</th>
<th>Stationarity Tests On Adjusted Series</th>
<th>Null</th>
<th>Actual Statistics</th>
<th>Critical values LR&lt;sub&gt;Max&lt;/sub&gt;</th>
<th>Critical values LR&lt;sub&gt;trace&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ADF&lt;sup&gt;τ&lt;/sup&gt;-Stat(k)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>PP&lt;sup&gt;Z&lt;/sup&gt;-Stat(k)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>H&lt;sub&gt;0&lt;/sub&gt;</td>
<td>LR&lt;sub&gt;Max&lt;/sub&gt;</td>
<td>LR&lt;sub&gt;trace&lt;/sub&gt;</td>
</tr>
<tr>
<td>G'&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-1.64(0)</td>
<td>-1.80(4)</td>
<td>r=0</td>
<td>23.73&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28.59&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>R</td>
<td>-2.17(0)</td>
<td>-2.24(4)</td>
<td>r=1</td>
<td>4.87&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.87</td>
</tr>
<tr>
<td>∆G'&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-3.62&lt;sup&gt;a&lt;/sup&gt; (0)</td>
<td>-3.43&lt;sup&gt;a&lt;/sup&gt; (4)</td>
<td>LM(1)&lt;sup&gt;a&lt;/sup&gt;=3.04, p-value=0.55</td>
<td>LM(4)&lt;sup&gt;a&lt;/sup&gt;=11.28, p-value=0.02</td>
<td></td>
</tr>
<tr>
<td>∆R</td>
<td>-4.27&lt;sup&gt;a&lt;/sup&gt; (0)</td>
<td>-4.16&lt;sup&gt;a&lt;/sup&gt; (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. r is the rank of cointegration.
2. From Table 1 of Saikkonen and Lütkepohl (1997).
3. From Table 1 of Lütkepohl and Saikkonen (2000).
4. LM(1) and LM(4) are one and four-order Lagrangian Multiplier test for autocorrelation, respectively [Godfrey (1978)].

a=Significant at 1%. For the critical value, see Table 1, Footnote 2.
b=Significant at 5%. For the critical value, see Table 1, Footnote 2.
Table 5*: Tests of the Cointegration Rank Between Primary Surplus per GDP and Debt per GDP for Iran

<table>
<thead>
<tr>
<th>$H_0=r$</th>
<th>$\lambda_{max}^1$</th>
<th>$\lambda_{max} 95^2$</th>
<th>Trace$^3$</th>
<th>Trace $95^4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>27.52</td>
<td>15.67</td>
<td>33.13</td>
<td>19.96</td>
</tr>
<tr>
<td>1</td>
<td>5.61</td>
<td>9.24</td>
<td>5.61</td>
<td>9.24</td>
</tr>
</tbody>
</table>

Diagnostic tests**:

- LM(1) $p$-value = 0.07
- LM(4) $p$-value = 0.86
- Normality $p$-value = 0.84

1. $\lambda_{max}$ has been adjusted to correct a possible small sample bias error. Namely, $\lambda_{max}$ has been multiplied by the small sample correction factor $(N - kp)/N$, where $N$ is the number of observations, $k$ is the number of lag lengths and $p$ is the number of endogenous variables, see Cheung and Lai (1993). Consequently, $\lambda_{max} = -(N - kp) \ln(1 - \lambda_w)$.
2. The source is Osterwald-Lenum (1992), Table 2, p. 469.
3. Trace has been multiplied by the small sample correction factor $(N - kp)/N$, see Cheung and Lai (1993).

Consequently, Trace test $= -(N - kp) \sum_{i=r+1}^{p} \ln(1 - \lambda_i)$. Both Trace and $\lambda_{max}$ tests were developed in Johansen and Juselius (1991).
4. The source is Osterwald-Lenum (1992), Table 1, p. 467.

* The model includes constant and the lag length is 1.

** LM(1) and LM(4) are one and four-order Lagrangian Multiplier test for autocorrelation, respectively [Godfrey (1988)].
Table 6: Error Correction Model for Turkey

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>$\Delta G'$</th>
<th>$\Delta R$</th>
</tr>
</thead>
<tbody>
<tr>
<td>constant</td>
<td>Coef. (SE)²</td>
<td>L₁ (p)</td>
</tr>
<tr>
<td>constant</td>
<td>4731 (7355)</td>
<td>1.00</td>
</tr>
<tr>
<td>$\Delta R_{t-1}$</td>
<td>-0.51 (0.37)</td>
<td>1.00</td>
</tr>
<tr>
<td>$\Delta G'_{t-1}$</td>
<td>0.21 (0.32)</td>
<td>1.00</td>
</tr>
<tr>
<td>EC67-73</td>
<td>-1.12 (13.02)</td>
<td>1.00</td>
</tr>
<tr>
<td>EC74-86</td>
<td>-1.22 (0.51)</td>
<td>1.00</td>
</tr>
<tr>
<td>EC87-01</td>
<td>-0.73 (0.46)</td>
<td>1.00</td>
</tr>
<tr>
<td>vtax</td>
<td>23358 (10754)</td>
<td>0.14</td>
</tr>
<tr>
<td>variance</td>
<td>-</td>
<td>0.18</td>
</tr>
<tr>
<td>joint-test Lc</td>
<td>-</td>
<td>1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specification</th>
<th>p-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{R}²$</td>
<td>0.13</td>
<td>0.05</td>
</tr>
<tr>
<td>DW</td>
<td>2.07</td>
<td>-</td>
</tr>
<tr>
<td>Godfrey(5)</td>
<td>0.93</td>
<td>0.49</td>
</tr>
<tr>
<td>White</td>
<td>19.58</td>
<td>0.84</td>
</tr>
<tr>
<td>ARCH(5)</td>
<td>4.38</td>
<td>0.49</td>
</tr>
<tr>
<td>RESET</td>
<td>0.13</td>
<td>0.93</td>
</tr>
<tr>
<td>Normality</td>
<td>0.76</td>
<td>0.68</td>
</tr>
</tbody>
</table>

1. The sample period is 1967-2001. $\Delta$ means the first difference, $G'$ is real government spending, including interest payments, $R$ is real government revenues. EC67-73, EC74-86 and EC87-01 are the error-correction terms generated from the long-run relationship for periods 1967-73, 1974-86 and 1987-2001, respectively. Dummy variable vtax is equal to 1 since 1984 and to zero, otherwise. White is White’s (1980) general test for heteroskedasticity, ARCH is the five-order Engle’s (1982) test, Godfrey is the five-order Godfrey’s (1978) test, REST is Ramsey’s (1969) misspecification test, Normality is Jarque and Bera’s (1987) normality statistic, L₁ is Hansen’s (1992) stability test for the null hypothesis that the estimated coefficient or variance of the error term is constant and Lc 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 OLS.