**IMF Working Paper**





WP/98/26

INTERNATIONAL MONETARY FUND

Fiscal Affairs Department

# Fiscal Sustainability with Non-Renewable Resources[1]

Prepared by Nigel Chalk

Authorized for distribution by Richard Hemming

March 1998

**Abstract**

This paper assesses sustainable fiscal behavior in an economy where wealth is derived predominantly from a non-renewable resource. It explores the issue in a simple dynamic framework that highlights the structural weaknesses in the underlying budgetary position, takes into account the rate of depletion of a country's natural resource base, and examines the impact of changes in a country's terms of trade. An alternative indicator of fiscal sustainability is derived, and the principal factors determining sustainability are identified. The results of the analysis are applied to Venezuela and Kuwait.

**JEL Classification Numbers**: C62, E62, H6, H30.

**Keywords**: Fiscal sustainability, non-renewable resource, oil producers.

**Author's E-Mail Address**: nchalk@imf.org

---

[1]Thanks are due to Richard Hemming, Zubair Iqbal, George Kopits, and Steven Symansky for their helpful comments on this paper.

**CONTENTS** **Page**

## CONTENTS

**Page**

Charts

**SUMMARY**

This paper assesses sustainable fiscal behavior in an economy where wealth is derived predominantly from a non-renewable resource endowment. It explores the issue in a simple dynamic framework that highlights the structural weaknesses in the underlying budgetary position, takes into account the rate of depletion of a country's natural resource base, and examines the impact of changes in a country's terms of trade. An alternative indicator of fiscal sustainability is derived, and the principal factors determining sustainability are identified. The model highlights the "core" deficit—defined as the overall deficit less net transfers and oil and investment income—as being an appropriate indicator of fiscal stance. A higher core deficit leads a country further away from long-run sustainability. The results of the paper also indicate that the behavior of a country's terms of trade is an important consideration for the conduct of fiscal policy. For a country with an improving terms of trade, a large resource endowment can act as a substitute for fundamental fiscal reform with overspending financed by returns from the appreciating resource endowment. However, such policies may be disastrous if fortunes change and the relative price of the country's resource begins to decline.

The paper suggests that the conventional summary indicators of fiscal health—the deficit-to-GDP ratio—may not be a reliable guide to the underlying policy stance when the budget is strongly influenced by natural resource income subject to exogenous world price volatility. In particular, the structure of the budget, rather than merely the bottom line, has important implications for sustainability. The model also demonstrates that to provide for future generations, governments that exploit their natural resources need to have a strong commitment to replace their non-renewable resource wealth with financial assets.

# I. Introduction

This paper seeks to answer the question "what constitutes sustainable fiscal policy in an economy where wealth is derived predominantly from a non-renewable resource?" In particular, the focus is on oil-producing countries. This issue requires an examination of fiscal policies in an explicitly dynamic framework because the current fiscal stance imposes constraints on future fiscal policies. For example, an oil producer's fiscal position, as typically measured by the ratio of overall deficit to GDP, can look quite sustainable either fortuitously, because of a temporary rise in the oil price or, if unconstrained by OPEC quotas, because of a deliberate increase in production. However, higher production has consequences beyond the current period since it speeds the depletion of the resource which in turn places greater constraints on future fiscal decisions. In such an economy, conventional fiscal indicators can be deceptive in describing the sustainability of the underlying fiscal position, particularly in the face of volatile world commodity prices.

The aim of this paper is to assess "sustainability" using a simple dynamic framework that explicitly incorporates a non-renewable resource. This approach leads to an alternative measure of the fiscal position, which we call the "core deficit." This measure is affected less by changes in resource revenue and also highlights structural weaknesses in the underlying budgetary position. The paper describes the type of fiscal policies that can be carried out in the long run. In addition, it examines the implications for fiscal policies of developments in the country's terms of trade. In some cases, a country endowed with a non-renewable resource may be able to permanently run core deficits without an explosive accumulation of public debt. The paper identifies the principal factors that determine the sustainability of these deficits which include, among others, the proportion of entitlements and net transfers in the budget, the net asset or liability position of the economy, the economy's endowments of natural resources, the rate of population growth, and the rate of return on assets.

It should be stated at the outset that in capturing the dynamic nature of the problem, the paper is forced to simplify and abstract to obtain a manageable framework for analysis. However, this effort is intended as a step toward assessing the fiscal situation in countries with non-renewable resources for eventual extension to capture additional salient economic features which are omitted here. It should be emphasized that the paper is concerned primarily with the long-run *feasibility* of a particular fiscal program and not with its optimality from a welfare perspective. A government's decision-making process is extremely complicated. One approach may be to assume that the fiscal authority aims to optimize aggregate welfare–however it may be defined–using a variety of tools. These tools include, in the case of a resource economy, the rate of extraction, whether the resource income should be absorbed or saved, whether that absorption should be through government consumption, investment or transfers, and whether spending should be on physical capital, human capital, social capital, industrial projects to diversify the economy, or other uses. For example, a permanent income approach would lead the government to save oil revenues in a boom and spend them in the future when the market turns down. Gelb [5] takes such an approach and in simulations suggests that, optimally, around 70 percent of oil windfall receipts should be saved.

Rather than investigate these decisions[1], this paper instead looks at whether a constant fiscal policy–either resulting from an attempt to optimize welfare or perhaps from rent-seeking behavior–is sustainable in the long-term or whether it will lead to an accumulation of fiscal liabilities that will force an eventual change in policy. Sustainability is taken as meaning "can a given policy continue indefinitely?" It should be noted that such a definition of sustainability constitutes a necessary, although not sufficient, condition for optimality.

## II. Sustainability Indicators and Tests

There is an extensive literature focusing on both conceptual and empirical issues in appropriately assessing the sustainability of a particular country's fiscal policies. For the most part, the literature has assessed fiscal sustainability by asking whether fiscal policy leads to budget balance in present-value terms or results in an explosive debt accumulation. This long-run solvency criterion is viewed as the main constraint faced by the public sector in running a sustainable program. In particular, it implies that the current public debt must be offset by the net present value of future public surpluses. Ponzi games are not possible and the government is forced to obey a transversality condition in the limit. Algebraically this implies that,

$$B_{t+1} = \sum_{j=0}^{\infty} R(t, t+j)^{-1} D_{t+j} \tag{1}$$

where $B_t$ is the stock of government debt, $R(t, t+j)^{-1}$ is the discount factor between period $t$ and $t+j$, and $D_t$ is the level of the primary surplus. It becomes an empirical question then as to whether a given country can be reasonably expected, ex ante, to satisfy the present value budget constraint or whether it will violate long-run solvency forcing either monetization, repudiation, rescheduling, or a change in the underlying fiscal stance.

By taking the present-value budget constraint to be synonymous with sustainability, most authors have attempted to construct indicators that highlight inconsistencies between current policies and the medium or long-term continuance of such policies. Buiter [3] uses the permanent adjustment necessary to maintain the ratio of public sector net worth to output at its current level as an indicator of sustainability. The larger the necessary

[1] Gelb [5] provides some insight into what are the factors driving these decisions in several countries.

adjustment, the further a given set of policies are from sustainable policies. Blanchard [2] takes a similar approach by calculating the deficit or surplus necessary to maintain the current debt-output ratio (rather than the government net worth). The "primary gap," which is the difference between the deficit needed to maintain a constant debt-output ratio and the prevailing deficit, measures the degree to which current policies differ from those necessary to stabilize the debt-output ratio in the long run. Blanchard [2] also looks at the necessary adjustment in taxes, given a projected path of expenditures, to stabilize the debt-output ratio in the medium term. The "tax gap" is calculated as the difference between the current tax ratio and that necessary to stabilize the debt stock. All three indicators, as outlined in Horne [7], attempt to measure *how far* current policies are from those that would satisfy the present-value budget constraint.

An alternative approach has been to examine the constraints the no-Ponzi game criterion places on the time series properties of fiscal variables. In particular, Hamilton and Flavin [6] test for the stationarity of the stock of debt in the United States as an implication of policies that satisfy the present value budget constraint. Trehan and Walsh [17] suggest that the transversality condition imposes a long-run cointegrating relationship on the behavior of the debt and primary deficit and test for such a relation. Wilcox [18] argues that the present-value budget constraint implies that the discounted value of the debt, $R(t, t+j)^{-1}B_{t+j}$, should be stationary and have an unconditional mean of zero and tests these constraints for the case of the United States. Kremers [14], by adding a further constraint on the ability to tax income, derives stationarity in the behavior of the debt-output ratio as a precondition for sustainability.

These approaches, while yielding useful information on the long-term viability of a particular fiscal stance, have some shortcomings. First, the tests on the time series properties of the debt and deficit, and the calculation of the fiscal indicators depend critically on the assumptions on either the interest rate, the growth rate, or both. In addition, the above empirical exercises can impose large information requirements--particularly on the stock of government assets and liabilities--which can be met in only a few nonindustrial countries.

Second, the indicators are usually presented as a ratio to GDP. In a country that is dependent on natural resource income, this can be quite misleading when GDP fluctuates widely from year to year. In an oil-producing country, for example, a temporary surge in world oil prices can make the country appear significantly closer to sustainability (by reducing the deficit-GDP ratio) without any change in the policy stance (or indeed even in cases where the underlying fiscal position is actually loosened).

Third, there is a more fundamental question as to whether the prerequisite of intertemporal budget balance is in fact a necessary condition for sustainability in the case of a country with a large natural resource. In particular, if the value of the resource wealth of a country is appreciating over time, it could indefinitely run a deficit equal to that appreciation without depleting its resources. Such a permanent primary deficit is not permitted, however, by the present-value budget constraint. This has led some to recommend that government assets and liabilities should be defined more widely to include natural resource endowments (see Liuksila et al. [15]), but this would require valuing a stock of proven reserves in the face of uncertain future prices.

# III. A Theoretical Framework

This section outlines an overlapping generations model of a country endowed with exhaustible resources which are being depleted over time. The model abstracts from the productive sector and assumes all national income is obtained either from returns to invested assets or from the sale of a natural resource. The government is assumed to own the resource which it then sells and uses a portion of the proceeds to make net transfers to the population. The government and private sectors are also endowed with a stock of financial assets (or liabilities).

## Consumers

Consumers are assumed to live two periods and to receive an income solely from government transfers $\tau_t$ when young.[2] In each period there are two generations alive, the young and the old. Population is assumed to grow at a rate $(1+n)$ and all the variables of the model described below are expressed in per capita terms. The consumer problem is

$$\begin{aligned} \max_{\{c_t(t), c_t(t+1)\}} \quad & u\left(c_t(t)\right) + \beta u\left(c_t(t+1)\right) \\ s.t. \quad & c_t(t) + z_t(t) = \tau_t \\ & c_t(t+1) = R_{t+1} z_t(t) \end{aligned} \tag{2}$$

where $c_t(t)$ represents consumption when young, $c_t(t+1)$ is consumption when old, $z_t(t)$ represents the savings of the young and $R_{t+1}$ is the rate of return on assets. Assuming a simple logarithmic utility function, the solution to the consumer problem is to save a constant fraction ($\phi = \frac{\beta}{1+\beta}$) of income received when young, i.e.

$$z_t(t) = \phi \tau_t \,. \tag{3}$$

[2] The model could be modified to allow for transfers to accrue to the old also but this would complicate the analysis and does not materially affect the results.

## Resource use and technology

The country is initially endowed with a per capita resource stock $s_0$ and the stock is depleted by per capita production $y_t$. The dynamic behavior of the real per capita resource stock is described by

$$(1+n)s_{t+1} = s_t - y_t \quad s_0 \text{ fixed, and } s_{t+j} > 0 \,. \tag{4}$$

Let $p_t$ represent the relative price of the resource in terms of consumption goods; as such it can be viewed as proxying the terms of trade a country faces. For simplicity, let us assume that the relative price of the resource evolves according to

$$p_{t+1} = \delta p_t \,. \tag{5}$$

If $\delta < 1$ this implies a deteriorating terms of trade whereby the resource the country possesses is worth less over time relative to the bundle of goods it consumes. Similarly $\delta > 1$ represents an improving terms of trade.

Letting $S_t = p_t s_t$ be the value of the resource in terms of consumption goods, we can rewrite (4) as[3]

$$(1+n)S_{t+1} = \delta S_t - \delta p_t y_t \,. \tag{6}$$

The country is also able to accumulate financial assets; such assets ($a_t$ in per capita terms) receive a gross return $R_t$. One can view this as a small country assumption where the rate of return on assets is exogenous. Aside from the natural resource, there are no other forms of domestic production. One could introduce a productive capital stock but it is ignored here for analytical convenience.

## The government

The government owns the natural resource and derives revenue from its sale. In addition, the government receives investment income from its asset holdings ($a_t^g$) while paying interest ($R_t$) on its debt ($b_t$). It is assumed that the government has access to the same foreign assets as private consumers and receives a return $R_t$. In addition, the government receives revenue from non-oil sources such as direct and indirect taxes. The government spends a portion of the oil and investment revenue on net transfers to consumers and runs a "core" deficit of $g_t$. The core deficit is defined as total government spending less transfers to individuals and revenue from sources other than oil and investment income. For simplicity, it is assumed that (i) government spending represents consumption expenditure and (ii) net transfers to the private sector are an exogenous proportion $\lambda_t$ of the total revenue from asset income and from the natural resource. Note that $\lambda_t$ is exogenous but *not* necessarily constant.

[3] See Appendix I for derivation of the model that follows.

These last two assumptions require some explanation. One could imagine the government using oil revenues to spend on investment goods and, as Gelb [5] points out, this was often the case in the oil-producing countries. Such investment could, in turn, increase future output, generate non-oil revenue, and perhaps reduce future deficits. This link between government spending and economic activity is not captured here. However, one could argue that the historical experience with such resource-financed investment has not shown a positive link from government investment to non-oil growth. Both Murphy [16] and Auty [1] conclude that, in general, the return on public investment projects in oil-producing countries has been generally quite poor and in some cases that there has even been negative value added. The second assumption of an exogenous share of transfers to income ($\lambda_t$) certainly does not reflect the historical experience in many oil producing countries. In fact, as will be shown below for the cases of Venezuela and Kuwait, the level of transfers in many oil-producing countries does not appear to be a constant fraction of income and is determined by a combination of political and economic factors. During oil booms, there is typically an increase in transfers as the public is allowed to "share the wealth." However, the political climate during the downturns makes it difficult for the authorities to cut social programs and subsidies. This "ratchet" effect–of an increase of the ratio in booms and a failure to reduce it in slumps–is well-documented in the literature. However, to provide behavioral explanations for this ratio would add significantly to the complexity of the model described here. As a result, the determination of $\lambda_t$ is regarded as an exogenous process.

Letting $Q_t = a_t^g - b_t$ be the net asset (or liability, if negative) position of the government in per capita terms, the government budget constraint can be written as

$$(1+n)Q_{t+1} = Q_t - g_t + (1-\lambda_t)\left(r_t Q_t + p_t y_t\right) . \tag{7}$$

The interpretation of this equation is straightforward. The net assets of the government increase with the government share $(1-\lambda_t)$ of income from the natural resource $(p_t y_y)$ and from net assets $(r_t Q_t)$, while the net asset position falls with a higher core deficit $(g_t)$.

## Equilibrium

The simple model of the economy can thus be summarized by three equations:

*Capital market*

In equilibrium, private savings are either held in the form of government debt $(b_t)$ or privately held investment in foreign assets $(a_t^p)$. Letting the total amount of financial assets held by the economy as a whole be $a_t = a_t^g + a_t^p$, the capital market clearing equation can be rewritten as,

$$\phi\lambda_t\left(p_t y_t + r_t Q_t\right) = (1+n)\left(a_{t+1} - Q_{t+1}\right) . \tag{8}$$

*Government sector*

Here we reiterate the evolution of the government net asset position,

$$(1+n)Q_{t+1} = Q_t - g_t + (1-\lambda_t)(p_t y_t + r_t Q_t). \tag{9}$$

*Resource constraint*

The evolution of the stock of resource is given by

$$(1+n)S_{t+1} = \delta S_t - \delta p_t y_t. \tag{10}$$

As yet we have not specified the dynamic behavior of $a_t$ or $\lambda_t$. As discussed above, for simplicity, we assume that $\lambda_t$ is an exogenous process although it would be interesting to model this process or assume an exogenous dynamic process that mimics the "ratchet" effect of transfers in the budget. Also, to reduce the dimensionality of the problem at hand, we assume that $a_t$ remains constant over time. The conceptual question asked here therefore is how large a deficit can the government have without diminishing the economy's net asset position.[4] An alternative would be to augment the model with an additional dynamic equation which would specify the process either for the depletion of the natural resource or for the accumulation of assets, perhaps based upon a permanent income or intertemporal consumption smoothing relation. For example, Liuksila et al. [15] assume that the level of extraction grows a constant rate over time until the resource is depleted while Zee [19] explicitly assumes an objective function for the government. In this paper, however, the aim is to place few restrictions on the structure of the economy in order to focus on the types of fiscal programs one should consider sustainable. In examining the implications of the model, it should be remembered that the results are conditioned on the presumption that the net asset position of the economy is kept constant.

# IV. The Fiscal Sustainability of Budget Deficits

## Case I: A deteriorating terms of trade

By drawing on the description of the economy that has been outlined above, it is now possible to determine what constitutes sustainable fiscal policy. The first case proceeds

[4] One could also imagine a stronger requirement related to the size of the deficit that is consistent with a stock of financial assets that is increasing over time at a particular rate (which might be an important consideration for an economy facing a finite stock of resource and which is trying to accumulate assets for future generations).

under the assumption that the economy faces a deteriorating terms of trade whereby the resource endowment is worth less over time in terms of the consumption good. Algebraically, this implies that $\delta < 1$ but the analysis follows even if the terms of trade are improving but do so at a rate less than population growth $(1 + n)$.

From (8), (9), and (10) one can derive a graphical representation of the simple economy described above.[5] In Figure 1, the lines which represent $\Delta S_t = 0$ and $\Delta Q_t = 0$ have a point of intersection such that, from some initial stock of resource and a given public net asset position, the economy will tend to a steady state in which the government maintains a positive net asset position and remains solvent without depleting the country's natural resource wealth. This can be described as the *sustainable case.* For example, a country in position A, in Figure 1, is initially endowed with a large stock of resources while the government has a relatively low endowment of financial assets. Over time, the economy depletes its per capita natural resource base while at the same time the government, with its sustainable fiscal position, accumulates financial assets. In steady state, the economy no longer relies on its natural resource wealth but rather the prudent fiscal policies allow it to consume from the income it receives from its stock of financial assets. By converting the non-renewable assets into interest-bearing financial assets, the economy can sustainably avoid the problems of exhausting its assets and debt accumulation.

By contrast, in Figure 2 the system no longer exhibits stable behavior around a steady state. From any initial stock of government asset and natural resource, the economy eventually exhausts its resources. Once the resource base is exhausted ($S_t = 0$), the government's net asset position falls over time and liabilities are incurred to cover the fiscal shortfall. This can be characterized as the *unsustainable case.* Take country A discussed in the previous paragraph which, as before, begins to deplete its non-renewable assets. In the sustainable case, the government placed greater reliance on its stock of financial assets to cover its expenditure needs in the long term but, in this unsustainable case, the government continues to rely heavily on the sale of its natural endowments. Eventually, the high expenditure demands lead to a depletion of the natural resource base while low government savings result in an inadequate stock of financial assets to finance public expenditures. Once the resource endowment is exhausted, the high fiscal deficit must be financed by consuming the government's stock of financial assets and eventually by increasing its level of indebtedness to unsustainable levels.

What distinguishes the two possibilities is that the intercept for the $\Delta S_t = 0$ locus lies below that for the $\Delta Q_t = 0$ locus in Figure 1 while the opposite is true for Figure 2. Algebraically, as explained in the appendix, for the fiscal policy to be considered sustainable this implies that

---

[5] See Appendix I for details.

$$g_t \leq \frac{(1-\lambda_t)r_t - n}{1 + \frac{\phi\lambda_t r_t}{1+n}} a_{t+1} \,. \qquad (11)$$

If the core deficit is sufficiently small as in Figure 1 (i.e., smaller than the return on assets adjusted for the size of government transfers to the private sector, the rate of population growth, and for the savings behavior of the private sector), then fiscal policy can be maintained indefinitely. Note that if this condition holds, even if the resource is depleted, then the net asset position of the government will be increasing over time since the return on government assets will outweigh the size of the core deficit.

On the other hand, if the country is running a relatively large core deficit, as in Figure 2, the condition in (11) is violated and a steady state path no longer exists. The loose fiscal stance leads to a depletion of the natural resource with insufficient offsetting investment in financial assets. Once the natural resource is depleted in this *unsustainable case*, the net asset position of the government falls over time and eventually the economy will encounter large public sector liabilities and a rising debt burden. Inevitably the fiscal position becomes untenable and policies must be changed to restore the economy to a sustainable fiscal program.

The simple model described yields two distinct cases (summarized by Figures 1 and 2) and leads to a precise criterion that discriminates between sustainable policies–which lead to a steady state accumulation of government assets–and unsustainable policies–that eventually erode public asset holdings and lead to a spiraling public indebtedness. That criterion states that governments can run deficits no larger than the return on it's asset holdings after adjusting for transfers to the private consumer and for the growth in the population.

Some comparative statics of the condition for sustainability (11) are perhaps useful. As outlined above, one aspect of the model is that a worsening of the core deficit is synonymous with less sustainable policies. An increase in this deficit might be a reflection of either an increase in spending by the government or a fall in non-oil, non-investment income revenue. A second feature of the model is that a lower return on externally held assets reduces the size of the sustainable core deficit that a government can run.[6] In a similar way, an increase in the population growth rate also reduces the permissible size of the deficit. Finally, an increase in the proportion of net transfers from the government to the private sector lessens the likelihood that a given fiscal program will satisfy the criterion for sustainability. As $\lambda_t$ rises, the budget becomes structurally weaker with the state transferring to the private sector a larger portion of its claims on resources. By doing so, the state gets poorer and the private sector becomes richer. The government

[6] In the case of the country being a net debtor (i.e., $a_t < 0$) however, a lower rate of return implies a lower interest burden on the economy and thus represents less of a constraint on policy.

has less room for discretionary fiscal spending and is forced to run smaller core deficits or face accumulating liabilities.

## Case II: An improving terms of trade

The second case to consider is one in which the economy's terms of trade are improving at a rate faster than population growth. In the model, this is captured by growth in the value of the natural resource relative to that of the consumption good (i.e., that $\delta > 1 + n$). In this case, the slope of the $\Delta S_t = 0$ locus becomes negative. As before, there are two possibilities to consider.

Figure 3 describes the case where $g_t \leq \frac{(1-\lambda_t)r_t - n}{1+\frac{\phi\lambda_t r_t}{1+n}} a_{t+1}$. In this case, from *any* initial condition on the stock of resource and the size of government assets or liabilities, the economy becomes caught in a virtuous cycle whereby the value of the natural resource grows over time at a rate faster than the growth in population. The appreciation in the value of the resource, and the small demand for government deficit financing, leads the economic wealth of the society, in per capita terms, to increase over time. Such fiscal policies are clearly sustainable. The implication is that even countries with relatively small natural resource endowments but whose *value* is appreciating, can experience rising income levels by engaging in appropriately conservative fiscal policies. Take country A again. Initially, a high rate of depletion of the resource leads to a fall in the per capita value of the stock of natural resources. However, as the government accumulates assets and uses the return on those assets to finance its expenditure needs, the rate of depletion will fall and the value of the remaining resource wealth will grow over time.

On the other hand, if the government pursues a considerably looser policy stance such that (11) is violated, then the economy faces a quite different situation. In Figure 4 it can be seen that from *some* initial conditions the path of natural resource wealth takes off in much the same way as that of Figure 3. However, in other cases, given by the shaded region in Figure 4, the economy pursues a path of resource depletion which, if continued, will eventually lead to the exhaustion of the natural resource and an accelerating rise in government liabilities in much the same way as the unsustainable case pictured in Figure 2. The larger is the gap between actual deficits and the limit described by (11), the larger will be the shaded region in Figure 4, and the greater will be the proportion of initial conditions that are considered unsustainable.

To be more concrete, take two cases pictured in Figure 4. A country may be endowed with a relatively large stock of natural resources at position A. Despite a low level of government assets and a loose fiscal policy, the government is able to rely on the appreciation in the value of its resource to offset the costs of an overly large fiscal deficit. The economy is able to rely on its good fortune of being endowed with a large resource base (that is becoming more valuable over time) to cover its imprudent fiscal position.

In this sense one can see how, in a country with a large stock of natural wealth, periods where the terms of trade are improving can lead to a temptation to delay or forego fiscal retrenchment. The appreciation of the resource wealth in effect acts as a cushion and substitutes for the reforms necessary to achieve a sustainable fiscal position. A country endowed with fewer natural resources at position B, despite a higher level of government assets, is less fortunate. In such a case, the high fiscal deficit cannot be compensated for by the appreciation of a smaller stock of resource. As a result, the government is forced to deplete its foreign asset reserves in order to finance its fiscal shortfall. Despite the increasing value of the resource endowment, the underlying stock of wealth is depleted and government liabilities are accumulated that force an eventual change in fiscal stance. It is clear, however, that any country relying so precariously on an uncertain terms of trade to escape the consequences of its loose fiscal policies, can get into serious difficulty should relative prices turn against them. Gelb [5] has suggested the costs of governments' plans predicated on overoptimistic projections of oil prices may have been the downfall of many oil-producing developing countries.

It should be noted, in both the case of a declining and an improving terms of trade, the criteria for a fiscal program to be considered sustainable is the same (i.e. condition (11)). Figure 4 demonstrates, however, that the criterion does not represent a necessary condition for sustainability in the case where the country has a sufficiently large stock of natural resource and an improving terms of trade. Although the sustainability condition is the same in both cases, there are considerable differences in the *consequences* of either satisfying or violating this constraint. In the case of a deteriorating terms of trade, sustainable policies lead the economy to settle at a balanced growth path of income, asset accumulation, and per capita resources. Unsustainability, on the other hand, results in resource depletion and fiscal insolvency. With improving terms of trade, sustainability is evidenced by an increasing stock of national wealth and income while the outcome of violating the sustainability condition depends crucially on the size of the country's resource endowment.

It should be recalled that the analysis has looked at the set of policies that are sustainable given that the stock of foreign assets ($a_t$) remains stable over time. It is likely to be the case, in particular with a rising terms of trade, that in fact the economy will face a rising asset position and a fixed or even declining value of their resource stock ($S_t$) as the resource is exploited and converted into larger stocks of financial assets. The model could be modified to capture this feature by assuming an increasing path for $a_t$ and looking at the consequences for sustainability.

Of the two cases examined, neither fully captures reality. It is unlikely that a country will experience a perpetually deteriorating of improving terms of trade. Instead, countries may experience long periods where Case I is the more appropriate description of the economy and other times when Case II applies. For example, as Chart 1 demonstrates, for many of the oil producers there was an overall improvement in the terms of trade from 1970 to 1981 (Case I) after which the terms of trade either declined or remained stable (Case II) until recently (with the exception perhaps of the Gulf War period). However, as a conservative guide, whether in a period of rising or falling natural resource prices, adherence to the condition of a low core deficit represents both a prudent and sustainable policy prescription. A low level of transfers in the budget, a small core deficit, and a commitment by the government to replace natural resource wealth with externally invested financial assets will all contribute to sustainable development and a long-run improvement in domestic economic welfare.

# V. An Application to Oil Producers

The model described above has some clear implications for fiscal policy. It highlights a specific criterion for determining whether current policies can be continued indefinitely or whether they will lead to an exhaustion of the country's resource wealth and a rising accumulation of government liabilities. In addition, the model draws attention to the relevant features one should consider when assessing which policies are consistent with long-run equilibrium and which must be eventually reversed. First, as noted in previous studies, the relationship between the interest rate and the population growth rate is an important determinant of sustainability. A higher rate of population growth, by diluting the stock of assets and resources among more claimants, lowers the ability of the government to run deficits. Similarly, a lower return on externally held assets, by reducing both national and government income, constrains budgetary policies.[7] On a related point, in many growth models, higher economic growth can increase the likelihood a given fiscal policy will be considered sustainable. However, in a model of a resource-based economy, higher growth could imply faster resource depletion and may actually be an indication of unsustainable policies.

Second, the structural nature of the budget deficit has important implications for sustainability. A deficit predicated on generous net transfers to individuals–rather than resulting from a temporary shortfall in oil and investment income revenue–is less likely to be sustainable. Similarly, a fiscal authority that generates little non-oil revenue, and thus has a high core deficit, is more likely to exhaust its natural resource wealth and increase its net liability position.

An additional feature of the model is that the derived indicator of sustainability is influenced less by temporary moves in resource prices than other indicators. Expressing the model in per capita terms–rather than as a fraction of GDP–means that increases in spot prices do not immediately translate to a more sustainable position as would happen if one looked at the deficit-GDP ratio. Changes in oil prices obviously have an effect in the

[7] In the case of a country being a net debtor, the effects are reversed with higher population growth reducing the per capita level of indebtedness and lower returns reducing government interest expenditure and helping the budgetary position.

model. Higher revenue automatically reduces the ratio of transfers to revenue ($\lambda_t$). In addition, insofar as the revenue from these higher prices is saved, the stock of assets and level of investment income rise which both increases $a_t$ and further decreases $\lambda_t$. This effect, of a lower transfer ratio and a higher stock of assets, results in a more sustainable fiscal position.

This section applies the measurable indicators suggested by the model to the cases of Kuwait and Venezuela and reviews the historical experience in these countries. Tables 1 and 2 at the end of the section compare the parameters of the model and the experiences of both these countries.

## Kuwait

*Background*

Over the last 20 years, 96 percent of total government revenue in Kuwait has derived from oil or investment income. The government is seen as an employer of both first and last resort and offers generous social welfare support. Kuwait also has had in place a policy of setting aside 10 percent of oil revenues for the Reserve Fund for Future Generations in an attempt to convert oil resource wealth into holdings of external assets (which, it is hoped, will provide income when the oil resources are exhausted). Kuwait has vast per capita reserves of oil amounting to 96 billion barrels or 135 years at current production rates although it's population is growing at a rapid rate–around 5 percent per annum–which will dilute the amount of resources, in per capita terms, available in the future.[8]

*The level of transfers*

Chart 2 shows the ratio of transfers to oil and investment income revenue ($\lambda_t$ in the model) in Kuwait's budget. With the large oil income of the 1970s and early 1980s this level was relatively low (below 20 percent). The decline in oil prices during the 1980s led to ratcheting up of the ratio to around one-third in the period just before the Iraqi invasion. During 1990-91 the collapse in oil production and large transfer payments to individuals led to a significant, albeit temporary, increase in the ratio. Subsequent to Kuwait's liberation, however, the level of transfers in the budget, relative to oil and investment income, has not fallen to pre-invasion levels but instead has remained high, estimated at 60 percent in 1995. As the model demonstrates, this structural weakening of the budget has negative connotations for overall fiscal sustainability.

[8] For a summary of the current economic situation in Kuwait see Chalk et al. [4].

*The fiscal position*

Chart 3 shows the net difference between the core deficit and the level of the sustainable core deficit, as suggested by the model, for the case of Kuwait.[9] A negative position in the chart indicates that the actual core deficit is greater than that which could be considered sustainable. Despite a fiscal surplus from 1977 to the Iraqi invasion, the calculation based on the core deficit indicates that the authorities' fiscal position during this period was not sustainable. The budget was almost entirely financed by natural resource income with substantial capital expenditure. In other words, despite provisioning for the future by accumulating foreign assets, Kuwait did so by depleting its natural resource wealth at such a rate that, in the longer run, it would eventually have to change policy.

From 1977 to 1981 it could be argued, however, that, since Kuwait's terms of trade were improving, as shown in Chart 1, Kuwait could be regarded to be in the sustainable position of Country A in Figure 4. During that period, Kuwait's large core deficit–due to almost zero non-oil revenue and a high level of capital expenditure–was completely compensated by the rising market value of its large endowment of oil.

During the 1980s, however, Kuwait's terms of trade moved onto a downward trend with the overall deficit continuing to be predicated on high capital spending and insignificant non-oil revenue. The deficit remained larger than that which could be considered sustainable, although towards the end of the decade, the gap between actual and sustainable policies did close (largely due to a containment of capital spending). However, this retrenchment effort was still insufficient to put government finances onto a sustainable track. The dual effects of a fall in the relative value of oil and the high rate of physical depletion of Kuwait's resource base resulted in a situation similar to the unsustainable situation of Country A pictured in Figure 2.

These results contrast with the conclusion one might obtain from examination of the overall deficit as a fraction of GDP (from 1982-89 Kuwait registered an average surplus of 14 percent of GDP) because the criterion examined here does not focus solely on the government financial situation but also considers the rate of depletion of the country's resource base. In other words, in the face of a worsening terms of trade, asset accumulation in Kuwait from 1982 to 1989 did not keep pace with the rate of resource depletion. However, given it's vast resource base, Kuwait would likely be able to continue pursuing such policies for quite some time, even taking into account the production constraints imposed by OPEC quotas. This highlights one of the difficulties in this analysis in distinguishing between a policy that is sustainable in the long-run and one that must eventually be reversed, albeit after a considerable period of time. One could imagine Kuwait continuing these policies–identified as unsustainable–for a century before having to reverse them. Should such policies therefore be regarded as truly unsustainable?

[9] The basis for the calculations is explained in Appendix II.

In 1990-91 the situation in Kuwait took a dramatic turn for the worse with the fiscal position moving to a large deficit as a result of the halt in oil production during the invasion as well as the rise in transfers in its aftermath. After liberation, there was a sizable reduction in the country's foreign asset position with resources expended in reconstruction efforts. In addition, higher transfer payments to the private sector (both wage rises and welfare spending) worsened the structure of the budget. Indeed, the proportion of oil and investment income revenues spent on net transfers rose from 35 percent in 1989 to 75 percent in 1994 (and the conventional deficit to GDP ratio rose to an average of 12.5 percent of GDP from 1993 to 1995). The combination of these two effects–a reduction in $a_t$ and a rise in $\lambda_t$–resulted in a fall in the size of the sustainable core deficit which, combined with a rise in the actual core deficit, led to a widening gap between actual policies and those which could be considered sustainable (as illustrated by Chart 3).

In summary, despite large overall surpluses, the analysis presented here suggests the Kuwaiti government policies, in the face of a worsening terms of trade, were causing unsustainable resource depletion during the 1980s which was not offset by a sufficiently rapid accumulation of foreign assets. Following the liberation, a rising level of transfers and a growing core deficit have moved Kuwait even further from sustainable policies. The ratchet effect in government spending, especially on entitlements, as indicated by the ratio of transfers to income, will be an important challenge for the fiscal authorities to reverse in moving Kuwait's fiscal position towards sustainability.

## Venezuela

*Background*

Venezuela, unlike Kuwait, has a more diversified economy with the oil sector accounting for 20 percent of GDP and 50 percent of government revenue in 1994. Revenue from oil and from net investment income accounted for 6 percent of GDP in 1994 (with the latter being negative due to the net debtor position of the government). Although Venezuela's reserves are estimated to last for 59 years at current production, actual depletion may be much faster with Venezuela planning investments to double current production capacity by 2005. In recent years, Venezuela has undergone a vigorous expansion of its oil production to 3 million barrels per day, well in excess of the OPEC quota of 2.3 million barrels per day. Also the government has considerable outstanding liabilities which lead to high public sector interest obligations.[10]

[10] For a discussion of the situation in Venezuela before 1983 see Gelb [5] and for the later years see IMF [10].

*The level of transfers*

Chart 2 indicates that transfer payments relative to oil and asset income in Venezuela, for much of the past two decades, have been considerably higher than those in Kuwait. This reflects both the net debtor position of the public sector and the structural rigidities in public expenditures in Venezuela. Following the first oil boom in 1973, which was estimated to represent a windfall of 20 percent of GDP, transfers rose from 22 percent of oil and investment income revenue to 48 percent in 1979. At the same time there was a significant increase in public investment on both infrastructure and industrial projects. Like Kuwait, the higher revenue associated with the 1979 oil price rise, resulted in further increases in transfers, although total spending was relatively stable during this period due to a decline in capital spending. The oil prices fall of the mid-1980s had a large effect on the budgetary situation. The authorities were unable to reduce expenditures in line with lower oil prices and rising net interest payments which, in turn, caused the ratio of transfers to oil and investment income to rise to 92 percent in 1987. Remedial policy action, however, did succeed in reducing transfers by the latter part of the 1980s. After declining during the 1990-91 price boom, the transfer ratio rose again from 1991 to 1993 before leveling off around 75 percent in 1994. These structural rigidities in the budget have remained a significant fiscal problem throughout the 1990s.

*The fiscal position*

Chart 4 shows the difference between the fiscal policies pursued in Venezuela and those that could be considered sustainable according to the model presented in this paper. Following the first oil shock, the core deficit rose dramatically as the government began a series of public investment projects funded by the oil windfall. In addition the level of transfers in the budget rose. Despite the fiscal surplus–due to the influx of higher oil revenue–there was a worsening in the underlying fiscal position, suggesting that government policies were on an unsustainable path. Despite growing expenditures on both transfers and interest payments during the 1970's the gap between actual and sustainable policies fell as foreign assets were accumulated through the Venezuelan Investment Fund. A rise in the core deficit, following the second oil shock, again pushed the fiscal position further from sustainability. Capital expenditures were cut during this period in favor of higher transfers, wages, and subsidies on domestic fuel products which contributed to a structural weakening of the budget. Despite an appreciation in the value of its natural resource from 1970 to 1981, Venezuela, unlike Kuwait, was insufficiently endowed for rising oil prices to offset the impact of its high core deficit. The rapid depletion of Venezuela's resources and the worsening net asset position of the government perhaps suggests a position more similar to country B in Figure 4.

Following the financial crisis in 1983, control of non-transfer spending appeared to be successful in moving the fiscal situation towards long-run viability. However, in the face of a higher net external liability position, the budget surpluses of 1984 to 1985 were not large enough for the fiscal position to be considered sustainable. The decline of oil prices in 1986 further damaged the fiscal position as transfer payments rose relative to oil and asset income and there was an increase in the external indebtedness of the government. In 1987 a decline in the core deficit was achieved by reducing the level of spending on investment and goods and services (which fell by a combined 3.2 percent of GDP in this one year) but these gains were quickly reversed the following year as expenditure growth resumed.

The move into overall surplus in 1990, following the rise in oil prices associated with the Iraqi invasion, had little effect on the sustainability indicator with a reduction in the relative size of transfers offset by a decline in the contribution of the oil sector to the budget in the form of tax and royalty payments. From 1991 to 1994, a strengthening of the budget, through improvements in non-oil revenue performance and a decline in non-interest expenditure, resulted in a slight improvement in the sustainability position. This was enhanced by the introduction of a VAT in 1993, which offset a decline in customs revenues, excises and the narrowing of the income tax base. Similarly, a fall in social transfers in 1994 contributed to a narrowing of the gap between prevailing and sustainable policies. Caution is warranted here however. The description above is based on available data on the central government. It does not include the operations of nonfinancial public enterprises or the Exchange Differential Compensation and Deposit Guarantee Fund. As IMF [10] points out, this will change the picture considerably in the latter years since the oil company had significant operating deficits in the 1990s and a large liability was incurred in 1994 as a result of public assistance to the banking sector. Both factors would move Venezuela's position further from sustainability than pictured in Chart 4, particularly in 1994. Unfortunately, a consistent time-series for the whole sample which encompasses these two extrabudgetary activities is not available. The data shown here, if anything, perhaps provides an optimistic view of Venezuela's state finances.

In summary, the two oil shocks in the 1970s moved Venezuela further from a sustainable fiscal positions despite temporarily large surpluses. It took several years to contain the fiscal spending undertaken as a result of the 1973 and 1979 oil price rises. The model shows that Venezuela's position as a net debtor has restricted its policy latitude both by reducing its oil and investment income (which in turn raises $\lambda_t$) and by a negative $a_t$ which reduces the size of the sustainable deficit. The underlying government position improved in the 1990s, despite a worsening in the overall structure of transfers, due to higher non-oil revenue and some restraint in other expenditures. However, broader coverage of the fiscal balance that includes the oil company's operations and accounts for the bank bail-outs, would lead to a worsening picture of Venezuela's underlying position in this period, particularly in 1994.

Table 1: Summary Parameters for Kuwait and Venezuela

| Percent | Kuwait | | | | Venezuela | | | |
|---|---|---|---|---|---|---|---|---|
| | $\lambda$ | $s$ | $n$ | deficit[1] | $\lambda$ | $s$ | $n$ | deficit[1] |
| 1977-81 | 14 | 7 | 6 | 38.2 | 47 | 20 | 3 | -1.7 |
| 1982-89 | 31 | 23 | 5 | 13.9 | 57 | 15 | 2 | -1.1 |
| 1990-91 | 36 | 5 | 5 | -62.4 | 48 | 16 | 2 | 0.6 |
| 1992-96 | 86 | 49 | 5 | -27.5 | 80 | 12 | 2 | -3.5 |

[1] Conventionally measured deficit as a percent of GDP.

# VI. Summary and Conclusions

This paper has attempted to examine what constitutes appropriate and viable fiscal policy in countries that derive much of their national income from a non-renewable natural resource. The motivation of the paper is a belief that conventional measures of the fiscal position, such as the budget deficit-GDP ratio, give an incomplete summary of fiscal performance. In particular, volatility in world commodity prices may have a dramatic impact on the deficit-GDP ratio despite no change in the underlying fiscal stance. The empirical indicators described here should be viewed as a complement to conventional fiscal measures in capturing the overall fiscal position and determining its long-run consequences. The following section summarizes the results, discusses some limitations, draws some broad policy lessons, and offers directions for future research.

*Summary*

The model proposed here takes explicit consideration of the dynamic effects of fiscal policy and its implications for the stock of government assets/liabilities, including the net stock of resources. The aim is to describe, as a benchmark for comparison, the set of policies that can be continued indefinitely and those that must eventually be reversed. The key aspects of fiscal sustainability highlighted by the paper include:

- The model highlights the "core" deficit–defined as the overall deficit less net transfers and oil and investment income–as being an appropriate indicator of fiscal stance. A higher core deficit–from higher discretionary spending or lower non-oil revenue–leads a country further away from long-run sustainability.

- The sustainable level of the "core" deficit is determined by the return on externally held assets adjusted for the size of government transfers, the rate of population growth, and the level of private savings.

- For net creditors, such as Kuwait, lower interest rates worsen the budgetary position by lowering the level of investment income while for net debtors, such as Venezuela, lower interest rates improve the fiscal position through lower debt service payments.

Table 2: Summary of the Fiscal Position in Kuwait and Venezuela

<table>
<tr><th>Period</th><th>Kuwait[1]</th><th>Venezuela[2]</th></tr>
<tr><td>1973-78</td><td rowspan="2">• Improving terms of trade<br>• High capital spending and little non-oil revenue results in a large core deficit<br>• Despite the large core deficit, the fiscal position is sustainable due to the appreciating value of Kuwait's large oil endowment (Point A in Figure 4)</td><td>• Improving terms of trade<br>• Increase in transfers following the 1973 oil boom as well as large expenditure on infrastructure and industrial projects results in a large core deficit<br>• Unsustainable (although position improves towards the end of the period as assets are accumulated by the Venezuela Investment Fund)</td></tr>
<tr><td>1979-81</td><td>• 1979 oil shock is followed by a shift from capital spending to higher current spending (transfers, wages and subsidies)<br>• Worsening structural nature of budget makes the fiscal position more unsustainable</td></tr>
<tr><td>1982-89</td><td>• Worsening terms of trade<br>• Core deficit remains high(although is gradually reduced as capital spending is reduced)<br>• Unsustainable (point A in Figure 2)</td><td rowspan="2">• Worsening terms of trade<br>• Following the financial crisis in 1983, control over nontransfer spending moves the fiscal position nearer to sustainability<br>• The 1986 decline in oil prices worsens the underlying fiscal situation<br>• Unsustainable</td></tr>
<tr><td>1990-91</td><td>• Enormous reconstruction spending erodes foreign asset holdings while at same time transfer payments rise<br>• Clearly unsustainable</td></tr>
<tr><td>1992-96</td><td>• Persistent high transfers, a large core deficit, an erosion of foreign asset holdings and a fall in investment income<br>• Unsustainable (Point A in Figure 2)</td><td>• Transfer ratio rises until 1994 after which the level of social transfers are cut<br>• Improvement in non-oil revenue with the introduction of a VAT accompanied by a decline in non-interest spending<br>• Improving but still unsustainable</td></tr>
</table>

[1] Data for Kuwait is available only from 1977.

[2] Data for Venezuela excludes oil company activities and public assistance to the banking sector.

- A higher proportion of transfers and entitlements relative to government income from asset holdings and natural resources is detrimental to sustainability.

- Higher population growth rates impose greater constraints on fiscal policy by dividing the available stock of assets, including physical resources, among more claimants.

- Countries violating the criteria for sustainability can face a depletion of their resource base and an accumulation of government liabilities which will force an eventual shift to tighter policies.

- The larger the resource endowment, the more distant may be the point at which a country will be forced to tighten its policy stance.

- Developments in a country's terms of trade are an important consideration.

- In the case of an improving terms of trade, the model describes how a large resource stock can act as a substitute for fundamental fiscal reform with overspending financed by revenue from the appreciating resource endowment. However, it is also shown how disastrous such policies can be if fortunes change and the relative price of the country's resource begins to decline.

- In the model presented here–unlike in models where growth is generated by renewable resources such as human and physical capital–a higher level of GDP growth does not necessarily make a country's fiscal position more sustainable. In fact the opposite may be true if the higher output growth is predicated on faster resource depletion which will be clearly detrimental to long-run sustainability.

*Strengths and weaknesses of the approach*

Applying the model to two major oil producers highlights the strengths and weaknesses of the approach. Among the strengths:

- The transfer-revenue indicator gives a reasonable summary description of the structural weakness of the budget, highlighting the ratchet effect of spending on transfers and entitlements (with transfers rising in periods of high oil prices but failing to fall as prices decline).

- The per capita core deficit, is a more robust indicator in the face of short-term fluctuations in oil prices than is the conventional deficit-GDP ratio. By focusing on a narrower measure of fiscal balance one can see that, even with overall surpluses, a country's budget may still be predicated on overly large, nonproductive expenditures which lead to an unsustainable situation. The per capita measure can also be useful in reflecting demographic developments.

- By placing relatively few restrictions on the process of resource exploitation, the conclusions can be generalized and made applicable to situations both where production is constrained by OPEC quotas or where it is determined by production capacity.

- By drawing attention to the behavior of the resource stock as well as that of government assets and liabilities, the model offers a broader perspective of what constitutes sustainable behavior in an explicitly dynamic context. For example, if a country were successful in doubling its oil production, its budgetary position would improve significantly despite there being no shift in the underlying fiscal position (there would simply be a more rapid depletion of the country's oil reserves). The measure suggested here can help disentangle actual shifts in fiscal stance from the fiscal effects of the changing pace of resource depletion.

The analysis is, however, subject to some limitations:

- Expressing the fiscal situation in per capita monetary value, while indicating on which side of the sustainability benchmark the economy resides, does not provide insight into *how far* the economy is from sustainability.

- The model seeks to identify a set of *constant* policies which can be continued indefinitely even though, in a world of fluctuating oil prices, it may be optimal to exceed sustainable deficits in periods of low prices while running large surpluses and accumulating financial assets in booms. The economy should on average, however, satisfy the long-run sustainability condition; as such, the constant policy benchmark can still provide a useful indication of where policies should be aiming.

- Assuming a constant per capita stock of foreign assets presents some problems. Although this assumption helps identify the criteria for a long-run steady state, foreign assets should be expected to rise in order to replace a diminishing resource base. To examine this possibility, it would be necessary to specify the desired path of the stock of financial assets. For each path, one could solve for the corresponding deficit ceiling above which that path of asset accumulation is not tenable (i.e., which will cause a spiraling accumulation of government liabilities). A faster pace of asset accumulation, for example, would imply a lower ceiling on the level of sustainable deficit. The criterion examined here–that is the maximum deficit which will support a constant path of foreign asset growth without contributing to an accumulation of government debt–should be interpreted as a simple, transparent benchmark of sustainability by which one can judge more complicated policy prescriptions.

- While the model describes policies that are viable in the long run, policies identified as unsustainable may still be continued for a relatively long period of time. In the case of a country as well endowed as Kuwait, for example, unsustainable policies can be continued perhaps for decades. It is argued here that, despite the impact of loose fiscal policies being far off on the horizon, the consequences of wasting the natural resources and the need to conduct policies that provide for future generations, justify applying the precautionary criterion described above as a guide to formulating sensible and prudent policies.

*Policy implications*

There are several policy lessons that can be drawn from the analysis above:

- The conventional summary indicators of fiscal health–the deficit-GDP ratio–may not be a reliable guide to the underlying policy stance in the case where the budget is strongly influenced by natural resource income which is subject to exogenous world price volatility.

- The structure of the budget, rather than merely the bottom line, has important implications for sustainability. A high level of transfers to the private sector poses considerably risks to sustainability. The momentum of public spending, particularly entitlements, built-up in periods of buoyant prices is often difficult to curb when world prices weaken. Policymakers who consider increasing the level of transfers during booms should be aware of this ratchet effect and the difficulty in subsequently reducing transfers.

- It has been demonstrated that even a country with a small natural resource endowment can experience stable and rising income levels if it pursues appropriately conservative fiscal policies (particularly in the case of an improving terms of trade).

- Prolonged periods in deficit may be feasible for a country that is well endowed with a valuable resource but such policies contain a significant danger. If the threshold level of the core deficit is exceeded, perhaps because of an adverse exogenous shock from a downturn in world prices, the country can quickly enter a spiral of accumulating government liabilities and diminishing resources.

- The model demonstrates how governments which exploit their natural resources need to have a strong commitment to replace their non-renewable resource wealth with financial assets in order to provide for future generations.

*Further extensions*

The investigation above can be extended in several directions. First, by introducing a stock of physical or human capital, one can examine the effect of channelling fiscal spending into productive investment (e.g., infrastructure, education, R&D, etc.) to enhance non-resource based growth and overall domestic economic development. The likely outcome is that looser, but growth enhancing, fiscal policy will be sustainable while tighter, unproductive policies will not. Second, a behavioral reaction function of the government could be introduced to look at what constitutes both sustainable *and* optimal policies in the face of volatile world commodity prices. By assuming an intergenerational welfare function, one can derive the optimal path of asset accumulation and resource exploitation to maximize the welfare function, subject to a path of resource prices. This approach has been employed in the context of an economy with debt and physical capital in Zee [19] whereby the government is assumed to use fiscal policy to optimize steady state utility.[11] Taking the optimal paths for $a_t$ and $S_t$ as given, one can then establish the maximum deficit possible that does not lead to an unsustainable path of debt accumulation. While such an approach allows one to examine intergenerational equity issues by assigning weights to the utility of current and future generations, it does involve a degree of arbitrariness in specifying the functional form of the government's objective function which, in turn, can make the analysis less transparent. Third, it might be interesting to expand the model to explicitly consider an external sector in order to examine the implications of policies on a country's current account and the size of its external (public and private) debt.

[11] Alternatively, one could assume a path of resource exploitation similar to Hotelling's [8] model.

# Derivation of the Model

The savings behavior of individuals is summarized as

$$z_t(t) = \phi\tau_t. \tag{A.1}$$

The dynamic behavior of the resource stock is described by

$$(1+n)s_{t+1} = s_t - y_t \quad s_0 \text{ fixed, and } s_{t+j} > 0. \tag{A.2}$$

Writing the resource constraint in terms of the consumption good where $p_t$ is the relative price between the resource and consumption good

$$(1+n)\frac{p_t}{p_{t+1}}p_{t+1}s_{t+1} = p_t s_t - p_t y_t. \tag{A.3}$$

Letting $S_t = p_t s_t$ we can rewrite A.3 as

$$(1+n)S_{t+1} = \delta S_t - \delta p_t y_t. \tag{A.4}$$

The government flow budget constraint in per capita terms is given by,

$$(1+n)\left(b_{t+1} - a_{t+1}^g\right) = R_t\left(b_t - a_t^g\right) - \lambda_t r_t(b_t - a_t^g) + g_t - (1-\lambda_t)p_t y_t. \tag{A.5}$$

Where $a_t^g$ is the stock of government storage assets, $b_t$ is the outstanding stock of government debt, and $\lambda_t\left(r_t(b_t - a_t^g) + p_t y_t\right)$ represents net transfers to consumers. Letting $Q_t = a_t^g - b_t$ then (A.5) becomes

$$(1+n)Q_{t+1} = Q_t - g_t + (1-\lambda)(r_t Q_t + p_t y_t). \tag{A.6}$$

Noting that $\tau_t = \lambda_t\left(r_t Q_t + p_t y_t\right)$ capital market equilibrium is given in per capita terms as

$$z_t(t) = \phi\lambda_t\left(p_t y_t + r_t Q_t\right) = (1+n)\left(b_{t+1} + a_{t+1}^p\right). \tag{A.7}$$

Letting $a_t = a_t^g + a_t^p$ (A.7) can be rewritten as

$$\phi\lambda(p_t y_t + r_t Q_t) = (1+n)(a_{t+1} - Q_{t+1}). \tag{A.8}$$

We can substitute out for $y_t$ from (A.4) and from (A.8) and (A.6) obtain the following equations in $S$ and $Q$ that describes the dynamics of the economy,

$$S_{t+1} = \frac{\delta}{1+n}S_t + \frac{\delta\left(R_t - \lambda_t(1-\phi)r_t\right)}{(1+n)\left(1-\lambda_t+\phi\lambda_t\right)}Q_t - \frac{\delta\left(g_t + (1+n)a_{t+1}\right)}{(1+n)(1-\lambda_t+\phi\lambda_t)}. \tag{A.9}$$

$$Q_{t+1} = \frac{\phi\lambda_t}{(1-\lambda_t+\phi\lambda_t)(1+n)}Q_t - \frac{\phi\lambda_t g_t - (1-\lambda_t)(1+n)a_{t+1}}{(1-\lambda_t+\phi\lambda_t)(1+n)}. \tag{A.10}$$

Let us examine first the equation for the evolution of $S_t$. From (A.9)

$$S_t \geq S_{t+1} \Rightarrow S_t \geq \frac{\delta}{1+n}S_t + \frac{\delta\,(R_t - \lambda_t(1-\phi)r_t)}{(1+n)\,(1-\lambda_t+\phi\lambda_t)}Q_t - \frac{\delta\,(g_t+(1+n)a_{t+1})}{(1+n)(1-\lambda_t+\phi\lambda_t)}. \quad \text{(A.11)}$$

Rewriting one can obtain the condition describing the dynamic behavior for when $S_t \geq S_{t+1}$ or $\Delta S_t \leq 0$

$$Q_t \leq \frac{(1-\lambda_t+\phi\lambda_t)\,(1+n-\delta)}{(R_t-\lambda_t(1-\phi)r_t)\,\delta}S_t + \frac{g_t+(1+n)a_{t+1}}{R_t-\lambda_t(1-\phi)r_t}. \quad \text{(A.12)}$$

Similarly rearranging (A.10)

$$Q_t \geq Q_{t+1} \Rightarrow Q_t \geq \frac{\phi\lambda_t}{(1-\lambda_t+\phi\lambda_t)(1+n)}Q_t - \frac{\phi\lambda_t g_t - (1-\lambda_t)(1+n)a_{t+1}}{(1-\lambda_t+\phi\lambda_t)(1+n)}. \quad \text{(A.13)}$$

Therefore the condition for $Q_t \geq Q_{t+1}$ or $\Delta Q_t \leq 0$

$$Q_t \geq \frac{-\phi\lambda_t g_t + (1-\lambda_t)(1+n)a_{t+1}}{(1-\lambda_t+\phi\lambda_t)\,(1+n) - \phi\lambda_t}. \quad \text{(A.14)}$$

There are two cases to consider: Where the intercept for the $\Delta Q_t = 0$ equation lies above that of the $\Delta S_t = 0$ equation (the *sustainable case*) or where it lies below (the *unsustainable case*). The condition for the sustainable case is given by

$$\frac{-\phi\lambda_t g_t + (1-\lambda_t)(1+n)a_{t+1}}{(1-\lambda_t+\phi\lambda_t)\,(1+n) - \phi\lambda_t} \geq \frac{g_t+(1+n)a_{t+1}}{R_t-\lambda_t(1-\phi)r_t}. \quad \text{(A.15)}$$

Rearranging this equation yields,

$$g_t \leq \frac{(1-\lambda)r_t - n}{1+\frac{\phi\lambda r_t}{1+n}}a_{t+1}. \quad \text{(A.16)}$$

# Calculation of Model Parameters

This appendix explains the calculations of the parameters of the model. The aim is to try and get as close a correspondence between the model and commonly available data. All data is derived from that produced in the Government Finance Statistics [11] or International Financial Statistics [12]. The government is defined as the consolidated central government and includes social security schemes but excludes public enterprises as well as deposit insurance funds. Net transfers are defined as wages plus transfers and subsidies less taxes on individuals. Oil and investment income are figures that are net of interest payments. The return on externally held assets ($r_t$) is proxied by the return on an efficiently diversified portfolio invested in the U.S. stock and bond markets. A proxy for the stock of foreign assets ($a_{t+1}$) is derived by dividing net investment income by this rate of return.

| Variable | Measurement |
|---|---|
| $p_t y_t + r_t Q_t$ | Entrepreneurial and Property Income + Tax on Net Income and Profit from Oil Companies - Interest Payments |
| $\tau_t$ | Wages and Salaries + Subsidies and Transfers to Households - Individual Income Tax - Taxes on Payroll - Domestic Taxes on Goods and Services - Import Taxes |
| $\lambda_t$ | $\tau_t/(p_t y_t + r_t Q_t)$ |
| $g_t$ | Total Expenditure and Net Lending - (Wages and Salaries + Subsidies and Transfers to Households + Interest Payments) - Total Revenue - (Entrepreneurial and Property Income + Tax on Net Income and Profit from Oil Companies + Taxes on Payroll + Domestic Taxes on Goods and Services + Import Taxes) |
| $r_t a_t$ | Net Income from Balance of Payments Statistics |
| $r_t$ | Return on an efficient portfolio for the U.S.(53 percent common stocks, 6 percent intermediate bonds, and 41 percent Treasury bills) as described in Ibbotson [9] |
| $n$ | Population growth rate |
| $\phi$ | Total Private Savings / (Total Private Savings + Private Consumption) from the World Economic Outlook [13] |

**Figure 1: Sustainable Case with Declining Terms of Trade**

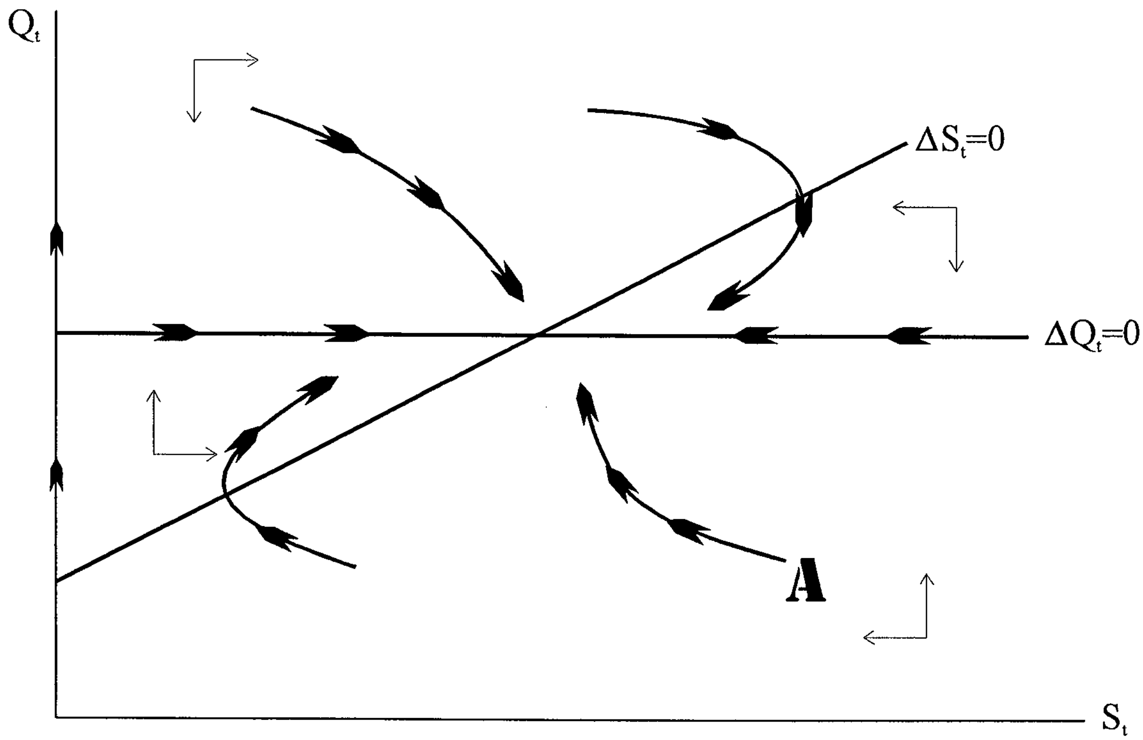



**Figure 2: Unsustainable Case with Declining Terms of Trade**

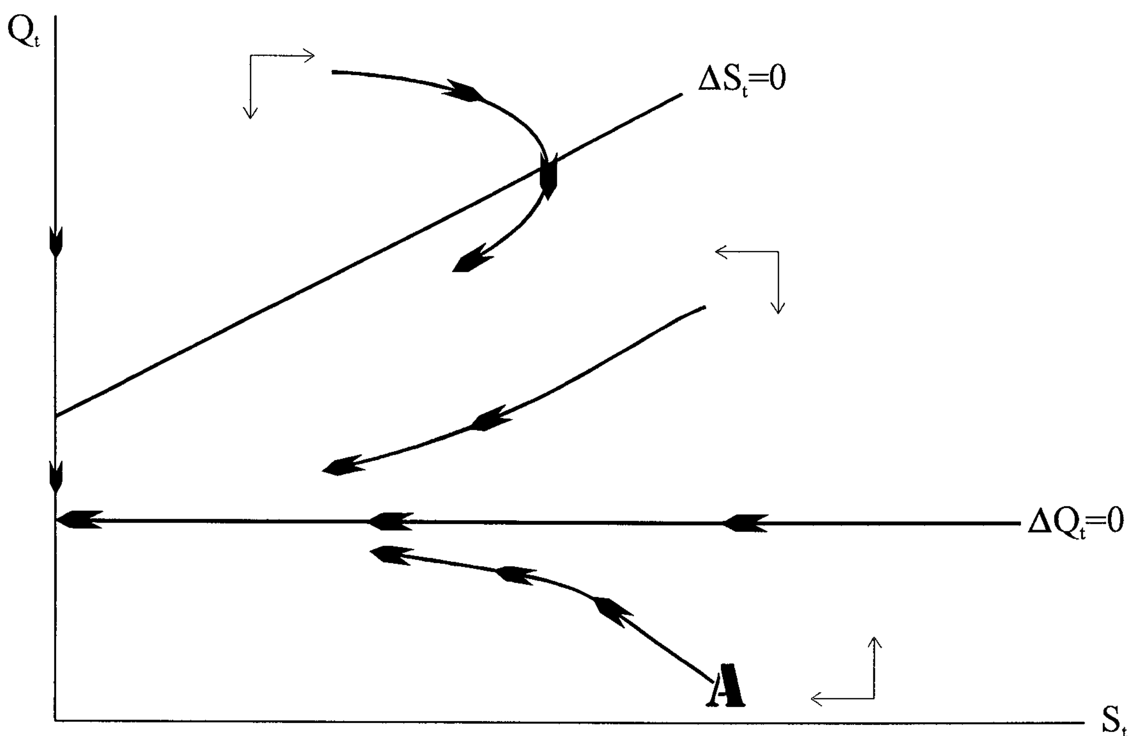


**Figure 3: Sustainable Case with Improving Terms of Trade**

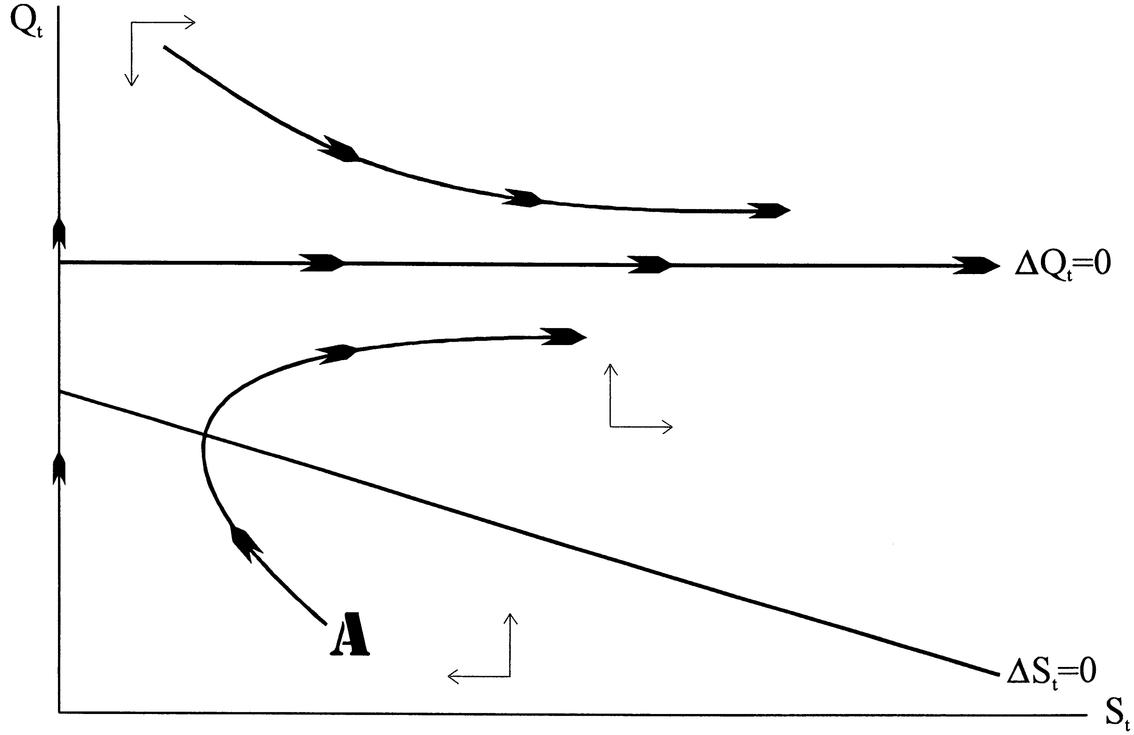
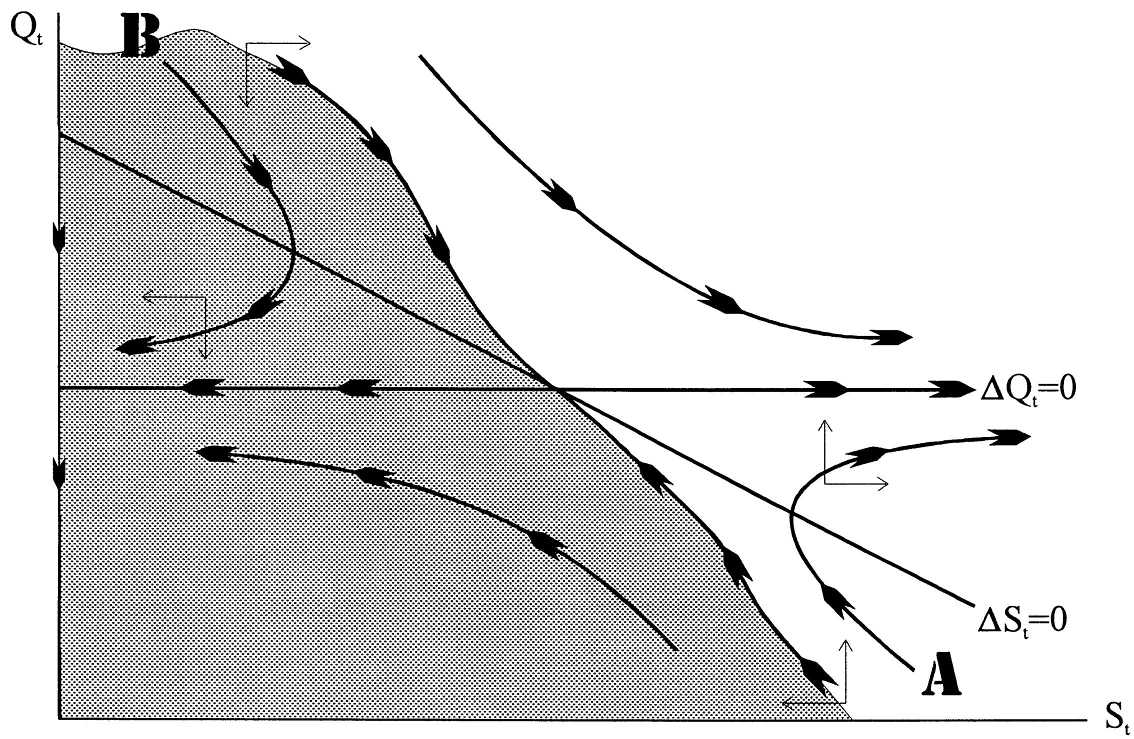
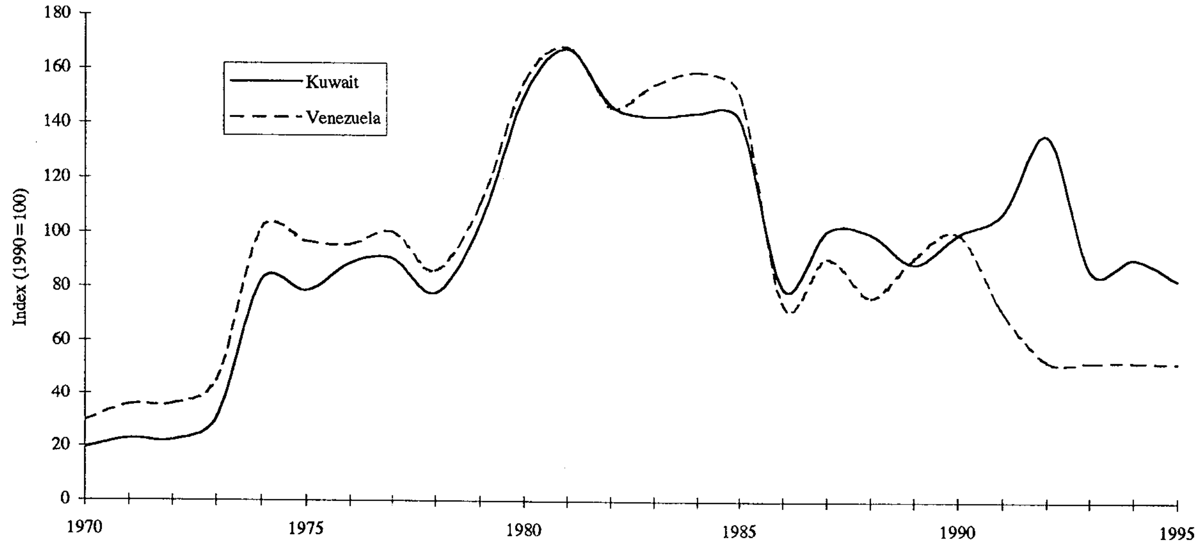



**Figure 4: Unsustainable Case with Improving Terms of Trade**

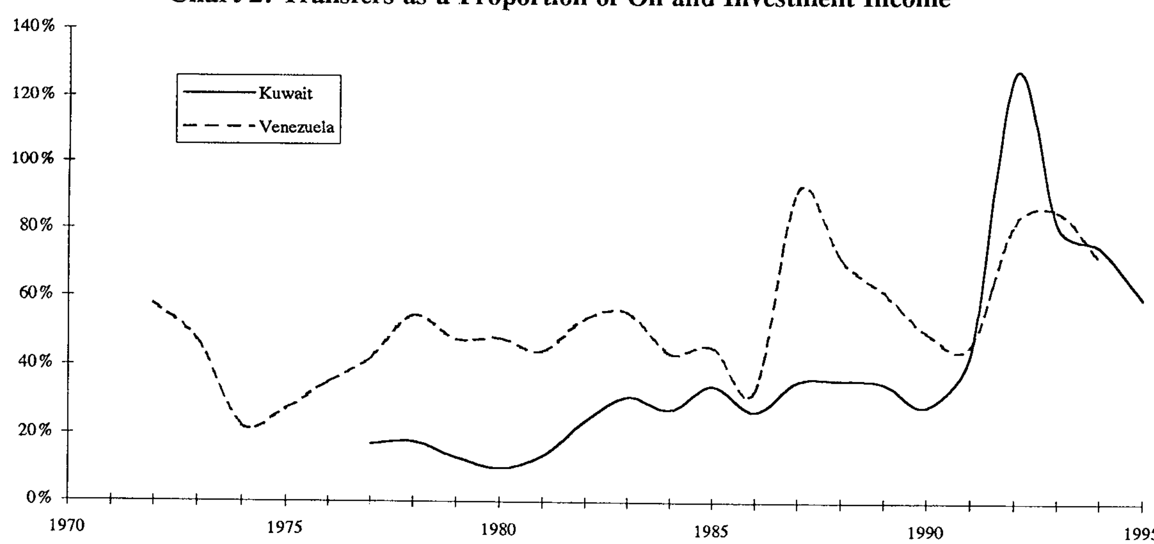


## Chart 1: Terms of Trade



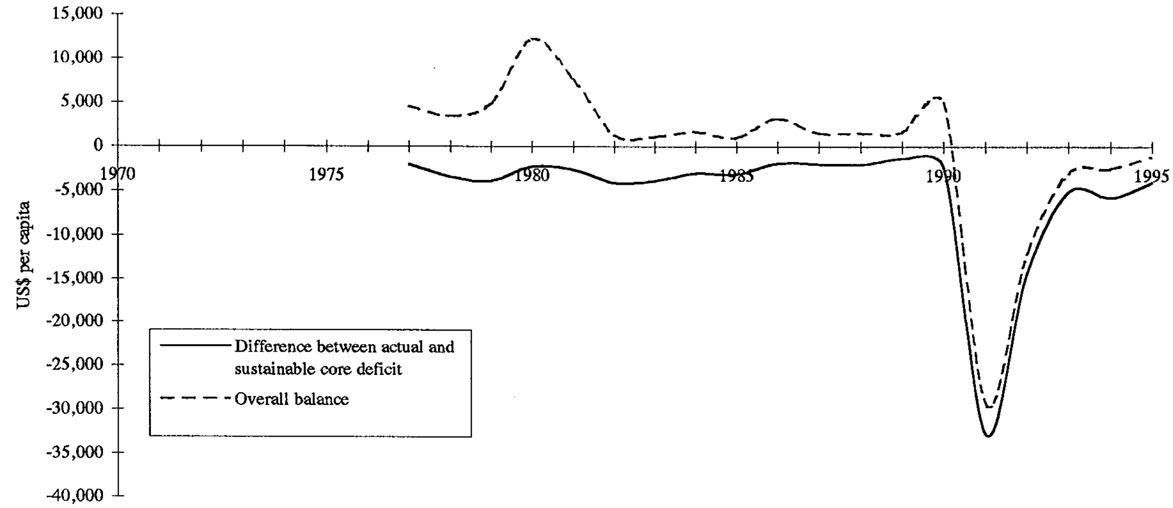

Source: World Economic Outlook, 1996.

## Chart 2: Transfers as a Proportion of Oil and Investment Income



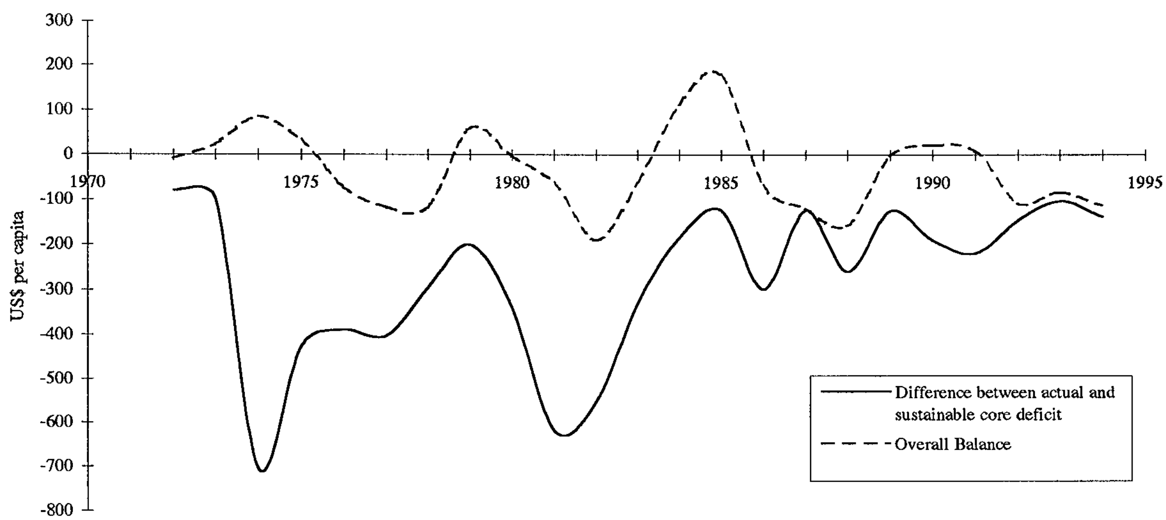

Source: Government Finance Statistics, 1995.

**Chart 3: Kuwait Fiscal Position 1/**




Source: Government Finance Statistics, 1995 and author calculations.

**Chart 4: Venezuela Fiscal Position 1/**




Source: Government Finance Statistics, 1995 and author calculations.

1/ Negative position indicates a deficit in the overall balance or an unsustainable core deficit.

## References

[1] Auty, Richard M., 1986, "Entry Problems and Investment Returns in RBI: A Cross-Country Comparison," Report to Research Project 672-49, Development Research Department (Washington: World Bank).

[2] Blanchard, Olivier Jean, 1990, "Suggestions for a New Set of Fiscal Indicators," OECD Working Paper No. 79 (Paris: Organization for Economic Cooperation and Development).

[3] Buiter, Willem H., 1985, "Guide to Public Sector Debt and Deficits," *Economic Policy*, Volume 1 (November), pp. 13-79.

[4] Chalk, Nigel Andrew, Mohamed A. El-Erian, Susan J. Fennell, Alexei P. Kireyev, and John F. Wilson, 1997, *Kuwait: From Reconstruction to Accumulation for Future Generations*, IMF Occasional Paper No. 150 (Washington: International Monetary Fund).

[5] Gelb, Alan H., and Associates, 1988, *Oil Windfalls: Blessing or Curse* (New York: Oxford University Press for the World Bank).

[6] Hamilton, James D., and Marjorie A. Flavin, 1986, "On the Limitations of Government Borrowing: A Framework for Empirical Testing," *American Economic Review*, Volume 76 (September), pp. 809-19.

[7] Horne, Jocelyn, 1991, "Indicators of Fiscal Sustainability," IMF Working Paper 91/5 (Washington: International Monetary Fund).

[8] Hotelling, Harold, 1931, "The Economics of Exhaustible Resources," *Journal of Political Economy*, Volume 39, No. 2 (April), pp. 137-75.

[9] Ibbotson, Roger G., and Associates, 1995, *Stocks, Bonds, Bills and Inflation: Historical Returns* (Chicago).

[10] International Monetary Fund, 1996, Venezuela—Recent Economic Developments, IMF Staff Country Report No. 96/87 (Washington).

[11] _____, 1996, *Government Finance Statistics Yearbook* (Washington).

[12] _____, 1996, *International Financial Statistics Yearbook* (Washington).

[13] _____, 1996, *World Economic Outlook, May 1996: A Survey by the Staff of the International Monetary Fund,* World Economic and Financial Surveys (Washington).

[14] Kremers, Jeroen J. M., 1989, "U.S. Federal Indebtedness and the Conduct of Fiscal Policy," *Journal of Monetary Economics*, Volume 23 (March), pp. 219-38.

[15] Liuksila, Claire, Alejandro García, and Sheila Basset, 1994, "Fiscal Sustainability in Oil-Producing Countries," IMF Working Paper 94/137 (Washington: International Monetary Fund).

[16] Murphy, Kathleen J., 1982, "Third World Macroprojects in the 1970s; human realities - managerial responses" *Technology in Society (U.S.)* (New York: Westmind Press), pp. 131-44.

[17] Trehan, Bharat, and Carl E. Walsh, 1991, "Testing Intertemporal Budget Constraints: Theory and Applications to U.S. Federal Budget and Current Account Deficits," *Journal of Money, Credit, and Banking*, Volume 23 (May), pp. 206-23.

[18] Wilcox, David W., 1989, "Sustainability of Government Deficits: Implications of the Present-Value Borrowing Constraint," *Journal of Money, Credit and Banking*, Volume 21(August), pp. 291-306.

[19] Zee, Howell H., 1988, "Sustainability and Optimality of Government Debt," *Staff Papers*, International Monetary Fund, Volume 35 (December), pp. 658-85.