Macroeconomic Stabilization and Economic Growth: The Case of Uganda*

Andrew Feltenstein and Sudipta Sarangi**

Abstract: This paper develops a computational general equilibrium model for analyzing some chronic economic problems facing developing countries. We build a multi-period model with multiple types of capital and three different financial assets. Moreover, capital is sector specific to capture the idea that many developing countries focus on a few specific industry groups. We model both rural and urban consumers with the possibility of rural-urban migration. One further modeling feature is a partially interdependent banking sector where the performance of, say, the agricultural bank can affect the functioning of the industrial bank. The model is used to examine problems of budgetary liquidity and alternative ways of alleviating these problems. Our analysis is applied to Uganda, a country that after years of economic decline is undergoing a phase of recovery and reform. Accordingly, we develop a model that captures some of the predominant institutional features of the Ugandan economy and evaluate two realistic reform scenarios. After calibrating the model with a base case scenario we test the implications of a simultaneous tariff reduction and increase in value added taxes. We then look at the implication of debt reduction.

Résumé: <Abstract in French to come from editors>

1. Introduction

This paper develops a computational general equilibrium model for analyzing some chronic economic problems facing developing countries.

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The model captures a number of salient features of several African economies. We build a multi-period model with multiple types of capital and three different financial assets. Moreover, capital is sector specific to capture the idea that many developing countries focus on a few specific industry groups. We model both rural and urban consumers with the possibility of rural-urban migration. One further modeling feature is a partially interdependent banking sector where the performance of, say, the agricultural bank can affect the functioning of the industrial bank. The model is used to examine problems of budgetary liquidity and alternative ways of alleviating these problems.

Our analysis is applied to Uganda, a country that after years of economic decline is undergoing a phase of recovery and reform. In an effort to dismantle the highly protected economy, it is now in the process of lowering trade barriers and making the tariff regime more uniform. At the same time there is also a move towards fiscal rectitude through a shift in the tax policy and an attempt to reduce the external debt. The country faces several obvious questions. Will there be significant allocative effects from tariff liberalization and additional changes in the domestic tax regime? What will be the consequences of reduced foreign debt service? And possibly most important, what will the welfare implications of these reforms be?

Accordingly, we develop a model that captures some of the predominant institutional features of the Ugandan economy and allows for the evaluation of alternative scenarios pertaining to budgetary liquidity and their growth consequences.

Computational general equilibrium models, or applied general equilibrium models, as they might perhaps better be called, are in wide use for the evaluation of government policies. Among the many different types of models that have been employed by a variety of researchers, two general types stand out. The first of these employs large-scale, highly detailed structures representing the production and consumption technologies of a particular economy and is static in nature. Consequently, there is little evaluation of, for example, monetary and exchange rate policies or of the behavior of investment, inflation, and interest rates.

The second approach generally incorporates smaller-scale models with less sectoral detail but having intertemporal structures that permit the evaluation of a wide variety of macroeconomic policies affecting growth, inflation and investment. The model we develop for Uganda has a considerable amount of sectoral detail, but its key feature will be the incorporation of financial instruments so that we may evaluate the endogenous outcomes of alternative government policies. The most relevant earlier work in this topic is Feltenstein (1992) which constructs a simple two-period model incorporating domestic and foreign financial
assets to study the Dutch disease phenomenon in Mexico. A similar model by Feltenstein and Shah (1993) is used to address the issue of investment tax credits in Pakistan (see also Feltenstein and Shah, 1995). The model can also be treated as a companion paper to Feltenstein and Sarangi (2002) where we examine fiscal policy and public utility improvements for the Tanzanian economy.

Section 2 will examine some of the relevant issues in Uganda. Section 3 will develop the theoretical structure of our model. Section 4 will discuss data sources for the parameterization of the model and will give examples of numerical simulations of the model. The examples will also look at some policy prescriptions examples. The final section will be a summary and conclusion.

2. Issues and Application to Uganda

Uganda’s post-independence political history has been quite unstable. The 15-year period of political turmoil that ended in 1986 has led to Uganda’s economic decline, with its GDP falling below the levels attained in the early 1970s. After peace was restored in 1986, the Ugandan government began to implement a set of reforms called the Economic Reform Program. The aim of this program was to liberalize the economy and to focus its incentives on the country’s tradable goods sector.

Considerable progress has been made on the liberalization front. Since 1990, explicit export taxes have been removed and import liberalization has taken place. Tariffs have been reduced and many quantitative restrictions on imports have been eliminated. The Coffee Marketing Board’s monopoly on coffee exports has been removed so that prices can now be market determined. The implicit taxation of coffee exports has been reduced, although coffee is the largest source of export revenue. Progress is also being made in the reform of public sector enterprises and in the financial sector. The government is already in the process of privatizing the two largest domestic banks and restructuring the weak banks. The Bank of Uganda Statute (1993) and subsequent legislation enhances banking supervision and introduces the regulation of non-bank financial institutions. The government has also launched initiatives for the reform of the power sector and railways. A recent IMF study (1999) states that the government of Uganda recognizes that the amount of subsidies to public enterprises is substantial compared with public expenditures allocated for poverty eradication programs. Hence the government is committed to creating more efficient public enterprises.

This paper develops a computational general equilibrium model to study the reform process of the Ugandan economy using data from the stable
phase of the economy. After calibration, the model is used to conduct counterfactual simulations that focus on certain policy changes that Uganda has been trying to implement. The model itself has been developed in keeping with some important stylized facts about the Ugandan economy. We aggregate the input-output matrix of Uganda into five non-agricultural sectors and the agricultural sector. As is often the case in many developing countries, economic activity is concentrated and many of these sectors often obtain machinery and equipment from external sources. We model this by having sector-specific capital. A significant proportion of the banks have been state-owned, though the banking sector is now in a transition phase. We model these state-owned banks by allowing each sector in the economy to have special access to credit from its own dedicated bank. We now proceed to develop the analytical structure of our model.

3. Model Structure

The model used here resembles Blejer et al. (2002) and for the sake of brevity we only present the essential features here. The model has \( n \) discrete time periods. All agents optimize over a two-period time horizon with perfect foresight, and have expectations about the future beyond the second period. These are based on an adaptive expectations framework using the entire past history. That is, in period \( t \) agents optimize given prices for periods \( t \) and \( t + 1 \) and expectations about prices for the future after period \( t + 1 \). Thus agents have short-term perfect foresight, while their beliefs about the medium-term future are based upon a learning process using past data.

We next describe the specific structure employed in carrying out our numerical simulations. Note that the exogenous variables in the model are initial allocations—both real and financial, consumer utility weights, production and investment functions, tax rates and real government spending, and the exchange rate, which incidentally is fixed. The endogenous variables are prices, demand for and supply of both real and financial assets, the government budget deficit (or surplus), and the balance of payments. Thus our model is comparable to a standard dynamic general equilibrium model with production and financial instruments. We begin by describing the modeling of production, consumption and the government role in the economy.

3.1 Production

Our stylized economy has eight factors of production and three types of financial assets. The five types of capital correspond to the five aggregate non-agricultural productive sectors and the details of this can be found in
the Appendix. Each of these factors and financial assets is replicated in each period and, accordingly, has a price in each period. Period 1 domestic currency is the numeraire.

An input-output matrix, $A_t$, is used to determine intermediate and final production in period $t$. Each sector in the input-output matrix produces sector-specific value added using capital and urban labor in the non-agricultural sectors, and land and rural labor in agriculture. A complete description of the sectors from which we obtain the five non-agricultural sectors and the agriculture is provided in the Appendix. The eight factors of production are allocated across different sectors. Capital is perfectly mobile across the subsectors in a given sector, but is immobile across sectors. As we shall see, labor, on the other hand, may migrate from the rural to the urban sector.

The specific formulation of the firm’s problem is as follows. Let $Y_{Ki}$, $Y_{Li}$ be the inputs of capital and urban labor in period $i$ to the $j$th non-agricultural sector. The outstanding stock of government infrastructure in period $i$ is denoted by $Y_{Gi}$. Then in period $i$, the production of value added in sector $j$ is given by:

$$v_{aji} = v_{aji}(Y_{Ki}, Y_{Li}, Y_{Gi})$$

(1)

where we assume that public infrastructure may act as a productivity increment to private production. In period $i$, sector $j$ pays income taxes on inputs of capital and labor, given by $t_{Ki}$ and $t_{Li}$ respectively. Agriculture is taxed on its use of labor. Hence the effective price for labor and capital ($P$) paid by sector $j$ also depends on these input taxes. Consequently, the prices charged by enterprises, $P$, are given by

$$P = v(P, Y_{Gi})(1 + t)(I - A)^{-1}$$

(2)

where $v(P, Y_{Gi})$ is the vector of cost-minimizing value-added per unit of output.

We suppose that each type of sectoral capital is produced via a sector-specific investment technology that uses inputs of capital and labor to produce new capital. It is assumed that the investment functions exhibit decreasing returns to scale. Investment is carried out by the private sector and is entirely financed by domestic borrowing. The investor pays a capital, or profit tax, on the returns to his investment and sells bonds to the public to finance his investment. Finally, note that the assumption of decreasing returns to scale, combined with a simple cost equation that takes into account the tax rate, the interest rate and returns to capital ensures a unique level of investment.
3.2 Consumption

There are two types of consumers, representing rural and urban labor respectively. We suppose that the two consumer classes have demands for the different types of goods that are given by constant fractions of their incomes. These fractions, derived from Cobb–Douglas utility functions, are normally different across consumers. The consumers also differ in their initial allocations of scarce resources and financial assets.

The consumers maximize intertemporal utility functions, which have as arguments the levels of consumption and leisure in each of the two periods. As in Feltenstein (1992), we permit rural-urban migration which depends upon the relative rural and urban wage rate. Consumers maximize these utility functions subject to their intertemporal budget constraints. The consumer saves by holding money, domestic bank deposits, and foreign currency. Money is required for transactions purposes, but the demand for money is sensitive to changes in the inflation rate. The full specification of the consumer’s maximization problem is given in the Appendix.

3.3 Government

The government collects income, profit, and value-added taxes, as well as import duties. It pays for the production of public goods, as well as for subsidies. In addition, the government must cover both domestic and foreign interest obligations on public debt. The deficit of the central government in period 1, $D_1$, is then given by:

$$D_1 = G_1 + S_1 + r_1 B_0 + r_{F1} e_{1B} F_0 - T_1$$  \(3\)

where $S_1$ represents subsidies given in period 1, $G_1$ is spending on goods and services, while the next two terms reflect domestic and foreign interest obligations of the government, based on its initial stocks of debt. $T_1$ represents tax revenues.

The resulting deficit is financed by a combination of monetary expansion, as well as domestic and foreign borrowing. If $\Delta y_{BG1}$ represents the face value of domestic bonds sold by the government in period 1, and $C_{F1}$ the dollar value of its foreign borrowing, then its budget deficit in period 2 is given by:

$$D_2 = G_2 + S_2 + r_2 (\Delta y_{BG1} + B_0) + e_2 r_{F2} (C_{F1} + B_{F0}) - T_2$$  \(4\)

where $r_2 (\Delta y_{BG1} + B_0)$ represents interest obligations on initial and period 1 domestic debt. Similarly, $e_2 r_{F2} (C_{F1} + B_0)$ is the interest payment on the

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initial stock of foreign debt plus period 1 foreign borrowing. We assume that while the government determines the face value of its bond sales in period $i$, $\Delta y_{BGi}$, foreign borrowing given by $C_{Fi}$, is exogenously determined by the lender. Hence $D_i = P_{Bi}\Delta y_{BGi} + P_{Mi}\Delta y_{Mi} + e_i C_{Fi}$ is the remainder of the budget deficit which the government finances through monetization.

### 3.4 The Foreign Sector and Exchange Rate Determination

The foreign sector is represented by a simple export equation in which aggregate demand for exports is determined by domestic and foreign price indices, as well as domestic real income. The export equation is defined in terms of change in exports. It takes into account the change in relative price ratios and change in real domestic income along with their respective elasticities.

The combination of the export equation and domestic supply responses determine aggregate exports. Demand for imports is endogenous and is derived from the domestic consumers’ maximization problem. Foreign lending behavior has not been explicitly modeled, and has been taken to be exogenous. Thus, while gross capital inflows are exogenous, the overall change in reserves is endogenous.

The government may intervene to affect the exchange rate. The supply of foreign reserves $y_{FGi}$, available to the government in period $i$ is given by:

$$y_{FGi} = y_{FG(i-1)} + X_i - M_i + x_{F(i-1)} - x_{Fi} + C_{Fi}$$

Here $x_{Fi}$ represents the demand for foreign assets by citizens of the home country, so $(x_{F(i-1)} - x_{Fi})$ represents private capital flows.

The government also has a demand for foreign assets which is determined by an exchange rate rule. Denote by $y_{Fi}$ whatever the government feels to be the critical level of period $i$ foreign reserves. This critical level is determined exogenously, and in our simulations is arbitrarily taken to be three months of imports. The government wishes to peg the exchange rate in period $i$ at its previous level, that is, set $e_i = e_{i-1}$. It will, however, adjust the exchange rate if its stock of reserves, $y_{FGi}$, deviates from its target, $y_{Fi}$. When reserves exceed the target, the government leaves the exchange rate as is or appreciates it only slightly. When reserves are below the target, the government devalues the exchange rate substantially.

Finally, changes in the money supply in period $i$, depend on government’s financing of its budget deficit, money created via open market operations and the domestic currency value of the balance of payments.
4. Applications to Uganda

In order to simulate our model we have used a variety of data sources and parameter estimates. We will first describe these sources, and then turn to numerical implementations of the model.

4.1 Data Sources

Production

The input-output (IO) structure of intermediate and final production is derived from the Input/Output Table for Uganda, 1992. As shown in the Appendix, this matrix is aggregated to 26 sectors, with sector 27 being imports. Real value added per unit output for each of the 26 domestic sectors is derived from the corresponding shares of wages and gross operating surpluses in each sector’s value added. The government is assumed to have a Cobb–Douglas production function whose coefficients are those of the aggregate economy. Finally, in the absence of direct estimation of investment functions, we have taken the functions to be the same for each type of capital. The coefficients of these functions are taken to be those of the value-added function for the construction industry. Even though the functions are the same, it does not imply that the levels of investment in the different capital types will be identical. This is because investment depends on the interest rate and the rate of return to capital, which may differ across capital types.

Effective Tax Rates

Using the Country Economic Memorandum (CEM) for Uganda and other World Bank estimates, we compute the various effective tax rates. Averages were taken between actual 1995 values and projected 1996 values.

The personal income tax ($t_p$) was computed using the pay-as-you-earn (PAYE) component of income tax, divided by the tax base of total wages and salaries ($w$):

$$
t_p = \frac{\text{PAYE}}{w} = \frac{25}{272} = 9.19\%$$

The corporate income tax ($t_c$) utilized the difference between total income taxes ($IT$) and the pay-as-you-earn tax, plus export taxes ($X$),
with the difference between Gross National Product (GNP) and wages as the tax base. Hence

$$t_c = \frac{IT - PAYE + X}{GNP - w} = \frac{72.1}{1295.4} = 5.56\%$$

The components of indirect tax ($t_i$) include the sum of sales taxes ($t_s$), value-added taxes ($t_v$), and excise taxes ($t_e$). Total consumption ($C$) is used as the tax base.

$$t_i = \frac{t_s + t_v + t_e}{C} = \frac{275}{5087.4} = 5.40\%$$

Finally, effective Import Duty ($ID$) was found to be 21.04%. It was computed using Custom Duties ($CD$) data values with total imports ($I$) as the base.

$$ID = \frac{CD}{I} = \frac{275.8}{1073.4} = 21.04\%$$

**Consumption**

There are two domestic consumer categories — urban and rural — in our model. We take consumption weights on each of the 27 input-output goods as the expenditure shares in the IO matrix. We assume that there is a single foreign consumer, representing the rest of the world. Export expenditure shares are used as the basis for consumer’s demand weights.

**Initial Stocks**

In our simulations, all initial allocations of factors and financial assets are taken to be stocks at the end of 1993. These are largely derived from the CEM. Stocks of urban and rural labor are obtained by applying the shares of income going to urban and rural labor (derived from the Uganda IO matrix) to 1993 Uganda GDP. Money stocks are taken from the M2 for 1993, while initial holdings of interest bearing assets are taken as total government domestic debt. Foreign assets, which are the initial dollar expenditures on Ugandan exports by the rest of the world, are derived as export plus service receipts. The stock of land is taken to be the real value added to agriculture and is taken from the Uganda IO matrix as the gross operating surplus of the agricultural sector (Columns 1–4). Finally, capital stocks are determined as the
gross operating surpluses of the corresponding five aggregate sectors in the Uganda IO matrix.

### 4.2 Estimation of Behavioral Equations

We now present the estimation of the behavioral parameters of money demand and export supply for the Ugandan economy. An export demand equation is not estimated here due to Uganda’s small share in the world trade. We use estimation techniques that have been used in the past for other developing countries.

**Money Demand**

The following behavioral equation specifying a functional form for the demand for money is based on Khan (1980). Let $y_t$ denote real income, and $\pi^e_t$ be the anticipated rate of inflation. Then, the demand for money can be expressed as:

$$\ln m_t - (1 - \beta)\ln m_{t-1} = \lambda a_0 + \lambda a_1 [\ln y_t - (1 - \beta)\ln y_{t-1}] + \lambda a_2 \beta \pi + \lambda a_3 \pi^e_t + \lambda a_4 \ln m_{t-2}$$

This equation is estimated using quarterly data obtained from International Financial Statistics (IFS) for the second quarter of 1981 to the last quarter of 1997. The money variable $m$ is acquired by deflating M1 and quasi-money by the consumer price index (CPI). Changes in CPI are used for the inflation variable $\pi$. Only annual GDP data is available through the IFS so we use a linear interpolation of this data to generate quarterly data for GDP. This is used for the real income variable $y$.

The likelihood function is maximized through a $\beta$-search where we allow $\beta$ to change in increments of 0.05. The optimal value of $\beta$ is found to be 0.65 and the estimated equation corresponding to this value is

$$m^* = 0.2248 + 0.4839 y^* - 0.0007 \pi^* + 0.541 m^*_{t-1}$$

with $t$-statistics $(-0.279)$, $(3.055)$, $(-2.239)$, $(5.028)$.

$$DW = 1.568 \quad R^2 = 0.809 \quad \text{Durbin’s } h = 3.229$$

where the values in parentheses are $t$-statistics, and $m^* = \ln m_t - (1 - \beta)\ln m_{t-1}$, $y^* = \ln y_t - (1 - \beta)\ln y_{t-1}$, and $\pi^* = \beta \pi$. The estimates found are all significant at the 5 percent level and their signs are consistent with
what theory would predict. We find a reasonable long-run income elas-
ticity of 1.0402.

The high Durbin’s $h$-statistic led to a re-evaluation of the model where
we included an additional lag. We find the optimal $\beta$ from this iterative
search to be $\beta = 0.25$.

\[
m^* = 0.1534 + 1.3432y^* - 0.003\pi^* + 0.094m^*_{t-1} - 0.535m^*_{t-2}
\]

\[
(0.252) \quad (3.822) \quad (-2.944) \quad (0.813) \quad (-4.741)
\]

$DW = 1.924 \quad R^2 = 0.506 \quad$ Durbin’s $h = 0.533

We now have a valid Durbin’s $h$-statistic, although the first lag in
money is now insignificant while the additional lagged estimate for
money is significant. A possible explanation for this occurrence is that
the representative consumer may fail to adjust to changes in money in a
single quarter. Using this revised formulation the long-run income elas-
ticity is found to be 1.4826.

**Export Supply**

Growth in Uganda is dominated by agriculture. It constitutes almost 50
percent of GDP, employs about 80 percent of the labor force, and
accounts for the bulk of exports, with coffee being the largest agricultural
commodity produced. The export supply equation estimated here is a
simple OLS regression. It is assumed that exports adjust instantaneously
since Uganda is an exporter of cash crops and we also assume that the
volume of exports is a function of the real effective exchange rate and of
GDP:

\[
\ln X_{st} = \beta_0 + \beta_1 \ln y_t + \beta_2 \ln e_t
\]

where $X_{st}$ is the real volume of exports, $y_t$ the real GDP, and $e_t$ is the real
effective exchange rate.

The annual data used to estimate this equation is obtained from the
IFS for the years 1981 to 1997. The estimated equation yields

\[
\ln X_{st} = 8.8584 + 0.2004y_t - 0.9056e_t
\]

\[
(5.979) \quad (0.653) \quad (-3.51)
\]

$DW = 1.522 \quad R^2 = 0.628$
The GDP coefficient is found to be insignificant, while the Durbin–Watson statistic is valid. Thus we conclude that exports are price, but not income, sensitive.

4.3 A Base-Case Simulation

The CGE model is solved using a standard fixed-point algorithm. There is perfect foresight for two periods and agents have endogenous expectations for the future. Using these expectations, agents update their behavior after two periods. Thus the solution is carried out in two-period sequences, that is, a fixed point is derived for periods \( t \) and \( t + 1 \). The final stocks from this solution are then used as initial allocations for a new solution for periods \( t + 2 \) and \( t + 3 \). If expectations that close a two-period sequence are always correct, then the solution would be equivalent to a perfect foresight model. Thus, for example, if the model were run for 10 periods, there would be 5 two-period solutions, all linked by end of period stocks and expectations.\(^{11}\)

In order to use our model for counter-factual simulations, it is first necessary to see how well it replicates historical outcomes. Accordingly, we have incorporated the various estimated parameters described above and have then run the macroeconomic model for the years 1994 to 1997, taking 1993 as the base year. This allows us to make comparisons between the simulated and actual values of endogenous variables, where 1997 is the last year for which a complete set of actual values are available. Thus initial allocations of capital, land, urban and rural labor, money, domestic bonds, and foreign reserves are given by their stocks at the end of 1993.

We assume that tax rates have their computed effective values. Government current and capital expenditures are given their actual values for 1994–97. We also suppose that the Central Bank wishes to maintain a level of reserves equal to three months of the level of imports in 1993. Clearly this is an arbitrary rule, but it corresponds to a standard policy prescription. The Central Bank does not maintain a pure float to achieve this goal. Rather, if the level of reserves falls below its target level, then the slope of the Central Bank’s devaluation is set equal to \((-2.0)\). If the level of reserves rises above the target level, then the Bank revalues with a slope of \((-0.5)\). Clearly these numbers are also arbitrary, but they offer an example of a possible policy exercise. Table 1 reports the simulation outcomes of macroeconomic variables, with actual historical values in parenthesis.

It may be worth making a few remarks concerning the simulated and actual values. First, notice that our model generates rates of growth in real GDP that are somewhat lower than historical values for the years for which comparisons can be made. Imports are somewhat smaller than
actual values, while exports are overstated. Hence the simulated overall trade deficit is understated. This probably stems from the simplistic nature of our export supply equation and from the fact that we cannot actually estimate the Ugandan import equation — both a consequence of data inadequacy. Inflation is somewhat lower than the actual rate, as we attribute all foreign lending to deficit financing. The budget deficit is close to its historical value in both years, as the directions of change in both revenues and expenditures are correct. Also the capital stock at the end of period 4 for each of the five sectors is normalized to hundred. Finally, we simulate a significant devaluation in the exchange rate. We thus conclude that our model, with the exception of exports, generates a reasonably accurate approximation of Ugandan reality.

### 4.4 Policy Changes

We now turn to the counterfactual policy simulations. These simulations have been chosen on account of their relevance to the Ugandan economy. They demonstrate the consequences of some key components of the reform process on the economy. Hence, we first provide a quick overview of recent happenings in the Ugandan economy and then present the results of our two simulations.

#### Background

A key objective of the Ugandan reform process concerns the government’s revenue strategy. Recurrent revenues had shrunk from around

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<th>Table 1: Base case, 1994–1998</th>
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<td>Nominal GDP&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Real GDP&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Trade balance&lt;sup&gt;b&lt;/sup&gt;</td>
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<sup>a</sup> These are index numbers based on period 1.  
<sup>b</sup> As a percentage of GDP.  
<sup>c</sup> Ugandan interest rates are not market determined, so there is little point in making historical comparisons.
15 percent of GDP in 1970 to 4.2 percent of GDP in 1986. Throughout the 1990s the Ugandan government has pursued strategies to raise the revenue-to-GDP ratio, while reducing the anti-export bias of the tax system. An independent Uganda Revenue Authority (URA) was established in 1991 to improve revenue collection.

The focus of tax reform has been on trying to expand the domestic tax base, while trying to increase reliance on non-trade taxes. Consequently in July 1996, the authorities introduced a value-added tax (VAT), which replaced the sales tax and the commercial transaction levy. The VAT was chosen for being an efficient tax and also for being able to expand the domestic tax base. Another major component of the tax reform has been to alter the tariff structure in order to facilitate exports. The thrust has been on gradually reducing tariff barriers by simplifying and lowering tariffs and phasing out exemptions and import bans. The number of rates fell from about 20 for Common Market for Eastern and Southern Africa (COMESA) imports and 5 for non-COMESA imports in 1993–94 to two structures of three rates each by 1998–99. More importantly, however, was the reduction in the rates themselves. The maximum rate for COMESA imports was lowered from 118 percent in 1994–95 to 6 percent in 1998–99. Similarly, the maximum rate on non-COMESA imports was reduced from 30 percent to 15 percent. Hence in our first simulation we explore the implications of this major policy change for Uganda.

Uganda has had a heavy debt burden, with the external debt increasing in a lockstep fashion with the economic reform program during the 1980s. By the early 1990s the total debt-to-export ratios were above 1400 percent, while debt-service ratios were over 60–70 percent (see Holmgren et al., 1999). By the end of June 1996, public and publicly guaranteed external debt amounted to $3147 billion or 62.7 percent of Uganda’s GDP. Consequently, in 1997, under the Highly Indebted Poor Countries (HIPC) initiative Uganda became the first country to receive debt relief close to the tune of $650 million. Uganda had already been the first country to receive debt rescheduling on ‘Naples’ terms in February 1995, corresponding to a reduction in eligible debt of 67 percent in net present value terms. Holmgren et al. (1999) show that there was an increase in donors’ debt relief disbursements from $12.9 in 1991–92 to $53.31 million in 1996–97. Consequently our second simulation explores the impact of such a debt reduction on Uganda.

Simulation I (Fiscal Policy Change)

Suppose now that the government carries out a simple fiscal policy change. Namely, it reduces tariffs on imports by one-third. That is, the effective tariff rate is reduced from our estimated 21 percent to 14
percent. This experiment thus reflects trade liberalization. At the same time, we will increase the value added tax by 30 percent. Of course this increases the average effective tax rate for aggregate indirect taxes from 5.4 percent to 7.0 percent. Our aim is that the tariff liberalization should have a neutral effect upon the budget deficit. Table 2 gives the results.

We observe a number of changes, as compared to Table 1. There is a small increase in real GDP, for three of the four years. The budget deficit has remained approximately constant, as a percentage of GDP. At the same time, there has been a slight depreciation in the exchange rate, and the trade balance has deteriorated by a small amount. It is interesting to note that although imports have risen, as might be expected, there has also been a noticeable increase in exports. This occurs because of the improved cost structure of the domestic economy, which uses a large component of imported inputs. Thus the tax reforms being currently carried out in Uganda are certainly a step in the right direction. The GDP growth can also be attributed to these changes. Finally, although it is not shown here, four of the five aggregate sectors experience a net increase in capital, as cost reductions outweigh the small rise in the interest rate. We thus conclude that the tariff reduction, combined with the tax increase, has had positive benefits for the economy.

**Simulation II (Debt Relief)**

As a second counterfactual experiment, let us suppose that foreign lenders unilaterally reduce the debt obligations of Uganda. In our simulation we assume that the outstanding stock of foreign debt is reduced by 20 percent, amounting to a debt write-off by the lender. Otherwise, we will

<table>
<thead>
<tr>
<th>Table 2: A tariff reduction and value added tax increase</th>
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<tbody>
<tr>
<td>Nominal GDP&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Real GDP&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Price level&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Government revenues&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Government expenditure&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Budget deficit&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Exchange rate ($/T)</td>
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<td>Interest rate</td>
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<tr>
<td>Exports&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Imports&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Trade balance&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> These are index numbers based on period 1.
<sup>b</sup> As a percentage of GDP.
keep all parameters at the same values as in Table 1, our base case. The results are given in Table 3.

We thus see that, as compared to Table 1, there is a very small increase in real GDP in all but one period. The budget deficit improves, as might be expected, and the interest rate declines due to the decreased debt service. Because of the reduced monetization of the deficit, there is a slight appreciation of the exchange rate. Note, however, that this is lower than the appreciation of the exchange rate in Table 2, where there is no direct reduction in external debts. Also as a result of this, we see a small deterioration in the current account. Finally, the reduction in the interest rate leads to a slight increase in net capital formation.

5. Summary and Conclusion

We have constructed a dynamic general equilibrium model and applied it to Uganda. The model can be used to address a variety of issues, from budgetary policies to changes in lending behavior. As initial examples, we first simulated the model, using historical exogenous parameters, and compared endogenous macro outputs with corresponding historical outcomes. With the exception of exports, our estimated model generated reasonably accurate replicas of historical reality.

We then imposed a program that attempts to increase real output by reducing tariffs on imports, while increasing the value added tax rate. The simulated changes have the expected qualitative movements and reasonable magnitudes. They indicate a small improvement for the economy, caused by the tariff decrease. Our next experiment analyzed the impact of a reduction in foreign debt obligations. Given our assumption

<table>
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<th>Table 3: A reduction in foreign debt service</th>
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<tr>
<td>Nominal GDP&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Real GDP&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td>Price level&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Government revenues&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>Trade balance&lt;sup&gt;b&lt;/sup&gt;</td>
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</table>

<sup>a</sup> These are index numbers based on period 1.
<sup>b</sup> As a percentage of GDP.
of a floating exchange rate, we find that the simulation generates an appreciation of the exchange rate, and a corresponding small deterioration in the trade balance. At the same time, as might be expected, the debt reduction leads to an increase in real GDP. Both simulations are topical since they are based on the current reforms being implemented in Uganda. We conclude that the predictions of the model seem reasonable, indicating that the model may be used for a number of other policy simulations.

**Notes**


2. Insufficient data is available from the time period 1971–85. Hence in the model we largely ignore data from this period.

3. The choice of five types of capital is essentially arbitrary, as we could introduce more or fewer capital types.

4. The use of neo-classical value added functions ‘sitting above’ an input-output matrix is quite standard in the literature. The reader may wish to see Shoven and Whalley (1984) for papers that use this approach.

5. An alternative approach would be to have fewer production sectors and then to have one capital type per sector. There would then be no mobility of capital across sectors in the short term. Such an approach would require us to aggregate the Uganda input-output matrix far beyond its actual 30 sectors. We prefer not to do so because of the information loss.

6. These taxes can thus be interpreted as a profit tax and a personal income tax that is withheld at the source. In practice, the capital and labor tax rates are taken to be the same across sectors.

7. We assume that the government carries out all foreign borrowing for investment, so that, implicitly, the government is borrowing for the private investor but the debt thereby incurred is publicly guaranteed. Thus the model does incorporate foreign borrowing for investment purposes.
8. This approach is motivated by the Harris and Todaro (1970) model of rural-urban migration, in which movement to the city depends upon relative urban/rural wage rates, as well as the probability of finding work in the city. Feltenstein (1992) estimates such a migration model for Mexico.

9. As before, 1 denotes period \( i \) and 2 denotes period \( i + 1 \).

10. Clearly a government production function should be estimated as a subject of future research.

11. The solution program is available upon request from the authors.

12. The bilateral creditor governments in the Paris Club had also agreed to debt rescheduling for Uganda on six occasions since 1980.

References


IMF (various issues), *International Financial Statistics* (IFS), International Monetary Fund.


Appendix

Factors and their Sectoral Correspondence

Factor inputs | Input-Output Sectors
--- | ---
1. Land, rural labor | 1–4
2. Capital 1, urban labor | 5–7
3. Capital 2, urban labor | 8–11
4. Capital 3, urban labor | 12–20
5. Capital 4, urban labor | 21–23
6. Capital 5, urban labor | 24–26

Sectors in the Uganda Input-Output Matrix and their Compression

Input-Output Sectors\(^a\)

1. Cash crops
2. Food crops
3. Livestock
4. Forestry, Fishing
5. Mining and quarrying
6. Coffee, cotton, manuf. foods
7. Beverages and tobacco
8. Textiles
9. Building materials
10. Chemicals
11. Metal products, other manuf.
12. Transport equipment
13. Electricity and water
14. Construction
15. Wholesale and retail
16. Hotels and restaurants
17. Road transport
18. Rail transport
19. Air trans. services
20. Communications
21. Rents
22. General gov. services
23. Education
24. Health
25. Finance services
26. Other services
27. Imports

\(^a\) These sectors are a compression of the 30 sectors in the 1992 Uganda input-output matrix, and are chosen to correspond to available surveys of demand data. We derive the compressed matrix by adding corresponding rows and columns of the original matrix.

Different Types of Factors of Production (8) and Financial Assets (3)

1–5. Capital types
6. Urban labor
7. Domestic currency
8. Bank deposits
9. Foreign currency
10. Rural labor
11. Land
**The Consumer’s Problem**

Here, and in what follows, we will use $x$ to denote a demand variable and $y$ to denote a supply variable. In order to avoid unreadable subscripts, let us let $1$ refer to period $i$ and $2$ refer to period $i + 1$. The consumer’s maximization problem is thus:

$$\max U(x), x = (x_1, x_{Lui}, x_{Lri}, x_2, x_{Lu2}, x_{Lr2})$$

such that:

$$(1 + t_i)P_i x_i + P_{Lui} x_{Lui} + P_{Lri} x_{Lri} + P_{M1} x_{M1} + P_{B1} x_{B1} + e_1 P_{BF} x_{BF} = C_i$$  \hspace{1cm} (A1)$

$$P_{K1} K_0 + P_{A1} A_0 + P_{Lu1} L_{ui} + P_{Lr1} L_{ri} + P_{m1} M_0 + r_0 B_0 + P_{B1} B_0$$

$$+ e_1 P_{BF1} B_{F0} + TR_1 = N_1$$

$$P_{K2}(1 - \delta) K_0 + P_{A2} A_0 + P_{Lu2} L_{ui} + P_{Lr2} L_{ri} + P_{M2} x_{M1} + r_1 x_{B1} + P_{B2} x_{B1}$$

$$+ e_2 P_{BF2} x_{BF1} + TR_2 = N_2$$

$$\log P_{M1} x_{M1} = a + b \log (1 + t_i) P_i x_i - c \log \Pi_i$$  \hspace{1cm} (A2)

$$\log P_{Bi} x_{Bi} - \log e_i P_{BFi} x_{BFi} = \alpha + \beta (\log r_i - \log \frac{e_{i+1}}{e_i} r_{Fi})$$  \hspace{1cm} (A3)

$$\log(L_{ui}/L_{ri}) = a_1 + a_2 \log \frac{P_{Lui} - P_{Lri}}{P_{Lui} + P_{Lri}}$$  \hspace{1cm} (A4)

if $P_{Lui} \geq P_{Lri}$, otherwise $\log(L_{ui}/L_{ri}) = 0$

$$P_{B2} X_{B2} = S(1 + T_2)P_2 X_2$$  \hspace{1cm} (A5)

$C_i$ = value of aggregate consumption in period $i$ (including purchases of financial assets).

$N_i$ = aggregate wealth in period $i$ (including potential income from the sale of real and financial assets).

$t_i$ = vector of sales tax rates in period $i$.

$P_{Lui}$ = price of urban labor in period $i$.

$L_{ui}$ = allocation of total labor to urban labor in period $i$.

$X_{Lui}$ = demand for urban leisure in period $i$.

$P_{Lri}$ = price of rural labor in period $i$.

$L_{ri}$ = allocation of total labor to rural labor in period $i$.

$X_{Lri}$ = demand for rural leisure in period $i$. 

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\( a_2 \) = elasticity of rural/urban migration.

\( P_{Ki} \) = price of capital in period \( i \).

\( K_0 \) = initial holding of capital.

\( P_{Ai} \) = price of land in period \( i \).

\( A_0 \) = initial holding of land.

\( \delta \) = rate of depreciation of capital.

\( P_{Mi} \) = price of money in period \( i \).

\( X_{Mi} \) = holdings of money in period \( i \).

\( P_{Bi} \) = discount price of a bond in period \( i \).

\( \Pi_i \) = domestic rate of inflation in period \( i \).

\( X_{Bi} \) = quantity of bank deposits, that is, CDs in period \( i \).

\( e_i \) = the exchange rate in terms of units of domestic currency per unit of foreign currency in period \( i \).

\( X_{BFi} \) = quantity of foreign currency held in period \( i \).

\( TR_i \) = transfer payments from the government in period \( i \).

\( a, b, \alpha, \beta \) = estimated constants.

\( S \) = savings rate in period \( i + 1 \).

The left-hand side of Equation (A1) represents the value of the consumption of goods and leisure. The next two equations contain the value of the consumer’s holdings of capital and labor, as well as the principal and interest that he receives from the domestic and foreign financial assets that he held at the end of the previous period. The equation \( C_i = N_i \) then imposes a budget constraint in each period. (This is an Arrow–Debreu approach in which the budget constraint is determined by the sales value of all assets the consumer controls. This includes both his real and financial assets, including the potential value of the sale of his labor. His portfolio allocation is then determined as part of the solution to his intertemporal optimization problem. Thus, in particular, we are not mixing flows and stocks.)

Equation (A2) is a standard money demand equation in which the demand for cash balances depends upon the domestic rate of inflation and the value of intended consumption.

Equation (A3) says that the proportion of savings made up of domestic and foreign interest bearing assets depends upon relative domestic and foreign interest rates, deflated by the change in the exchange rate. Finally, Equation (A4) is a migration equation that says that the change in the consumer’s relative holdings of urban and rural labor depends on the relative wage rates. In period \( 2 (i + 1) \) we impose a savings rate on the consumers, as in Equation (A5). This savings rate, \( s \), is determined by adaptive expectations, based on all previous savings rates. Thus savings rates are endogenously determined by intertemporal maximization in period \( i \), but are based upon past history in period \( i + 1 \). We therefore have a framework with short-term perfect foresight, but medium-term adaptive expectations. Hence, in particular, the saving rate will be different in all periods unless a steady state is reached.