CAPITAL FLIGHT AND EXTERNAL DEBT RELATIONSHIPS IN TANZANIA BEFORE THE ENHANCED HIPC DEBT INITIATIVE

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ABSTRACT

This article investigates factors that influence capital flight in Tanzania, with a special focus on external debt as one of such factors. In doing so, the article assesses the feedback effects and long run impacts of such variables using time series data covering the 1970-2000 period and employs a VAR methodology within the Johansen Maximum Likelihood framework. The findings show that the external debt, budget deficit, interest rate differential and GDP growth are the major factors that influence capital flight from Tanzania. The use of Granger causality test also reveals the existence of bi-directional causality among some of the variables. In a way of policy implication, the study suggests the need for ensuring stable macroeconomic environment, particularly sound fiscal and monetary policies, sustainable debt, and high and stable economic growth if the country is to reverse the flow of capital from Tanzania.

1. INTRODUCTION

Mobility of capital internationally in search of highest risk-adjusted returns is one of the methods of portfolio diversification. However, not all capital that moves from one country to another is in search of such returns. Some of the capital movements are influenced by the desire to run away from risk, rather than the pursuit of high returns. Capital movements of this type comprise what has come to be known as "capital flight", which simply refers to international capital movements which respond to heightened domestic economic and political uncertainty. Thus, as the risk profile of a country changes, capital flight, which then connotes illegal movement of capital from a risky to less risky country, ensues (Lessard and Williamson, 1987; Schineller, 1997). In the past two decades, many developing countries experienced increases in their debts to unsustainable levels coupled with increased capital outflows, suggesting that debt and capital outflows could be linked (Ajayi, 1991; Varman-Schneider, 1991). Before the highly indebted poor countries (HIPC) debt reduction initiative, for example, flow of capital from Africa as a result of debt servicing was significantly more than flow of new capital to the region, making capital flight a serious impediment to growth (Charrete, 1991: Iyoha, 1999).

Capital flight phenomenon ought to be avoided particularly in the context of external indebtedness for a number of reasons (Ajayi, 1997). First, capital flight leads to a reduction of growth potential,

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because it is a diversion of domestic savings away from domestic real investment. Second, capital flight leads to the erosion of the domestic tax base in as far as income generated and wealth held abroad cannot be taxed. This reduces the potential government revenue and also shifts the tax burden from capital to less mobile assets like land and labour making their taxation more regressive (see also Cuddington, 1986). Third, is the adverse income redistribution consequence of capital outflow. As a result of multiple outflow of resources, including payment for external debt obligations to foreign creditors, highly indebted poor countries have found themselves faced with problems of debt and economic management. Although the recent HIPC initiative has provided some debt relief to these countries, such a relief has not been substantial to the extent that these countries continued to depend on foreign aid, part of which has resulted in re-accumulation of debt.

During the late 1970s through the 1990s, the debt crisis plagued many developing countries, including Tanzania. The debt crisis compounded the problem of capital flight, thus making capital flight and rising external debt a double-edged problem which impaired economic growth of these countries2. Capital flight and its link with external debt look paradoxical, hence requiring further analytical attention to fully understand how big the problem is, why it occurs or what can be done about it. Available primary analyses, each with a slight different focus, include Cuddington (1986), Dooley (1988), Varman (1989), and Schineller (1997), among others. Econometric studies of the determinants of capital flight from developing countries are not extensive and only a few studies have appropriately linked the issue of capital flight and external debt3. However, none of these studies employed recent developments in econometric analysis in their methodogies. It is on this ground that a further empirical investigation on the matter becomes inevitable so as to reveal some evidence.

In the Tanzanian context, Malyamkono and Bagachwa (1990) discuss some issues related to capital flight, but Baruani (1995) and Nyoni (1997) are more analytical in their investigation of determinants of capital flight in Tanzania. However, neither of these studies analyzed the causal relationship between capital flight and external debt, nor did they incorporate external debt as one of the explanatory variables in the capital flight determination model. This article attempts to fill that gap. The article adopts the VAR approach, where each variable is allowed to play a major role in the determination of the impact on each of the other variables as well as in determining whether or not each variable is driven by its own history. More specifically, the objectives of this article are to: identify factors that influence capital flight in

Tanzania; establish the causal relationship between capital flight and external debt; and draw policy implications from the empirical results of the determination of capital flight. The analysis is important in understanding the determinants of capital flight and the association between capital flight and external debt in the context of Tanzania.

2. Macroeconomic Performance, External Debt and Capital Flight: 1970-2000

2.1. The Pre-reform Period, 1970-85

As noted earlier, movements of capital in search of highest risk-adjusted returns usually take place from risky to less risky environments. As such, as the risk profile of a country changes, capital flight ensues. Tanzania's economic environment changed from free competitive market to a command economy with the advent of the Arusha Declaration of 1967, which culminated into the nationalization of the "commanding heights"4 of the economy and introduced the policy of Socialism and Self-Reliance. This was primarily motivated by the need to create nationally-owned and internally integrated economy. By the early 1970s, the Government had consolidated its hold on a large part of the economy. The Government became involved in setting and regulating prices, allocation of foreign exchange, and determination of the pattern of domestic investment. The overall economic and political environment became hostile, creating uncertainty to the private sector in economic development and marked the beginning of relocation of capital to other uses outside the country.

Due to government control of the economy, most macroeconomic indicators began to deteriorate in the mid-1970s and the country experienced severe economic strains beginning from the late 1970s. By the mid-1980s the Tanzanian economy was in deep macroeconomic crisis, with overall economic performance having declined to the lowest levels since independence (World Bank, 2001). The crisis was generally a result of both exogenous and internal factors. Exogenous factors, which impacted on the economy during the 1970s when the economy had started to deteriorate include: drought, high petroleum prices, collapse of the East African Community, the war with Idd Amin's Uganda, and volatility in the terms of trade, among others. Internal factors were mostly in the form of poor economic and management policies, manifesting themselves in central control of economic activity and stringent macroeconomic environment. These led into: insufficient and declining overall GDP growth averaging 1 percent during 1980-85 and negative per capita growth given that population grew at 2.8 percent annually; food deficits and declining export volumes of traditional export crops due to poor performance of the agricultural sector; currency

overvaluation and severe balance of payments problems, caused by declining export volumes and commodity export prices, rising import prices and debt service obligations as both domestic and foreign debts accumulated5; widespread shortages of foreign exchange and goods due to poor performance of agricultural and industrial sectors. Also there was general deterioration of both social and physical infrastructure; and accelerating rate of inflation which seriously eroded real incomes and real interest rates. Inflation was mainly a result of unsustainable budget deficit, which was caused by decreasing tax revenues as the Government's revenue base (GDP) got eroded leading to excessive government bank borrowing and increased dependence on external sources of finance.

Thus, by the first part of the1980s, Tanzania was in deep economic crisis of unprecedented proportions coupled with rising external debt and declining foreign inflows in the midst of government clashes with foreign donors on issues regarding macroeconomic fundamentals. The adoption of "National Economic Survival Program" (NESP) in 1981-82 and "Structural Adjustment Program" (SAP) after the failure of NESP did not rescue the country from the crisis in as far as the two initiatives could not address important issues such as exchange rate overvaluation and liberalization of agricultural marketing; overlooked structural transformation issues; and in order to deal with problems relating to increasing production, the programs required significant amount of foreign exchange, which was not forthcoming.

The performance of the foreign sector worsened during the period, leading into decline in exports and rising external debt. The period also witnessed high levels of inflation. The government compressed imports through direct foreign exchange rationing rather than accommodating inflation through nominal depreciation. It also began to reverse its producer pricing policies as an attempt to promote exports in the early 1980s, but the efforts were offset by increases in marketing inefficiencies and overvaluation of the exchange rate (Adam et al. 1994). The decline in official exports during the crisis period in part reflects a diversion of exports from official to unofficial channels in response to the rising black market premium on exchange rate. During the same period, per capita income fell by 1.5 percent per year.

2.2. Reform Period: 1986-2000

The sheer magnitude of the crisis, pressure from Brettonwood institutions (World Bank and IMF) and bilateral donors, and the failure of the development efforts initiated domestically to revive the economy, together combined in persuading the government to adopt a far reaching Economic Recovery Program (ERP) in 1986, with IMF and World Bank support.

Under the ERP, a broad range of policies was adopted aiming at liberalizing internal and external trade, unifying the exchange rate, reviving exports, stimulating domestic saving and restoring fiscal sustainability. Furthermore, in 1989 the reforms entered the second phase through the so-called "Economic and Social Action Program" (ESAP), which considered the inclusion of social aspects of adjustment while still focusing on trade and exchange rate liberalization and overall macroeconomic stabilization. It further incorporated reforms in agricultural marketing, the financial sector and the public sector - including the parastatal sector, civil service and the local government; and also targeted the social sector which had deteriorated considerably during the crisis period (Bigsten et al., 1999).

Real GDP growth fluctuated during the period 1988 - 1994, rising to a peak of 6.2 percent in 1990 but declining afterwards to as low as 0.4 percent and 1.4 percent in 1993 and 1994, respectively (table 1). This occurred because the period was marked by some policy reversals, beginning 1990 especially in relation to fiscal and monetary policy conduct, after initial successes in recovery effort. This is proved by the rising fiscal deficits resulting mainly from low revenue effort occasioned by the government's partial attempt to reform the tax system in fiscal year 1992/93 (amid a tax system characterized by poor tax administration, tax evasion, tax exemptions6), high growth rates of money supply, and rising inflation (table 1). Money supply growth rates were higher than the monetary policy targets of around 10-20 percent, while inflation averaged around 30 percent. Debt stock increased over time from US$ 265 million in 1970 to US$ 8840.7 million by 1994, due to accumulation of both stock and debt service arrears (table 2).

Given the dismal performance of the economy, the third phase government, which came into office in 1995 engaged more stringent reform measures such as the downsizing of the public sector, privatizing loss-making public enterprises, and reforming the financial sector. This resulted into considerable reduction of fiscal deficits and led into better economic performance, a sign that successes were being recorded in terms of stabilization and structural adjustment. The Tanzania's economy started to show signs of recovery again beginning the second half of 1995. Real GDP grew on average of 4 percent during the period 1995-2000, having steadily increased from 3.6 percent in 1995 to 4.9 percent in 2000 with slight decrease in 1997 due to El-Nino effects (table 1). This performance was driven by improved resource allocation and increased capacity utilization leading to good performance in most of the sectors - especially mining, manufacturing, construction, communication and transport, and trade and tourism, all of which grew at above 5 percent on

Table 1: Important Macroeconomic Indicators, 1988 – 2000#

Indicator	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Real GDP Growth (%) (calendar year)	4.4	2.6	6.2	2.8	1.8	0.4	1.4	3.6	4.2	3.3	-4.0	4.7	4.9
Money Supply (M3) Growth (%)	34.8	37.3	45.4	26.9	40.5	43.9	46.3	36.1	16.3	18.2	7.7	9.2	21.7
Expenditure as % of GDP	15.7	16.1	16.6	15.3	15.3	19.0	17.5	14.1	12.2	12.0	11.1	14.7	15.6
Revenue as % of GDP	9.9	12.3	12.5	13.5	13.6	10.2	11.4	11.8	13.0	13.4	12.1	11.3	11.3
Fiscal Deficit (before grants) (% of GDP)	-5.8	-3.8	-4.2	-1.9	-1.7	-8.8	-6.0	-2.3	0.8	1.1	1.0	-3.4	-4.4
Fiscal Deficit (after grants) (% of GDP)	-2.4	-0.2	-0.5	0.4	0.9	-5.1	-2.4	1.5	2.2	3.2	1.9	0.5	-0.5
Inflation (%) (year average)	31.8	30.3	35.8	28.7	21.8	24.0	35.5	27.4	21.0	16.1	12.9	7.8	6.0
Savings Deposit Rate (%)**	21.5	26.0	26.0	26.0	26.0	24.0	25.0	21.1	16.7	15.1	7.00	7.2	4.9
Lending Rate (%)**	24.0	26.0	26.0	26.0	30.0	30.0	31.5	35.5	33.5	26.5	26.0	23.9	23.1
Wedge - Lending Rate vs.Savings Rate (%)	10.4	0	0	0	13.3	20.0	20.6	40.6	50.1	43.0	73.1	69.9	78.8
Official Exchange Rate (Tshs/$) (average)	99.3	143.4	195.1	219.2	297.7	405.0	509.6	574.8	580.0	612.1	669.8	797.3	803.3
Exports of Goods & Services (Mil. US$)	499.9	517.9	548.9	558.9	555.6	747.9	937.6	1265.8	1300.9	1246.4	1141.5	1189.7	1325.8
Imports Goods and Services (Mil. US$)	1320.4	1365.4	1273.6	1336.3	1438.5	1983.6	1812.6	2140.3	2028.5	1948.2	2360.1	2241.4	2094.4
Current Account Balance	-387.0	-401.8	-558.9	-736.1	-800.1	-1022	-711.0	-647.6	-455.0	-589.1	-993.0	-793.5	-514.5
Foreign Reserves (months of imports)	1.3	0.5	1.1	1.8	3.2	2.4	2.3	2.0	1.4	2.8	2.9	4.0	4.2
External Debt (% of GDP)	167.1	127.9	159.7	150.5	141.5	156.1	178.4	128.7	101.0	90.21	88.11	89.3	94.3
External Debt Service as % of GDP	10.8	9.6	10.2	8.9	8.5	14.4	15.5	11.2	9.8	6.6	6.3	10.4	10.5
External Debt Service as % of Exports	9.9	15.8	14.9	20.4	24.1	21.9	21.1	25.3	26.8	30.2	57.2	50.9	50.7

* Fiscal years, unless stated; ** Based on the lowest and highest rates within calendar year; + As % of GDP

Source: Bank of Tanzania; President's Office - Planning and Privatization; Ministry of Finance.

average; and a fairly good performance in agriculture, finance and insurance, and energy and water.

Inflation fell from 27.4 percent in 1995 to 6 percent in 2000, owing mainly to tight fiscal policy marked by adoption of the cash budget system in 1996/97 and sector budget ceilings that allowed the government to address the large fiscal imbalances of the early to mid 1990s and to repay domestic debt; monetary restraint kept real interest rates positive. Balance of payments also improved as exports recovered and foreign reserves rose from an equivalent of 1.4 equivalent months of merchandise imports in 1995 to an equivalent of 4.2 months of merchandise imports in 2000. The good performance of the Tanzanian economy would probably have been even better had it not been for the high level of accumulated debt and debt service burden which constrained growth and efforts toward poverty reduction. Debt stock decreased slightly from US 7933.0 million in 1995 or 128.7 percentage of GDP to US$ 7603.2 or 94.3 percentage in 2000, owing to repayment and forgiveness under Paris and bilateral agreements (tables 1 and 2). On average, the external debt grew at an annual rate of 9.70 percent over the period 1970-2000. Debt service claimed about a half of export earnings by 2000. Tanzania managed to secure HIPC debt relief in 2001 after showing a concerted effort in pursuit of economic reforms, particularly addressing problems of fiscal mismanagement and governance. Tanzania is also among the poor countries that will benefit from the recent decision by the World Bank and the International Monetary Fund to cancel their foreign debts. Tanzania's debt amounting to US$3 billion that accrued over the past 20 years is to be cancelled under this arrangement.

2. Capital Flight and External Debt Developments

External indebtness and capital flight are issues that have dominated policy discussions in international forums in recent times because of their effects on capital movements across countries and consequently on poverty because of the recently initiated Highly Indebted Poor Countries (HIPC) initiative which aims at addressing poverty and indebtness in developing countries. The earlier studies undertaken in Tanzania by Baruani (1995) and Nyoni (1997) applied different methods of quantifying capital flight. Both gave varying results. In this article, we adopt and update the results obtained by Nyoni (1997) based on the Morgan Guaranty (1986) measure of capital flight and considered trade misinvoicing, since it has been argued that capital flight can occur through over-invoicing imports and under-invoicing of exports (Eggerstedt and van Wijnbergen, 1995). This is more rampant in countries where currencies are over-valued and foreign exchange and trade controls are prevalent as was the case in Tanzania, especially between the late 1970s and the early 1990s before foreign exchange was liberalized and

became market determined in 1993.

Invoices for imports or exports are often faked7 and imports are carried out avoiding registration. In such cases, the balance of payments is imprecisely recorded and does not fully reflect the actual trade and capital flows. It is also observed that, depending on the nature of trade policies in the domestic economy, trade misinvoicing may occur for other motives than financing capital flight. Thus, rather than imports being over-invoiced to transfer funds abroad, imports may be under-invoiced to lower the cost of customs duties and value-based quantitative restrictions (Eggerstedt and van Wijnbergen, 1995). If there are export incentives, it will be more rational for exporters to over-invoice their exports to take advantage of the export subsidies and preferred access to subsidized credits. The net effect of under-invoicing imports and over-invoicing exports will be reverse capital flight.

The magnitudes of capital flight adjusted for trade misinvoicing (export and import misinvoicing) and external debt stock are shown in tables 2 and figure 1. The measure of capital flight is adjusted by taking the sum of import over-invoicing and the negative of export under-invoicing since capital flight appears with positive values in our measures.

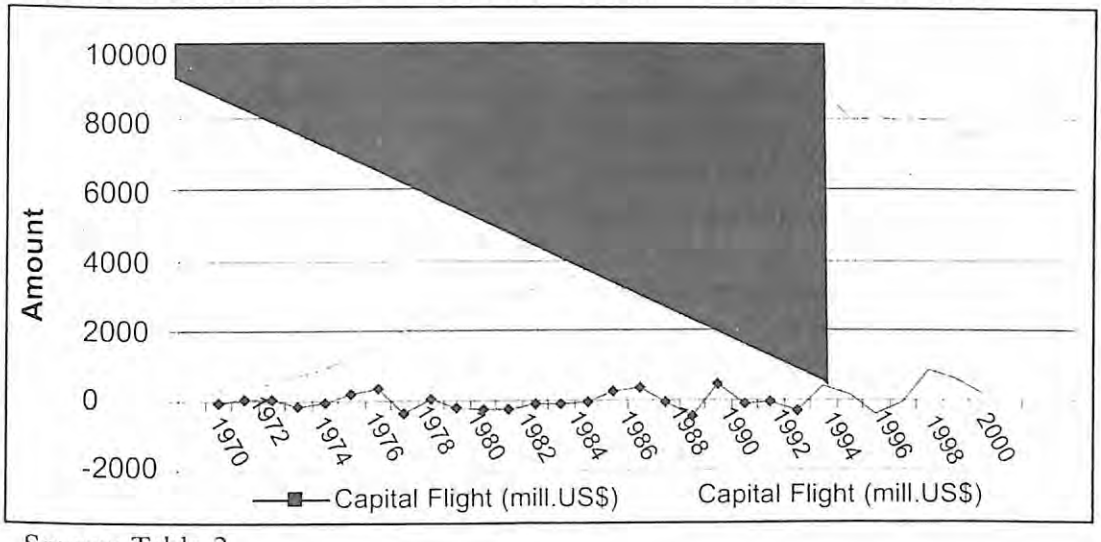
Table 2: Trade Misinvoicing, Capital Flight and External Debt in Tanzania (in millions of current US dollars)

Year	Misinvoicing Adjustment	Capital Flight*	External Debt**	Year	Misinvoicing Adjustment	Capital Flight*	External Debt**
1971	-31.86	-27.3	326.7	**1986**	-67.29	268.1	4295.0
1972	-110.53	63.6	401.8	**1987**	-134.42	371.4	5142.0
1973	-95.96	54.1	509.5	**1988**	-75.85	-61.2	5409.0
1974	-78.96	-133.3	729.3	**1989**	-36.80	-451.2	5349.0
1975	55.92	-34.1	944.6	**1990**	-86.26	480.0	6129.0
1976	-71.81	204.3	1341.7	**1991**	-100.91	-101.6	7175.0
1977	-73.16	375.7	1780.8	**1992**	-114.77	-55.7	7304.0
1978	12.86	-371.6	1996.6	**1993**	-111.41	-308.7	7522.0
1979	-21.01	70.8	2196.5	**1994**	-259.67	413.8	8840.7
1980	-125.60	-204.2	2476.0	**1995**	-464.71	168.1	7933.0
1981	-131.50	-270.4	2665.0	**1996**	-636.84	-420.8	8100.8
1982	-12.95	-244.7	2915.0	**1997**	-410.42	-30.8	7901.7
1983	-7.78	-70.1	3226.0	**1998**	-459.86	902.2	7972.9
1984	-50.29	-102.5	3320.0	**1999**	-184.18	612.9	7595.7
1985	27.97	-21.1	3752.0	**2000**	-158.80	233.6	7603.2

Notes: * Capital flight measure adjusted for trade misinvoicing using Morgan Guaranty Residual method *Source*: Nyoni (1997); IMF, *Direction of Trade Statistics Yearbook* for the trade flows; and own computations[8]

** Data from World Bank, *World Debt Tables*, Various issues, Washington D.C

Figure 1: Capital Flight and External Debt Developments in Tanzania (1970-2000).



Source: Table 2

It is clear from table 2 and figure1 that capital flight from Tanzania were episodic in nature, occurring in the early 1970s, reflecting the policy shift of the late 1960s to the early 1970s - particularly in the nationalization of what was classified as the commanding height of the economy; and second part of the 1970s as the economy entered the crisis period. The 1980s are not marked by capital flight problem, owing probably to various adjustment and economic recovery efforts, which signalled the reversal of earlier stringent macroeconomic policies. The 1990s recorded some capital flight in the mid 1990s, reflecting reversal in recovery effort in 1994 and uncertainties associated with the adoption of multiparty and political regime change in 1995. Capital flights in the late 1990s are most likely a reflection of serious debt burden faced by Tanzania, just before its qualification to HIPC debt reduction initiative in 2001.

It is clear also from table 2 and figure 1 that while capital flight trend in Tanzania has been episodic, foreign debt has been rising over time. For a long time, particularly during the mid-1970s to the mid-1990s, the size of the debt surpassed the size of the economy resulting in capital flight as well as discouragement of both foreign direct investment and domestic wealth holding. As noted earlier, the total debt stock of Tanzania rose from US$265m in 1970 or 14.8 percent of GDP to US$ 7603.2m or 94.3 percent of GDP in year 2000 after peaking at 178.4 percent in 1994..

3. Theoretical Framework

Capital flight is an unobservable phenomenon, whose agreement on its definition is difficult. The term capital

flight connotes illegal movement of capital from one country to another, implying that there may be "normal" or "legal" and "abnormal" or "illegal" flows of capital (Lessard and Williamson, 1987). Normal capital flows are those that are sanctioned by the government. They comprise all outflows that are not motivated by the attempt to avoid large losses. Normal outflows, therefore, include those resulting from households' attempts to maximize returns through international portfolio diversification; enterprises efforts to promote trade; and commercial banks' efforts to expand theirs activities abroad.

Abnormal capital flows are illegal capital movements that take place without the government's approval. The concept of capital flight thus refers to capital that runs away or flees abnormal risks at home, regardless of whether or not the flight is legal. On the other hand, external debt is the amount the country owes her foreign lenders, mostly foreign banks or foreign countries or both. External debt is measured in absolute terms, but commonly the ratio of debt to gross domestic product is used. Normally, countries borrow because they experience current account or budget deficits. This deficit may be brought about by either fall in exports, increase in imports and the rise in domestic spending.

Many theoretical constructs exist on the determinants of capital flight and external debt but very few are available for sub-Saharan Africa. Stated in a formal way, capital flight is directly related to the behaviour of a risk averse individual who diversifies his or her wealth in order to maximize returns. This emphasizes the decision to hold assets abroad as part of the process of portfolio diversification (Cuddington, 1986; Lensink, Hermes and Murinde, 1998). Since there is no universal definition of capital flight, the literature offers several and corresponding approaches for devising flight estimates. Theories have focused on tax and tax like distortions that lower returns and add risk to domestic financial and physical assets, leading to capital flight and how often these risks are related to foreign borrowing. According to the standard portfolio model, capital flight arises from portfolio diversification incentives, return differential incentives, and risk incentives (Sheets, 1995). Domestic investors face a higher risk of expropriation, so that they decide to invest abroad while some use foreign funds to finance domestic investment.

The capital flight literature focuses mainly on three directions. First, the risk of expropriation is generalized to risks of high taxation and is related to large foreign borrowing. In most of these models, capital flight is subject to spillovers such that as capital flees, the expected per capita tax liability increases and accelerating incentives for further capital flight. Second, political economy models have endogenized reasons why governments may levy very high and variable taxes on domestic assets. Third,

public finance models have focused on effects of capital income taxation that vary in relation to residence and source, thereby explaining capital flight and domestic investment financed by foreign borrowing.

In a macroeconomic model, Ize and Ortiz (1987) show that when fiscal rigidities create difficulties for servicing foreign debt, private capital flight is encouraged by foreign borrowing since there is an expectation of higher domestic asset taxation in order to service future debt. Alesina and Tabellini (1989) consider a model in which different government types with conflicting distributional goals randomly alternate in office. The uncertainty over future fiscal policies leads simultaneously to capital flight, low domestic investment and occurrence of large external debts. The over-borrowing occurs since the current government does not fully internalize the future costs of servicing the debt. Lessard and Williamson (1987) show that factors such as natural resource discoveries, changes in terms of trade or technologies that alter the value of national endowments, effective industrial policies or demographic shifts may cause the economic return on capital in a particular country to tend to diverge from the world level. Moreover, national macroeconomic and regulatory policies may cause financial and investment returns to diverge from the underlying economic returns than in the world economy at large. Thus, higher tax rates, financial repression, price controls and bureaucratic restrictions will cause such divergence and lead to capital flight.

3.1. Linkage between Capital Flight and External Debt

According to Boyce (1990), there are two kinds of linkages between external debt and capital flight. The first linkage runs from external debt to capital flight, while the second runs from capital flight to external debt.

Debt Driven Capital Flight: This view of the debt-capital flight linkage maintains that the association between the two variables may be attributable to poor economic management and track records of debtor governments. For instance, the Morgan Guaranty Trust Company (1986) contends that indirect factors such as slow growth regimes, overvalued exchange rates and poor fiscal management not only cause capital flight but also generate demand for foreign credit. Alternative scenarios of the indirect nature of the debt-capital flight relationship is that lower debt inflows mirror and contribute to deteriorating local economic conditions that result in greater capital flight. Other researchers have advanced the argument that external borrowing can directly cause capital flight by providing the resources necessary to effect flight (Cuddington, 1986). External borrowing may also trigger conditions that motivate residents to engage in capital flight. Lessard and Williamson (1987) argue that debt disbursements signal an increase in

the probability of a fiscal crisis and thus induce capital flight, implying a negative correlation between external debt and capital flight.

Capital Flight Driven External Borrowing: Another perspective on the association between external debt and capital flight maintains that the causality runs from capital flight to external borrowing. Capital outflows may drive a country into external indebtness where debt essentially replaces the funds lost on account of capital flight. Boyce (1990), notes that foreign creditors may be willing to fill the vacuum created by flight if they perceive a comparative advantage in risk and return. To this end, Lessard and Williamson (1987) suggest that disparities in taxation, interest rate ceilings and risk pooling may lead to systematic differences in risk adjusted returns to resident and non resident capital. Khan and Ul Hague (1995) highlight also the coexistence of two-way capital flows and describe instances where flown resident capital re-enters the country as a publicly guaranteed loan.

3.2. Measures of Capital Flight

There are various measures of capital flight; a reflection that there are also various definitions of the term. A handful of measures of capital flight have been proposed in the literature. In these measures, magnitudes of capital flight would vary with accuracy of data as well as the approach used. The common measure is a residual approach developed in 1983 and which is frequently used in estimating capital flight indirectly on the basis of balance of payments (BoP) statistics9. This estimation technique compares the sources of finance (i.e. the increase in gross external debt and net foreign direct investment) and uses of finance (i.e. changes in official reserves, current account deficits and capital outflows) and estimates capital flight as a residual. The residual method has been widely used and various modifications have been made since it was developed

The World Bank (1985) approach is premised on the definition of capital flight as the change in the nation's foreign assets. It is based on an attempt to identify both the sources and uses of international funds by a nation and calculates capital flight as the difference between increase in gross external debt and net foreign direct investment (sources of funds) and the current account balance and increase in official reserves (uses of funds). Essentially, the method equates capital flight with non-official capital outflows. Morgan Guaranty's (1986) approach provides an interesting modification to the standard residual method. This version of the residual method takes into account the change in the short-term foreign assets of the domestic banking system as an additional term. This modification is introduced to focus exclusively on non-bank capital flight. The Morgan Guaranty variant of the residual method estimates capital flight based on balance of payments identity10.

Dooley (1988) approach represents another variation of the residual approach, which attempts to distinguish between the so-called normal and flight capital flows. The method is premised on the view that flight stems from the desire to avoid domestic taxation and therefore flight need not be a current transaction, but merely reflects a change in the motive for holding a previously acquired foreign asset as the domestic investment climate changes. In this case, flight is that stock of foreign assets whose returns have not been reported as an investment in BOP. The Modified World Bank approach, which in essence is a combination of the World Bank and Dooley "residual" measures capital flight, offers an easy way to calculate Dooley flows, whereby capital flight is broadly defined to encompass both short and long term non official outflows (the World Bank measure) less any capital outflows that correspond with a desire to avoid domestic taxation.

4. Econometric Model, Estimation Techniques and Empirical Results

Both quantitative and descriptive techniques are utilized in analyzing the causal relationship between capital flight and external debt developments in Tanzania. Tests providing an analysis of the summary of descriptive statistics and unit root tests are done in order to address the weaknesses of the Classical econometric theory, which assumes that observed data come from a stationary process, where means and variances are constant over time. Subsequently, cointegration analysis and VAR Granger Causality tests are carried out to test the hypotheses that: first, capital flight is positively related to budget deficit, disbursed debt stock, tax payments, interest rate differential, and inflation rate; second, capital flight is negatively related to GDP growth; and third, capital flight and external debt drive each other.

4.1. Model Specification

The study employs a modified version of the simultaneous model adopted by Chipalkatti and Rish (2001).11 The literature on capital flight identifies external debt, budgetary deficit, inflation, tax payments, real GDP growth rate and interest differential as important determinants of capital flight. Research has also documented the influence of these same variables in determining country's indebtedness (see Cuddington, 1986; Henry, 1996). Generally, capital flight model can be specified as:

$$(2)\ CF = f(\pi, YG, DF, TP, RD, EX),$$

where CF is capital flight defined as the change in domestic holdings of foreign assets in the current period, π is inflation, YG is the rate of growth of gross domestic product, DF is budget deficit, TP represents tax payments as measured by ratio of tax revenue to GDP (tax effort), RD stands for interest rate differential as measured by the difference

between real foreign interest rate and real domestic interest rate, while EX stands for debt disbursement (total external debt). Equation (2) can be rewritten in log linear form as:

$$(3)\quad CF = \beta_0 + \beta_1 \pi + \beta_2 YG + \beta_3 DF + \beta_4 TP + \beta_5 RD + \beta_6 EX$$

Here, $\beta_1, \beta_4, \beta_5, \beta_6 > 0$; $\beta_2 < 0$ and β_3 and can take any sign. In this case, equation (3) can be rewritten in a general autoregressive distributed lag form of order to yield:

$$(4)\quad CF = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} CF_{t-i} + \sum_{i=0}^{m} \alpha_{2i} \pi_{t-i} + \sum_{i=0}^{m} \alpha_{3i} YG_{t-i} + \sum_{i=0}^{m} \alpha_{4i} DF_{t-i} + \sum_{i=0}^{m} \alpha_{5i} TP_{t-i} + \sum_{i=0}^{m} \alpha_{6i} RD_{t-i} + \sum_{i=0}^{m} \alpha_{7i} EX_{t-i} + \varepsilon_{1i}$$

where m is the lag length and is a white noise process with the usual properties. Equation (4) expresses capital flight as a function of its lagged values and lagged values of inflation, the rate of growth of gross domestic product, budget deficit, tax payments (tax effort), interest rate differential, and total external debt.

In establishing the link between variables used in the model, a dynamic standard structural VAR model is used, which is technically specified as:

$$(5)\quad B(L)X_t = V$$

Here X_t represents the number of variables used and $B(L)$ is a vector of matrix with the lag operator L and $B_0 = I$. V's are the innovation process for X with $E(V_t V_t') = \sum$ and $E(V_t V_{t-l}) = 0$ for $l \neq 0$. This framework provides the basis for comparing the relative importance of the various factors which cause capital flight. As a result of this, each variable is given a chance to play its role in the determination of the impact on each of the other variables as well as determining whether or not each variable is driven by its own history.

4.2. Analysis and Discussion of the Results

Unit Root Test: The variables used in this study were analyzed to determine the existence of stationarity before proceeding to test the variables for cointegration. Augmented Dickey Fuller (ADF) unit root test was applied to each of the series. The results revealed that all variables (in levels) except capital flight had at least one unit root. However, when unit root test was conducted for variables whose null was not rejected in their first difference, results indicated that all the series were stationary, implying that with the exception of capital flight, all variables were integrated of order one such that they became stationary when differenced only once. This implied also that in order to avoid spurious regression results, estimations should be carried out with variables in their first differences except capital flight.

Cointegration Analysis: This analysis aimed at addressing two main issues. First, was to determine whether external

debt, inflation, interest rate differential, GDP growth, budget deficit, tax payments drive each other and whether they as well were driving capital flight. Second, was to check whether there was a long run relationship (cointegration) between capital flight and its determinants. The analysis began by investigating whether the variables were cointegrated or not because unit root test indicated the presence of unit root with the exception of capital flight, which was observed to be integrated of order zero. In order to determine whether capital flight and its determinants are cointegrated, the so-called Maximum Likelihood Procedure as developed by Johansen (1988), was used. Cointegration test and other subsequent estimations were carried out using PCFIML program in PCGIVE - version 9.1 (Doonrnik and Hendry, 1991). The results for unrestricted capital flight model are presented in table 3. Both the λ_{max} and λ_{trace} reject the null hypothesis that there is no long run relation between the variables, i.e., $r = 0$, in favour of the alternative that there is one long equilibrium relationship. Therefore, the results imply that there exists a single cointegrating equation as exhibited by the long run cointegrating vector.

Table 3: The Cointegration Test Results

H0 : rank = p	λ_{max}	*Adj.fordf*	*95%*	λ_{trace}	*Adj.fordf*	*95%*
p== 0	59.07**	44.81	45.3	141.4**	107.3	124.2
p < = 1	36.67	27.82	39.4	82.36	62.48	94.2
p < = 2	21.03	15.96	33.5	45.69	34.66	68.5

Notes: p = number of cointegrating vectors; **means significant at 1 percent; *Adj.for df* reads as adjusted for degrees of freedom.

From the standardized eigenvectors, the cointegrating long run equation can be presented as:

(6) $CF = -26.282\pi - 28.874YG + 0.40608DF - 2.0395TP + 10.137RD + 0.02850EX$

The analysis of the above long run capital flight equation implies that budget deficit, interest rates differential and external debt contribute positively to fuelling capital flight; while GDP growth rate, inflation and tax effort seem to be negatively related to capital flight. While the former result confirms the hypothesis that capital flight is positively related to budget

deficit, interest rates differential and external debt, the latter indicates the opposite. The hypothesis that capital flight and GDP growth are negatively related in the sense that GDP growth tends to reverse flow of capital out of the country, is clearly supported by the results.

Granger Causality Tests: The Granger causality test aims at determining how the variables used in the model drive each other after establishing long run cointegration relationships (i.e., it establishes how variations in one particular variable Granger cause variations in the other variable). This test is usually carried out using the Granger Non-Causality (GNC) tests. The results from the pair-wise Granger causality tests indicate that the only variables that granger-cause each other (at 5 percent level of significance) are interest rates differential and external debt accumulation. Otherwise, capital flight granger causes external debt accumulation with no reverse effect; inflation rate granger causes capital flight but capital flight does not granger cause inflation; external debt accumulation granger causes budget deficit but the converse is not true; budget deficit granger causes changes in interest rates differential with no reverse effect; GDP growth granger causes budget deficit also with no reverse effect; budget deficit granger causes tax effort but the reverse is not true; interest rates differential granger causes inflation rate but the converse is not true; while tax effort granger causes GDP growth but GDP growth does not granger cause the tax effort. From this analysis, it can be concluded that capital flight in Tanzania is predicted by inflation rate, budget deficit, interest rates differential, GDP growth, external debt accumulation and tax effort; and that these variables tend to predict each other in the directions already indicated. These results also confirm the hypothesis that capital flight and external debt drive each other indirectly through the other determinants of capital flight.

Forecast Variance Decomposition: Variance decomposition originates from the moving average representation of the VAR model. Unlike Granger causality, variance decomposition shows the portion of the forecast error variance (predictive power/relative strength) of each variable that is attributable to its own innovations and shocks with respect to other variables in the system. In this regard, variance decomposition of the forecast error was used (Appendix 1). The results indicate that over 91 percent of the variations in capital flight are due to own innovations with remaining percentage due to inflation, budget deficits and to a lesser extent due to external debt, GDP growth and interest rates differential. Variations in external debt are largely accounted for by shocks in inflation (38 percent), capital flight (23 percent), interest rates differential (4.8 percent), and GDP growth and tax effort (3 percent each). On the other hand, variations in

GDP growth are due to its own innovations (over 60 percent), budget deficit (20 percent), capital flight (8 percent) and inflation (4 percent). Most of the variations in inflation are explained by shocks to inflation (67 percent) aided by budget deficit, tax effort, external debt and capital flight.

Furthermore, variations in budget deficits are mainly due to own innovations (78 percent) aided by tax effort, capital flight, and GDP growth and external debt respectively. Interest rate differential and capital flight account for variation in tax effort by 10 percent and 7 percent respectively, while over 76 percent of its variations are due to own innovations. Variations in interest rates differential result from GDP growth, capital flight, external debt and budget deficit at 11, 8, 7 and 7 percents, respectively, while own innovations account for 60 percent. The analysis implies that while most variables accounts for their own innovations, there are slight contributions of variations from other variables. It can generally be concluded that interest rate differential, external debt, budget deficit and tax effort play a role in predicting capital flight movements.

Impulse Response Functions (unrestricted VAR): The impulse response functions (IRFs) trace the effects of a shock to one endogenous variable on the other variables through the dynamic structure of the VAR. In the present case, the IRFs trace the effects of unanticipated shocks of external debt, budget deficits, inflation, interest rate differential, tax effort, and GDP growth on capital flight. The IRFs, which originate from the moving average representation of the VAR model, show the estimated response of each variable to a one standard deviation impulse in one of the innovations (Appendix 2). The IRFs results indicate that innovations to capital flight had a positive impact on external debt for the whole period but with gradual decay, while innovations to external debt do not show a clear impact trend. The functions also show that an innovation to inflation impacts capital flight within the first two periods but quickly stabilizes. The same applies to innovations to capital flight on inflation. There is evidence also that a one standard deviation shock to interest rates differential impacts capital flight positively with gradual stabilization thereafter while innovations to capital flight negatively impact interest rates differential within the first four periods then stabilizes quickly. By virtual inspection, some of the responses seem to be hardly significant for some pair of variables. This might be attributed to the fact that observations span for only thirty one years. Given the number of variables in the model, this makes it difficult to generate impressive results within the VAR framework although this should not be a constraint to interpreting the findings.

6. Conclusion: Summary of Findings and Emerging Policy Issues

The key objective of this study was to establish factors that determine capital flight in Tanzania, understand their dynamics in terms of how they drive capital flight and each other over time, and in particular establish a causal relationship between capital flight and external debt. The conceptual framework of this study involved laying out economic model and choosing appropriate variables for the analysis based on the existing theory and postulated hypotheses that capital flight is positively related to inflation rate, tax effort, interest rates differential, budget deficit and external debt; and negatively related to GDP growth rate. To test the hypotheses, the study employed both qualitative and quantitative analyses using the 1970-2000 period annual time series data. Appropriate data transformations were applied to establish whether the variables mimic the normal distribution and time series properties of the data, before various tests within the framework of the VAR models were carried out. The tests include Cointegration, Granger Causality, Variance Decomposition and IRFs.

Empirical analysis led to the following main findings. The cointegration analysis of capital flight indicated that budget deficit, interest rate differential and external debt fuel capital flight when there is a surge in either of the variables. Similarly, GDP growth is another determinant of capital flight particularly when the economy is in crisis/recession. However, if the economy is robust and stable, there is an incentive for massive capital inflow. The results of the Granger causality test revealed a one-way causation between capital flight and external debt, inflation rate, budget deficits, and GDP growth rate. The analysis also revealed a bi-directional causality between interest rate differential and external debt accumulation. The Granger causality results thus confirm further the results of the cointegration analysis. Variance decomposition of the VAR model suggested that 91 percent of the variations in capital flight were due to own innovations, with the remaining percentage being due to inflation, external debt, budget deficit, GDP growth rate and interest rate differential. On the other hand, variations in external debt were mainly due to shocks in capital flight by 23 percent, accompanied by shocks to inflation, interest rate differential, GDP growth rate, and tax effort. Finally, the IRFs revealed that external debt, inflation, and interest rate differential contributed towards movements in capital flight over time. In general, all these results suggest that both tests are relevant in investigating capital flight determinants although with varying degrees and strengths.

From the foregoing empirical findings, certain policy issues are implied. The study suggests the existence of a contemporaneous relationship between capital flight and external debt, GDP

growth, inflation, budget deficit and interest rate differential. A shock in any of the variables in the system is likely to spill over to all other variables with reverse effects in some cases. For instance, a persistent increase in GDP growth rate may attract massive capital inflows, with high rates of investments and more government resources in terms of revenue collection. With high revenue collection, there is likelihood of reduced fiscal deficits as well as external borrowing. This suggests that sound macroeconomic policies and good governance are essential in ensuring sustainable economic growth. Hence, in order to reduce capital flight and external debt accumulation, the government may focus on establishing and sustaining sound macroeconomic and political situation. In particular, sound fiscal and monetary policies12, sustainable debt management, and high and stable economic growth are necessary if the Tanzania is to reverse and discourage any further capital flight.

Despite weaknesses in terms of data quality as is common with many developing countries, it is hoped that the results of this study are strong enough to be used to inform policy decisions. This study limited itself to the variables discussed above, and it cannot boast of having explored all the determinants of capital flight in Tanzania. There are definitely other variables such as measures of perceived risk and business competitiveness, and indexes of governance including corruption and political stability, among others, which have a bearing on capital flight but were not tested in this study.

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1 As estimated by a Morgan Guaranty Trust Company study (1986), over the 1976-85 period least developed countries (LDCs) experienced net capital flight of nearly $200 billion, while simultaneously accumulating $450 billion additional foreign debt. In Tanzania, massive capital flight is acknowledged in Nyoni (1997), Baruani (1995) and Malyamkono and Bagachwa (1990).

2 In particular, studies by Ajayi (1997) and Chipalkatti and Rish (2001) attempted to address the issue.

3 These were mainly private industries, banks, insurance companies, commercial farms and privately owned commercial buildings.

4 The accumulation of debt and debt service obligation was also contributed by over-borrowing to finance the war against Iddi Amin's Uganda.

5 For details, see Mwinyimvua and Wangwe (2002).

6 Import under-invoicing was a common practice in Tanzania as evidenced in Mpango (1996).

7 Export misinvoicing (XMIS) was calculated as XMIS=XD-MW/kW where XD is exports to the world trading partners as recorded by Tanzania, MW is imports from Tanzania as recorded by world trading partners and kW is the world cif/fob correction factor.

Import misinvoicing (MMIS) was calculated as MMIS=MD/kT -XW where MD is imports from the world trading partners as reported by Tanzania, XW is exports to Tanzania as reported by world trading partners and kT is Tanzania's cif/fob correction factor.

8 The approach was developed by Doley et al and their first article, in Dutch, appeared in Rotterdamse Monetaria Series No.11 of 1983. An English version was published in 1986 (see Doley et al, 1986).

9 Capital flight is calculated as:, where CF is capital flight according to the Morgan Guaranty variant of the residual method, denotes change, ED is stock of gross external debt, FI is the net foreign inflows, CAD is the current account deficit, F is the stock of official foreign reserves, and B the change in the short-term foreign assets of the domestic banking system.

10 Instead of the simultaneous model, the study uses a single equation expressed as a Vector Autoregressive (VAR) model. The choice of VAR methodology is attributed to a prior assumption about the causality of the variables under simultaneous equations, that some variables are exogenous and others endogenous. VAR model incorporates feedback effects and determines the direction of causality.

11. Clear and stable policies regarding management of public finances and foreign borrowing as well as with respect to monetary policy conduct affecting both inflation and interest rates, so as to reduce risk and uncertainty over the country's policies and their impact on the real value of wealth perceived by domestic wealth holders.

Appendix 1: Forecast Variance Decomposition

Variance Decomposition of CF:

Period	S.E.	CF	EX	YG	INFL	DF	TP	RD
1	285.4219	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	290.8668	96.35614	0.014878	0.113860	2.652905	0.392299	0.022107	0.447813
3	294.4441	94.13152	0.064149	0.200030	3.594460	1.527039	0.045608	0.437192
4	296.7262	92.87282	0.086423	0.448115	3.838900	2.273850	0.045566	0.434328
5	298.2453	92.09899	0.090253	0.620310	3.837887	2.867943	0.046495	0.438120
6	299.2425	91.62610	0.089817	0.728376	3.813488	3.247111	0.053140	0.441971
7	299.9242	91.31909	0.095365	0.784495	3.827440	3.462962	0.064235	0.446409
8	300.4238	91.10066	0.110575	0.811135	3.882321	3.566370	0.077069	0.451868

Variance Decomposition of EX:

Period	S.E.	CF	EX	YG	INFL	DF	TP	RD
1	224.9190	40.29366	59.70634	0.000000	0.000000	0.000000	0.000000	0.000000
2	360.1075	42.39683	40.65273	2.029536	6.410729	1.150438	0.221530	7.138200
3	486.3678	39.25999	32.29616	4.332280	14.58457	0.842097	0.336279	8.348620
4	598.8186	35.16076	28.64944	4.718262	22.34450	0.603885	0.577157	7.945998
5	698.9552	31.38634	26.97547	4.503575	28.62213	0.447195	0.964537	7.100757
6	788.5788	28.14544	26.16613	4.117013	33.33971	0.429970	1.544423	6.257307
7	869.3800	25.41822	25.73885	3.739265	36.69624	0.545652	2.346661	5.515118
8	942.8222	23.12018	25.46619	3.419818	38.96790	0.750512	3.392588	4.882818

Variance Decomposition of YG:

Period	S.E.	CF	EX	YG	INFL	DF	TP	RD
1	1.854597	11.71459	1.546297	86.73911	0.000000	0.000000	0.000000	0.000000
2	2.098504	9.660564	1.568694	69.33737	2.235904	16.12466	1.035882	0.036929
3	2.182609	9.039023	1.452813	65.50413	3.384653	18.62897	1.340400	0.650015
4	2.228528	8.670950	1.402778	62.99736	4.125091	19.99781	1.705641	1.100380
5	2.252177	8.492002	1.400699	61.74633	4.506683	20.35307	2.055737	1.445475
6	2.266416	8.391032	1.415350	60.99773	4.704405	20.41078	2.424454	1.656244
7	2.276331	8.323622	1.434616	60.48591	4.805128	20.35378	2.807213	1.789727
8	2.284411	8.269944	1.453220	60.07617	4.856514	20.26037	3.204735	1.879048

Variance Decomposition of INFL:

Period	S.E.	CF	EX	YG	INFL	DF	TP	RD
1	6.462447	0.035526	3.535337	0.039589	96.38955	0.000000	0.000000	0.000000
2	8.121623	0.525985	5.068379	0.934949	90.29723	2.234827	0.135142	0.803488
3	8.991235	1.194569	5.874932	2.171557	83.92911	4.999008	0.620881	1.209938
4	9.501457	1.705787	6.242405	2.836415	78.69435	7.682419	1.446640	1.391989
5	9.825065	2.065698	6.359170	3.087281	74.76797	9.646411	2.593065	1.480408
6	10.04812	2.318180	6.347735	3.110451	71.84470	10.83188	3.995878	1.551180
7	10.21772	2.501860	6.273282	3.045309	69.57562	11.38726	5.582136	1.634539
8	10.36095	2.640587	6.167688	2.963313	67.68471	11.52223	7.277256	1.744214

Variance Decomposition of DF:

Period	S.E.	CF	EX	YG	INFL	DF	TP	RD
1	124.8387	1.746462	3.112421	0.114129	0.496786	94.53020	0.000000	0.000000
2	145.6939	2.871597	2.883798	4.181352	0.546822	87.85665	0.995951	0.663832
3	157.2458	3.276098	2.577195	4.243384	0.481092	86.85073	1.844017	0.627480
4	163.2664	3.684116	2.521676	4.260870	0.535174	85.42616	2.986401	0.585604
5	166.9746	4.026184	2.412582	4.154873	0.688887	83.90258	4.234947	0.579945
6	169.5909	4.324095	2.343079	4.042561	0.897169	82.21442	5.538505	0.640172
7	171.7453	4.575356	2.303319	3.941793	1.130443	80.45725	6.821886	0.769952
8	173.7087	4.783971	2.284946	3.858540	1.367280	78.71190	8.037581	0.955783

Variance Decomposition of TP:

Period	S.E.	CF	EX	YG	INFL	DF	TP	RD
1	1.177660	7.513085	0.214969	2.497180	3.796051	0.796827	85.18189	0.000000
2	1.669969	7.003688	0.397824	2.562450	2.030090	5.327114	78.30714	4.371695
3	2.042343	7.489472	0.338352	1.882787	1.359426	3.982877	78.69474	6.252342
4	2.362936	7.577664	0.270780	1.719048	1.065966	3.038422	78.53734	7.790780
5	2.648654	7.527697	0.216622	1.691007	0.965662	2.429849	78.30790	8.861261
6	2.908286	7.395164	0.180479	1.759782	0.958151	2.115969	77.92262	9.667832
7	3.146687	7.232343	0.158571	1.868102	0.986737	2.017252	77.44747	10.28952
8	3.366795	7.064033	0.146232	1.991261	1.024989	2.058984	76.92963	10.78487

Variance Decomposition of RD:

Period	S.E.	CF	EX	YG	INFL	DF	TP	RD
1	10.74127	6.936477	7.601102	6.215978	0.131791	0.430125	1.951057	76.73347
2	11.92774	6.382662	6.915156	12.67954	0.130248	6.569122	1.626805	65.69647
3	12.02928	6.413236	7.045650	12.54782	0.277913	7.020989	1.848282	64.84611
4	12.11301	6.813156	7.069684	12.37826	0.275111	7.404749	2.042583	64.01646
5	12.21037	7.357151	7.088474	12.25890	0.354216	7.500147	2.255579	63.18553
6	12.31602	7.847150	7.134545	12.11683	0.646055	7.477685	2.447329	62.33041
7	12.42350	8.238707	7.221990	11.95013	1.138315	7.380095	2.606321	61.46444
8	12.52958	8.532302	7.346282	11.76850	1.761294	7.257660	2.722691	60.61128

Ordering: CF EX YG INFL DF TP RD

Appendix 2: Impulse Response Functions