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Aid, Public Expenditure and Dutch Disease*

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Abstract

Contemporary policy debates on the macroeconomics of aid often concentrate on short-run Dutch disease effects, ignoring the possible supply side impact of aid–financed public expenditure. We develop a simple model of aid and public expenditure in which public infrastructure capital generates an inter-temporal productivity spillover for both tradable and non-tradable sectors, where these productivity effects may display sector-specific biases. The model also allows for non-homothetic demands. We then use an extended version of this model, calibrated to contemporary conditions in Uganda, to simulate the effect of a step increase in net aid flows. Our simulations show that beyond the short-run, where Dutch disease effects are present, the relationship between enhanced aid flows, real exchange rates and welfare is less straightforward than simple models of aid suggest. We show that public infrastructure which generates a productivity bias in favour of non-tradable production delivers the largest aggregate return to aid, with the real exchange rate appreciation reduced or reversed and enhanced export performance, but it does so at the cost of a deterioration in the income distribution. Income gains accrue predominantly to urban skilled and unskilled households, leaving the rural poor relatively worse off. Under plausible parameterizations of the model the rural poor may also be worse off in absolute terms.

Keywords: Aid, Dutch Disease, Public Expenditure, Africa.

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1. Introduction

In recent years patterns of aid allocations have begun to change in ways that anticipate a significant concentration of aid on a small number of recipients. These changes themselves reflect a number of factors including the Highly Indebted Poor Countries (HIPC) debt relief initiative, pressures for increased country selectivity in aid allocations (for example, Collier and Dollar, 2002), as well as specific initiatives aimed at increasing net aid flows to selected low-income countries[1]. Hand in hand with these developments has come a heightened anxiety amongst both donors and potential recipients that such initiatives may jeopardize their economic recovery. Not surprisingly, these concerns are most acute in already aid-dependent countries, such as Uganda, where their recent track-record on growth, policy reform and poverty reduction has ensured they are best placed to take advantage of the donors' willingness to increase aid in support of higher levels of public expenditure. In part this anxiety reflects reservations about the absorptive and managerial capacity of over-stretched public sectors to deliver higher public expenditure, and in part it reflects deeper reservations about aid dependency and the impact of foreign aid on the domestic political economy (for example, Adam and O'Connell (1999), Svensson (2000)). However, more traditional concerns about the macroeconomics of aid also figure large, and it is on these that this paper focuses.

Dominating these is the fear that the Dutch disease effects of aid will inhibit the development of the tradable goods sector and lower growth in the recipient economy. Research in this area has tended to focus on the tax-like distortion of aid or resource discoveries on the competitiveness of the tradable sector, typically where the latter enjoys learning-by-doing productivity effects (for example, van Wijnbergen (1984), Sachs and Warner (1995), Gylafson *et al* (1997), Elbadawi (1999), Adam and O'Connell (2003)). Recently, Torvik (2001) has shown that the conventional Dutch disease effects may be overturned if there are productivity spillovers in both tradable and non-tradable sectors. The model presented in this paper arrives at a similar conclusion but does so by focussing on an arguably more plausible dynamic mechanism, at least for low-income countries. To be precise, we examine the case where public infrastructure investment – of the type envisaged under the current aid dispensation – generates an inter-temporal productivity spillover for both tradable and non-tradable production, but in a potentially unbalanced manner. For example public investment in rural roads is likely to impact more on the production of (non-tradable) food crops than on urban-based (tradable) manufactures and *vice versa* for, say, telecommunications infrastructure. This differential effect can, and generally will, deliver growth and real exchange rate effects similar to those suggested by Torvik (2001).

[1] For example the G8's endorsement of the New Partnership for Africa's Development (NEPAD) in July 2002, and the report of the World Health Organization's Commission on Macroeconomics and Health in December 2001.

The second source of concern is that the distributional effects of higher public expenditure may run counter to inequality and poverty reduction objectives. There are two elements here. The first is that the immediate beneficiaries of higher public expenditure tend to be the non-poor working in the services and manufacturing sectors as opposed to the poor who are predominantly engaged in food and cash crop production. The second is that even if public expenditure is devoted to infrastructure that enhances productivity in the non-tradable sector the distribution of aggregate income may move against net producers of non-tradables and hence, to the extent that the poor are located in these sectors, worsen the distribution of income. We show that this is a distinct possibility in circumstances where preferences are non-homothetic and the income elasticity of demand for non-tradable output (in this case basic food) is low.[2]

The paper is organized as follows. In the next section we outline a simple two-sector, two-good model to analyze these Dutch disease effects in the presence of aid-financed public infrastructure investment. This model is highly stylized and so in Section 3 we present a simulation model of Uganda to offer a sense of the possible magnitudes likely to prevail in reality, and to focus on the distributional consequences arising from alternative aid and public expenditure choices. To do so we disaggregate on the production and consumption sides of the economy, bring in private savings and investment, and allow for differentiated households to give meaning to distributional considerations which are not reflected in the model of Section 2. We then simulate the medium-term effects of alternative aid-financed increases in public expenditure based on the recent experience in Uganda. Section 4 discusses the simulation results and Section 5 concludes. Our results suggest that for reasonable parameter values governing the supply-side response to public expenditure, traditional Dutch disease effects are not present beyond the short-run. Rather, it appears that for low-income countries with a structure similar to that of contemporary Uganda, public expenditure whose productivity effects are skewed towards the non-tradable sector delivers the highest growth in exports and total output and sustains the highest aggregate real income. The model also highlights important distributional tensions which disadvantage rural households relative to urban households and which may even lead to an absolute decline in rural incomes.

2. A simple model of productivity spillovers

We consider a two-period Ricardo-Viner model of a small open economy that produces and consumes a non-traded good and a traded good. Private capital stocks are fixed and

[2] Matsuyama (1992) uses the assumption of non-homothetic preferences and a low income elasticity of demand for agricultural output in a traditional endogenous growth framework to analyse the link between agricultural productivity and growth. That structure delivers the result that in a closed economy increased agricultural productivity will have a positive effect on industrialization (growth) but the effect will be reversed if the economy is open to trade.

sector-specific (and do not depreciate), and a fixed endowment L of labor moves freely between sectors to equalize real consumption wages. The economy faces fixed external terms of trade and there are no tariffs or taxes. Aid, represented by a fully fungible transfer of (tradable) resources, is the only international capital flow in the model. To focus on the mechanisms of interest, we assume that aid is received in the first period only, although in the simulation model in Section 3 we find it more appropriate to treat the aid flow as permanent. Total aggregate expenditure consists of private expenditure on tradable and non-tradable goods, and public expenditure on infrastructure. Total income derives from domestic production plus the exogenous aid flow.

We express all values in terms of tradable goods, the price of which is normalized so that $P_T = 1$. Hence defining the real exchange rate $P_N/P_T = Q$, and using the superscripts P and G to denote private and government expenditure, we can express the first period income-expenditure balance as

$$E^P(Q,U) + E^G(Q,K) = R(Q;L) + A \tag{1}$$

where where A is aid, U is private utility and K is public infrastructure capital. $E^P(Q,U)$, $E^G(Q,K)$ and $R(Q;L)$ represent private and public expenditure and revenue functions respectively. Letting the supply and compensated demand functions for non-traded goods be R_Q , E^P_Q and E^G_Q respectively, we obtain the first-period market clearing condition in the non-traded goods market

$$E^P_Q(Q,U) + E^G_Q(Q,K) = R_Q(Q;L). \tag{2}$$

Equations (1) and (2) imply that the trade balance is equal to exogenously given aid flows, thus: $E^P_T(Q,U) + E^G_T(Q,K) - R_T(Q;L) = A$. Finally we define the government budget constraint as

$$E^G(Q,K) = A. \tag{3}$$

The government's role in this model is simply the conversion of donor aid into public infrastructure. Since infrastructure is composed of tradable and non-tradable goods, the actual quantity of public investment realized will depend on the real exchange rate and the elasticity of substitution between tradable and non-tradable goods in investment demand.[3] Public investment takes place in the first period (at first period prices) but augments productive capacity in both the tradable and non-tradable sectors only in the second period.

This completes the characterization of the first period. Using lower-case letters to denote second-period values, we assume that firms in both sectors may enjoy productivity gains from public infrastructure investment, and that if forthcoming these are sector

[3] At this stage we impose no prior on this elaticity, although in the simulation model in Section 3 we assume a Leontief structure for investment demand.

specific but not appropriable by individual firms. Production in period two therefore depends on the real exchange rate, q, and the size of the public capital stock K installed from period 1. Second period GDP and sectoral equilibria conditions are given by:

$$e(q,u) = r(q,K) \tag{4}$$

$$e_q(q,u) = r_q(q,K) \tag{5}$$

$$e_t(q,u) = r_t(q,K) \tag{6}$$

where the value of the marginal product of infrastructure capital is given by $r_K = qr_{qK} + r_{tK}$.

First Period Equilibrium Given the characterization of the government's behaviour, public capital formation is the only inter-temporal spillover in this simple model. Hence equations (1), (2), and (3) fully determine the first period equilibrium. Totally differentiating these three equations we arrive at the following expressions for the proportional change in the real exchange rate, private utility and public infrastructure in terms of the increase in aid, where a hat ($\hat{}$) denotes a proportional change (see Appendix I)

$$\hat{Q} = \frac{dA}{QE_Q}\left[\frac{(\gamma/\phi)\Lambda^G}{B}\right] \tag{7}$$

$$\hat{U} = \frac{dA}{UE_U^P}\left[\frac{\eta(\gamma/\phi)\Lambda^G}{B}\right] \tag{8}$$

$$\hat{K} = \frac{dA}{KE_K^G}\left[1 - \frac{\eta(\gamma/\phi)\Lambda^G}{B}\right] \tag{9}$$

where

$$B = \Sigma_{QQ} - [(1-\eta)\Delta_{QQ}^P + \eta\Delta_{QQ}^G] - \gamma\left[\frac{(1-\eta)}{(1-\phi)}\Lambda^P - \frac{\eta}{\phi}\Lambda^G\right]. \tag{10}$$

E_Q is total (private plus government) demand for non-tradables, and $\Sigma_{QQ} > 0, \Delta_{QQ}^P < 0$ and $\Delta_{QQ}^G < 0$ are the real-exchange rate elasticities of supply and (private and government) demand for non-tradables respectively. The three parameters, ϕ, γ and η describe the composition of government expenditure, as follows: ϕ is the share of government expenditure in total expenditure and γ is the share of government expenditure on non-tradables in total expenditure, so that (γ/ϕ) is the non-tradable share in government expenditure; and η is its share in the total demand for non-tradables. $\Lambda^P$and Λ^G denote the (uncompensated) income elasticities of demand for non-tradables of the public and private sectors respectively.

Expressions (7) to (9) deliver the standard demand-side Dutch-disease results. First, notice that unless Λ^P is very large relative to Λ^G, Σ_{QQ} and Δ_{QQ} , the expression B will be positive; letting $\Delta_{QQ} = (1-\eta)\Delta^P_{QQ} + \eta\Delta^G_{QQ}$ be the overall real exchange rate elasticity of demand for non-tradables, B will be positive provided[4]

$$\Lambda^P < \left(\frac{\eta}{1-\eta}\right)\left(\frac{1-\phi}{\phi}\right)\Lambda^G + \left(\frac{1-\phi}{\gamma(1-\eta)}\right)(\Sigma_{QQ} - \Delta_{QQ}). \tag{11}$$

Hence for reasonable values, an increase in aid will appreciate the real exchange rate and will increase first period private welfare. The latter result may at first seem counterintuitive but, as can be seen immediately from equation (A4) in the Appendix, it arises from the fact that the private sector is a net seller of the non-tradable good to the public sector so that the aid-induced real exchange rate appreciation generates a favourable movement in the private-public terms of trade. Finally, aid will succeed in increasing public infrastructure as long as $B > \eta(\gamma/\phi)\Lambda^G$ which requires that

$$\Lambda^P < \left(\frac{1-\phi}{\gamma(1-\eta)}\right)(\Sigma_{QQ} - \Delta_{QQ}). \tag{12}$$

Assuming $\Lambda^G > 0$, this is a stricter condition than that required for increased aid to appreciate the real exchange rate and increase private welfare although, for the reasons noted in footnote 4, this condition will be satisfied in most circumstances.

In all three cases the magnitude of these effects is determined by the behavioural structure of the economy. Consider, for example, the responsiveness of the real exchange rate to the aid inflow (equation (7)). Here the degree of appreciation moderates the higher are $\Sigma_{QQ}, \Delta^P_{QQ}$ and Δ^G_{QQ} (in absolute value) but increases with the private and government income elasticities of demand for non-tradables.[5] A similar set of comparative static results can be derived for the private welfare and public expenditure effects of aid. Since these are not of central importance in this paper we do not discuss them here.

It is worth noting, however, that if public investment is entirely composed of tradables so that $\gamma = \eta = \Lambda^G = 0$, we get the obvious result that $\frac{dQ}{dA} = \frac{dU}{dA} = 0$ and $\frac{dK}{dA} = \frac{1}{E_K}$, in other words that the aid inflow has no consequences for the first-period real exchange rate or private utility and that public capital increases in direct proportion to the aid inflow.

[4] In the simulation model below $\gamma \approx 0.10$ and $\eta \approx 0.125$ and $\phi \approx 0.20$ so that the second term on the right hand side will be around nine times the sum of the real exchange rate demand and supply elasticities. Since it is reasonable to expect that in fact Λ^P will be less than unity then even if Λ^G were low B will be positive.

[5] In the case of the private sector expenditure elasticity the effect is unambiguous; in the case of the government elasticity, the responsiveness of the real exchange rate elasticity is increasing in Λ^G provided condition (12) is satisfied.

Notice, also, that if there is no public investment response to the aid inflow (so that $E^G(.) = 0$ in (1) and aid resources accrue directly to the private sector as an income transfer), equation (3) disappears and we obtain

$$\hat{U} = \frac{dA}{UE_U^P} \tag{13}$$

$$\hat{Q} = \frac{\Lambda^P dA}{E(\Sigma_{QQ} - \Delta_{QQ}^P)} \tag{14}$$

which confirm the simple demand-side results of a pure consumption transfer which emerge from any standard model (for example Devarajan *et al*, 1993). In this case the aid flow is strictly welfare increasing and will, unambiguously, appreciate the real exchange rate, with the extent of the appreciation being determined by the income elasticity of demand and the elasticities of demand and supply in the non-tradable sector.

Second-Period Equilibrium The second period equilibrium is derived in an analogous fashion by totally differentiating (4) and (5) to solve for dq and du in terms of dK and the productivity of investment in the two sectors as follows.[6] Noting that $r_K = qr_{qK} + r_{tK}$ and letting $\theta = qe_q/e$ be the share of non-tradables in total expenditure, we obtain the following expressions for second-period utility,

$$\hat{u} = \frac{r_K dK}{ue_u}, \tag{15}$$

and the second-period real exchange rate

$$\hat{q} = \frac{[(\theta\lambda^p - 1)qr_{qK} + \theta\lambda^p r_{tK}]dK}{qe_q(\sigma_{qq} - \delta_{qq})} \tag{16}$$

where, following the procedure defined in Appendix 1, λ^p is the second-period private sector income elasticity of demand for non-tradables, and $\sigma_{qq} > 0$ and $\delta_{qq} < 0$ are the second period real exchange rate elasticities of supply and (private sector) demand for non-tradables, respectively.[7]

[6] We express the results which follow in terms of dK, the increase in public infrastructure, rather than solving out for dK from (9) since from the perspective of period 2 the relationship between the original aid flow and the volume of additional infrastructure it financed is immaterial. Though we choose not to do so, it would be a simple matter to to solve the donor's optimal aid allocation as a function of the second-period productivity given the donor's welfare function and budget constraint.

[7] Notice that we could derive the same result by solving (3) and (5). In this instance equation (16) would take the form

$$\hat{q} = \frac{[((1-\theta)\lambda^{pt} - 1)r_{tK} + (1-\theta)\lambda^{pt} qr_{qK}]dK}{e_t(\sigma_{tq} - \delta_{tq})}$$

where λ^{pt} is the second period income elasticity of demand for tradables, and $\sigma_{tq} < 0$ and $\delta_{tq} > 0$ the second-period real exchange rate elasticities of supply and demand for tradables.

Three key results emerge from the above. The first is that in this model the change in second period utility depends on the value of the *aggregate* product of public capital; it does not depend on the presence or absence of any bias in productivity. Second, and by contrast, the evolution of the real exchange depends on the scale of infrastructure investment and the relative bias in productivity spillover between the tradable and non-tradable sectors. Thus, noting that $(\sigma_{qq} - \delta_{qq}) > 0$ it follows that the higher the impact on non-tradable (tradable) productivity the more likely is the real exchange rate to depreciate (appreciate). Third, these effects are moderated by the income elasticity of the demand for non-tradables. For given values of r_{qK} and r_{tK}, the lower the income elasticity, λ^p, the weaker the tendency for the real exchange rate to appreciate. Specifically, solving (16) it follows that

$$\hat{q} \gtreqless 0 \qquad \text{as } \lambda^p \gtreqless \frac{1}{\theta}\left[\frac{qr_{qK}}{qr_{qK} + r_{tK}}\right]. \tag{17}$$

If productivity is exactly balanced, in the sense that $qr_{qK} = r_{tK}$ condition (17) simplifies to

$$\hat{q} \gtreqless 0 \qquad \text{as } \lambda^p \gtreqless \frac{1}{2\theta}. \tag{18}$$

In the simulation model in the following section we consider only 'extreme-bias' cases where alternately $qr_{qK} = 0$ and $r_{tK} = 0$. In the former case, where productivity gains are located exclusively in the tradable sector, the real exchange rate will unambiguously appreciate for any non-negative income elasticity, while in the latter (where productivity gains are located exclusively in the non-tradable sector) condition (17) becomes

$$\hat{q} \gtreqless 0 \qquad \text{as } \lambda^p \gtreqless \frac{1}{\theta}. \tag{19}$$

Taken together, these results highlight the principal aggregate effects of aid we explore in the remainder of the paper. They indicate that in the presence of productivity effects the dynamic evolution of the equilibrium real exchange rate is ambiguous but that in the configuration which characterizes the current aid environment in low income countries – where substantial aid financed public expenditure is targeted to improving the productivity of the non-tradable sector and where income elasticities of demand for non-tradable goods such as basic food are low – then the initial appreciation is likely to be followed by a subsequent equilibrium depreciation of the real exchange rate.

3. The simulation model

This model is necessarily highly stylized. It assumes fixed private resource endowments, a highly simplified government structure, and focuses only on aggregate consumption. To give greater substance to its central mechanisms, to offer a sense of the magnitude of

the possible effects policy makers are likely to confront, and to unpack some first-order distributional consequences of the aid and public expenditure interaction, we construct a small recursively dynamic computable general equilibrium model calibrated to reflect the principal features of contemporary Uganda. In this section we provide a brief sketch of the features of the simulation model; the properties of the data calibration employed in the simulations are summarized in Appendix II.[8]

We use a real (barter) model of a small open economy enjoying no market power in world markets, either for its imports or exports, so that the terms of trade are independent of domestic policy choices. The terms of trade are thus held constant across the range of experiments. The production side of the model is standard. Firms in each of the four productive sectors, food-crop agriculture, cash crops, manufacturing and services, are assumed to be perfectly competitive, producing a single good which can be sold to either the domestic or export markets. Production functions in each sector are Cobb-Douglas of the form

$$X = AS^{\alpha s} \prod_{lc} L_{lc}^{\alpha lc} KP^{\alpha k} KG^{\alpha g} \tag{20}$$

where sectoral subscripts are suppressed. The factors S, L, KP, and KG denote land, labour (consisting of skilled and unskilled labour), sector-specific private capital and infrastructure respectively. Only production in the rural sectors requires land which is fixed in perpetuity. Private sector-specific capital is fixed in each period, but can be augmented over time, so that labour is the only variable factor in the short run. Labour is fixed in aggregate but is mobile across sectors and at the margin is paid the value of its marginal product. Private sector output is also determined by the level of infrastructure, KG, which is provided by government. In keeping with the model in Section 2, infrastructure is a public good capable of augmenting the productivity of private factors in all sectors. Constant returns to scale prevail in the private factors of production, but increasing returns are possible in the presence of public infrastructure.

Producers and consumers are price takers in world markets. Domestic production and imports are imperfect substitutes in consumption while gross output is imperfectly substitutable between domestic and export markets, with both relationships governed by homothetic constant elasticity of substitution and transformation functions respectively. Sector-specific real exchange rates for consumers and producers can therefore be tracked independently.

The distributional consequences of aid and public expenditure are tracked though their impact on three different households, differentiated by their factor ownership and patterns of consumption and saving. The first is a 'rural' household, which is primarily involved in food-crop agriculture (it owns the land and capital in this sector) but it

[8] The full model and calibration data are available on request from the authors.

also supplies unskilled labour to the cash crop sector. This household is outside the direct tax net, and has zero net savings.[9] The second household is the 'urban unskilled' household whose only factor of production is unskilled labour which it supplies to the manufacturing, services and government sectors. It owns no capital or land, has zero (gross and) net savings, but in contrast to the rural household it does pay direct taxes. Finally the 'urban-skilled' household supplies skilled labour to the manufacturing, services and public sectors and owns the remainder of the land and capital in the economy. This household pays direct taxes to government, at a higher rate than the unskilled household, earns interest on its net holdings of government domestic debt, and has a non-zero but constant propensity to save out of disposable income.

Consumption for each household type is defined in terms of a constant elasticity of substitution linear expenditure system (CES-LES) of the form

$$cd_{(i,h)} = b_{(i,h)} + \left(\frac{pc_i^{1-\varphi} \beta_{(i,h)}^{\varphi}}{\sum_j pc_j^{1-\varphi} \beta_{(j,h)}^{\varphi}} \right) \left(\frac{yd_h - \sum_j pc_j b_{(j,h)}}{pc_i} \right) \qquad i \in j \tag{21}$$

where goods are denoted i and j and households h, pc_i is the net price of the composite good i, yd denotes household disposable income, $\beta_{(i,h)}$ household-specific consumption shares, and $b_{(i,h)}$ household-specific subsistence consumption of good i, which must be met prior to any discretionary allocation of income. The CES aspect means that consumers are not indifferent (in utility terms) between different goods in their consumption bundle but rather face a constant elasticity of substitution (denoted by φ) between each good and the rest of the consumption aggregate. The LES aspect allows for the income elasticity of demand for different goods to deviate from unity. In the simulations reported in the next section, we restrict our attention to the case where only food consumption is subject to a subsistence threshold. This implies that the marginal income elasticity of demand for food is less than unity and the income elasticity of demand for all other goods (manufactured goods and services) is greater than unity.[10]

This structure of consumption underpins households' utility which is defined as the product of private consumption, defined in (21),and the level of public good provision in the economy, $Xpub$ (which is assumed to be valued equally by all household types). Aggregate social welfare is simply the weighted sum of the welfare of the three households

$$U = \sum_h hw_h \left[\sum_i \beta_{(j,h)} (cd_{(i,h)} - b_{(i,h)})^{1-1/\varphi} \right]^{\frac{1}{1-1/\varphi}} X_{pub}^{\beta g} \tag{22}$$

[9] Gross savings in this sector are exactly equal to the depreciation of agricultural capital.

[10] Since cash crops are produced solely for export, final household consumption is defined over food, manufactures and services only.

where hw represents household weights based on the (fixed) relative size of each household type and βg is the weight of public consumption in total private sector utility.

Government policy decisions impact the private sector through a number of channels, only some of which we consider in this paper. We do not examine the consequences of changes to the structure of taxation, nor to changes in direct transfers and interest costs. These are kept constant throughout all experiments. Instead we focus entirely on changes to public expenditure and in particular the balance between investment in infrastructure and the provision of government services. All public expenditure will have direct aggregate demand effects, but infrastructure investment also directly affects the supply side of the economy by augmenting private sector productivity, possibly differentially across sectors depending on the composition of their production. Government sector-specific investment (in government offices, schools, hospitals etc.) obviously influences the cost of producing public services (by altering the marginal product of labour), while direct current expenditure on public services has only pure demand side effects.[11] Current government savings are applied to government capital formation which is allocated between sector-specific investment (i.e. in government building etc.) and public infrastructure. The shortfall/excess of government savings relative to the cost of government capital formation is financed from foreign savings or by directly crowding out private investment.

The model has a simple recursively dynamic structure. Each solution run tracks the economy over 10 periods from the initial policy change, and each period may be thought of as a fiscal year. Within each year public and private capital stocks are taken as given and the model is solved given the parameters of the experiment (e.g. the increased aid flows and the corresponding public expenditure decision being analyzed). This solution defines a new vector of prices and quantities for the economy, including the level of public and private sector investment. This feeds into the dynamic equation for investment

$$K_{i,t} = K_{i,t-1}(1 - \mu_i) + \Delta K_{i,t-1} \tag{23}$$

where μ_i denotes the rate of depreciation and hence determines the new capital stock available to the economy at the beginning of the following year. In order to focus exclusively on the impact of increased aid flows on the economy we calibrate the model to an initial equilibrium in which net public and private investment is zero (i.e. gross investment exactly matches depreciation) and there is no growth in the labour supply.

[11] It is reasonable to assume that there are long-run returns to recurrent public expenditure on health and education so that the value of this expenditure is also felt on the supply side. The simulation model does not, however, reflect this feedback. We take the view that this feedback is relatively slow. Accordingly our simulations reflect a "medium-term" in which adjustment to the physical capital stock takes place but where changes to the human capital stock have not yet materialized. The utility generated from public services, which are not purchased through the market and hence do not enter private expenditure decisions (equation (21)), is reflected through the term X_{pub} in equation (22).

The baseline therefore represents a steady-state equilibrium for the economy.

We adopt a neoclassical closure which constrains total investment to equal the level of domestic savings. This closure rule is consistent with conditions in Uganda where unrationed access to world capital markets is virtually zero and domestic savings (in aggregate) are relatively interest inelastic. Hence total household and government savings are augmented by an exogenously determined level of foreign savings (aid), and together these three determine the total resources available for gross investment. Once total public sector investment requirements have been met, the residual investment is allocated across sectors in proportion to the differential between the sectoral real rate of return and the economy wide average private return on capital.

4. Experiments and Results

4.1. Simulation Experiments

The data used to calibrate the CGE model are described in Appendix II and summarized in Appendix Table 1. As noted above, we focus our attention mainly on one basic experiment and consider the consequences of varying a number of key assumptions about the functioning of the economy. The experiment is concerned with the consequences of a permanent 12.5 percent increase in the net (grant) aid inflow to the economy, equivalent to just under 2 percent of GDP at baseline domestic prices. This increase is roughly the size of the increase in net aid flows to Uganda between 2000 and 2002.

Given our focus on public investment we limit our attention to alternative domestic fiscal responses to the increase in aid. In practice, the government may decide to take all the adjustment on the side of expenditure, by increasing current expenditure or infrastructure investment, for example, or to offset part of it by altering the rate of revenue mobilization. Some combination of both is likely to be optimal in many circumstances, especially if current tax structures are highly distortionary at the margin and there are limitations to the public sector's absorptive capacity. However, in order to focus exclusively on variations in the public expenditure programme, our simulations take the tax structure as given; any consequent changes in the domestic budget balance after grants is financed through a direct crowding-out or crowding-in of private investment.

In the core experiment the incremental aid flow is used to finance an increase in infrastructure investment. In this experiment we make a range of assumptions about how the investment affects the private productive sectors of the economy, and in particular what the consequences are for productive capacity in these sectors. Simulation 1 provides our benchmark, where the infrastructure investment has no productivity value whatever: the economy's total capital stock is increased but public capital does not sustain higher private output. This allows us to isolate the pure demand side effects of the aid flow. Simulation 2 examines the case where the investment does enhance private

sector productivity but these effects are uniform across all sectors of the economy and is represented by outward shift in each sector's production possibility frontier between domestic (non-tradable) and export (tradable) variants of the good. The remaining permutations on the basic experiment (simulations 3 – 5) examine three central cases where the productivity impact is still felt across all sectors but now embodies a bias such that within each sector the shift in the production possibility frontier is skewed in favour of either tradable or non-tradable production. Specifically, we consider only the 'extreme-bias' cases described in equations (17) and (19) above which are represented by a rotation in the frontier around either end-point. Simulations 1 through 4 assume that the subsistence component in consumption is zero so that the consumption side of the economy is homothetic in income. In Simulation 5, however, we impose a subsistence component for food consumption (equal to 90 percent of the initial consumption level) so that the income elasticity of demand for food falls sharply below one.

Our second experiment is reported in simulation 6. Here we examine the effect of the same aid flow being used exclusively to finance an increase in the volume of public services, leaving infrastructure unchanged. Public service provision is enhanced by increasing sector specific capital and recurrent expenditure (ultimately) in equal proportions. Initially the enhanced aid flow is used to raise capital to its new (stationary) level, and then the flow is used to hire the associated additional labour and intermediate inputs to produce additional government current consumption.

It is assumed throughout that the government does not alter its tax structure but does takes into account price changes in determining the volume of expenditure which can be financed with the additional aid. Hence the government is portrayed as setting out to behave in a way which is (domestic) budget neutral. Second order changes in the level of household income, demand, and relative price effects arising from infra-marginal government activities are not, however, internalized in the government's decisions so that the experiments are not budget neutral *ex post.*

For each experiment we report the impact effect (year 1) and the cumulative evolution of the economy after 5 and 10 years. In order to simplify our presentation we focus only on changes in a small number of key aggregates. These are: (i) the export-weighted real exchange rate ; (ii) the volume of exports and imports and the domestic good supply; (iii) real GDP; (iv) private investment; (v) the fiscal accounts; and (vi) the real disposable income of our three household types, measured in terms of the household-specific consumption price index. For a given level of government expenditure real disposable income is a direct measure of household welfare, although as we discuss below, when the level of government current expenditure is altered this measure understates true welfare. These summary results are presented in Table 1, and the experiments are ranked according to various criteria in Table 2.

4.2. Results

*** Table 1 here ***

Experiment 1 provides a benchmark for what follows. Here the infrastructure investment confers no benefits on private productivity so that in terms of the model in Section 2, $qr_{qK} = r_{tK} = 0$. Hence the aid flow has little initial impact on GDP, but it does lead to an appreciation of the export real exchange rate and a sizeable contraction in exports in favour of higher production of domestic goods. The higher permanent level of aid necessarily implies an increased current account deficit, so that total imports rise despite the decline in private export earnings. In contrast to the endowment model of Section 2, the evolution of the simulated economy over the medium-term points to a progressive deterioration in overall economic performance as a result of a decline in real private sector investment. In part this reflects a decline in total savings as the fiscal balance deteriorates, which in turn reflects the adverse effects of the real exchange rate on the budget.[12] However the main reason for the decline in real investment is that the real exchange rate appreciation raises the cost of capital goods (since capital formation is intensive in non-tradable services). This means that although the real exchange rate appreciation moderates over time the deterioration of the capital stock ensures that the decline in export performance does not reverse and hence the initial welfare gains weaken over time. Finally it is worth noting that in this simulation while total real income increases, rural households actually suffer a decline in their income. This is an important result and, as will be seen, recurs across all simulations to a greater or lesser degree. The principal reason for this outcome is that the demand effects from increased government expenditure (either capital or current) fall disproportionately on urban skilled and unskilled labour and on intermediate goods from the manufacturing and services sectors. In other words, backward linkages from the formal urban sectors (manufacturing, services and government) to the rural sectors (food and cash-crops) are extremely weak. As later results show, these demand effects are exacerbated in circumstances when relative price effects turn against the rural sector, and the income elasticity of demand for food is low.

By contrast, in Experiment 2 government infrastructure investment raises private-sector productivity uniformly across sectors although the productivity effect is unbiased between the domestic goods and exportable sectors. There is now a fairly substantial cumulative growth in GDP over the ten years, some improvement in the fiscal balance, and a marked increase in private investment.[13] As a consequence, while the impact effects on the real exchange rate and on exports are very similar to experiment 1,

[12] Since government is a net seller of foreign exchange, the real exchange rate appreciation reduces the domestic value of the budget balance and therefore increases the domestic financing requirement.

[13] Government revenue grows as real incomes and expenditures grow while, after the initial step change, real government spending does not. Savings available for private investment grow partly with GDP but

they diverge sharply over time. Over the medium-term most of the real exchange rate appreciation has been reversed, but more importantly, even though the real exchange rate remains appreciated relative to its baseline value, the initial 6 percent fall in exports is reversed, moving to a 4 percent increase over the baseline by the end of the simulation.

While the impact effects on household incomes are the same as in the previous experiment, matters improve over time so that not only is total real income more than 4 percent higher over the long run but the previously poor and declining position of rural households has been reversed. Rural households enjoy an increase in real income over time in this experiment, even though their gain is appreciably lower than that of the urban households.

Experiments 3 and 4 consider the likely outcome if the productivity gains witnessed in Experiment 2 are biased towards the production of tradable (exportable) or non-tradable (domestic goods).[14] In the former case, considered in Experiment 3, while the productivity effect is again positive and uniform across sectors, it is now biased within the food and manufacturing sectors in favour of export production. As expected, there is no increase in the productivity of non-tradable production, this powerfully exacerbates the RER appreciation. The adverse export supply response is equally marked for the cash-crop sector with the long-run export growth in this sector only 1.6 percent above baseline compared with 4.1 percent in the previous experiment. By contrast, although manufacturing exports suffer in the short- to medium-term from the more appreciated real exchange rate, the export-biased productivity gains are powerful enough to offset this effect so that in the long-run export supply performance is better than in Experiment 2.

When the productivity gain is biased entirely towards the production of the domestic good, as shown in Experiment 4, outcomes are markedly different. The bias in production (which increases the supply of non-tradable goods) is sufficiently strong to almost entirely offset the demand effects of the increased aid flows so that the real exchange rate movement is more or less neutral.[15] The effects on exports are symmetrical with Experiment 3; cash-crop exports fall by less initially and recover more strongly than in earlier experiments, but the domestic bias in manufacturing productivity results in a greater initial decline and more sluggish recovery in manufacturing exports.

The domestic-biased supply response leads to a larger improvement in the long-

also because of 'crowding-in' from the improvement in the fiscal balance. It is a consequence of the closure rule mentioned earlier that these resources are duly invested.

[14] Since the cash-crop sector is exclusively an export sector and the public and private services sectors wholly non-tradable, this switch in the bias of productivity gains is only meaningful in the context of the food crop and manufacturing sectors.

[15] Notice that the model in Section 2 predicts that the real exchange rate change should be exactly zero. That it is not so in the simulation model reflects its richer structure including the fact that the government budget is not invariant to changes in the real exchange rate.

run fiscal balance (of 0.6 percentage points of GDP) reflecting favourable relative price movements and higher growth, higher long-run private investment and higher real GDP growth than either the neutral or export-biased forms of productivity growth.

The most striking difference between these two experiments, though, is the effect on real household disposable incomes. Compared to the case of a neutral supply response, a strong export bias in the productivity gain induced by infrastructure expenditure sharply moderates real income growth in the economy. Long-run total income rises by only 2.1 percent over its baseline compared to 4.5 percent when the supply response is neutral between exports and domestic production. However, the income gain is spread relatively equally across household groups. This contrasts sharply with the domestic-biased supply response which generates a markedly higher aggregate real income gain of 7 percent in the long-run but one that is disproportionately skewed in favour of the urban households.

As noted above, the tendency for urban households to gain disproportionately from aid-financed increases in infrastructure partly reflects the low backward linkages from government expenditure to the rural sector of the economy. The relative price movements underpinning Experiment 4 exacerbate these weak linkages. As the economy's increased ability to produce domestic goods reverses the real exchange rate appreciation this shifts the domestic terms of trade in favour of those consuming the now relatively cheaper domestic goods (all households) and against those producing them (the rural household). Rural households thus share more or less equally in the consumption gain from lower-cost domestic goods but share disproportionately in the income loss from producing them.

In Experiments 2 and 4 these adverse distributional effects are weak enough not to offset the rural household's share in the aggregate income gain for the economy. This is not the case, however, in Experiment 5. This experiment repeats the previous one, but assumes that there is a high subsistence requirement in food consumption for all households. The implication of this is that having met this requirement, positive income gains will be allocated disproportionately *away* from food expenditure so that on the margin the income elasticity of demand for food will be less than unity, and increasingly so the higher is the subsistence threshold, and *vice versa* for the other sectors. The effect of this minor adjustment to assumed consumer behaviour is dramatic; the real exchange rate now initially depreciates sharply and remains more depreciated than the baseline throughout the simulation run. Similarly after a small initial fall, export volumes increase substantially, as does the fiscal balance, private investment and real GDP. In all cases the gains are greater than in any of the other experiments. The same holds for aggregate real income which increases by 8.6 percent over the baseline in the long-run.

The distributional impact in this experiment is rather unpleasant, though. Urban households enjoy substantial real income gains as a result of the decline in food prices,

while rural households experience large income falls. The reason is simple; in this experiment the adverse shift in the internal terms of trade against rural households noted under Experiment 4 is magnified by the low income elasticity of demand in consumption from all households. Rural households suffer twice over in this case, first from the fall in prices of food and second from the weakness of the demand for food as a result of the low income elasticity, which drives food prices even lower.[16]

In the final Experiment 6, we move away from considering the effects of increased infrastructure investment to examine the case where the aid inflow is used exclusively to increase production of the public service. Since by construction there are no spillovers onto private sector productivity in this experiment the simulation is rather similar to experiment 1 (wasteful investment), at least initially. Over the longer-run, this experiment leads to a marginally larger domestic fiscal deficit, lower private investment and lower long-run real GDP growth.[17]

The movement of real incomes also closely matches the outcome for Experiment 1. As with infrastructure, the production of public services is relatively intensive in urban skilled labour and so benefits urban workers relative to rural ones. There is one important caveat in this case, though. As we noted in our discussion of household welfare above, households directly derive utility from the consumption of government services. By reporting only the real consumption income component of household welfare Table 2 understates any implicit valuation of the increased volume of public services produced under this experiment. Given the parameterization of the model, the valuation of this increase is unlikely to exceed 1-1.5 percent of income for each household type. Factoring in this valuation would reinforce the welfare gains of urban households; it would be insufficient to fully compensate for the decline in rural incomes.[18]

4.3. Summary

The mass of detail in Table 1, even though it represents an extremely concise summary of the full output from the model, is difficult to digest. Table 2 attempts to 'summarize the summary', by ranking the experiments, at 1 year and at 10 years, in terms of

[16] It is exactly this mechanism that Matsuyama (1992) identifies as generating the surplus labour and rising real consumption wages in manufacturing necessary to fuel industrialization in his closed economy model.

[17] We assume that the government designs its expansion of expenditure to be budget-neutral ex ante and hence factors in the impact of its additional expenditure on its price. However we assume that the existing volume of expenditure represents 'real' commitments. The effect of relative price movements on this inframarginal component of government expenditure is therefore not anticipated in the experiment. It is these relative price movements which alter fiscal outcomes.

[18] Assuming, of course, that each household type values government expenditure equally. Only if this valuation differed greatly between household types, in particular it was much more highly valued by rural households, would these results change.

their impact on various magnitudes of concern to recipients and donors. These are the real exchange rate (from maximum appreciation down to maximum depreciation), export volume, real income of rural households, real income overall, real GDP, private investment and the fiscal balance. The additional figures for the real exchange rate, exports and GDP report the corresponding general equilibrium elasticities with respect to aid.

*** Table 2 ***

There are five qualitative conclusions from this exercise. First, there is a broad similarity between the rankings for both impact and long run effects, with the notable exception of the export-biased experiment (experiment 3). An increase in aid in the presence of an export-biased supply response has an adverse impact effect on the economy, but improves markedly over time. The second main conclusion is that the presence of a domestic-bias in the aggregate supply response (experiments 4 and 5) is broadly beneficial to the economy, in terms of aggregate growth and investment, welfare, exports and in moderating the appreciation of the real exchange rate. Third, in general across all experiments, and particularly when there is a domestic-good bias in the supply response, the rural household does not share proportionately in the aggregate income gains to the economy. Fourth, the combination of a domestic bias in production and a high subsistence requirement in food (experiment 5) delivers a large supply response which dominates the other cases, were it not for its highly adverse distributional effects. Fifth, there are potentially substantial payoffs via an improved fiscal balance and increased private investment in all the experiments involving uniform effects across sectors, regardless of the presence or absence of bias (experiments 2-5).

As indicated by the elasticities these effects are sizeable. With the exception of experiment 5 an increase in net aid, regardless of its use, will lead to an appreciation of the export real exchange rate with an elasticity of between 0.1 and 0.5, and a decline in total exports with an elasticity of around 0.5. In the short-run, of course, this decline in exports reflects a pure reallocation effect; there is no substantial growth in total real GDP. Over the long-run, however, the real exchange rate and export supply elasticities moderate sharply (with the latter turning positive for experiments 2, 3, 4 and 5) while the output elasticity rises to almost 0.3 for the same experiments. Only in the case where the aid is devoted exclusively to higher current government expenditure, or if infrastructure investment fails to deliver any productivity gains at all, does real GDP remain stagnant.

5. Conclusion

The basic conclusion of this paper is that beyond the short-run, in which demand-side effects dominate, the relation between enhanced aid flows, real exchange rates, export

volumes and welfare is a complex one. It is certainly not inevitable that over a medium term horizon concerns about the Dutch disease effects of aid are warranted. The key to the evolution of the aggregate economy is obviously the supply-side response to the aid-funded public expenditure; we have indicated that productivity enhancements that are skewed towards the production of domestic goods deliver the largest aggregate return to aid.

Such productivity biases however also exacerbate a key underlying distributional tension. Public expenditure is intensive in formal sector (urban) employment and draws disproportionately on the manufactured goods and services sectors for its intermediate inputs. Rural households capture little of the direct benefit from these demand factors. On the other hand, if supply side effects are powerful enough that domestic food prices fall relative to manufacturing and service prices, and if these are reinforced by a low income elasticity of demand for food, rural household incomes suffer, possibly absolutely as well as relative to urban households. These adverse distributional effects have the potential to undermine the aggregate gains from productivity-enhancing public expenditure. This result, as with the others in this paper, emerges from a simulation model and is therefore only illustrative. Nonetheless it is of sufficient strength to suggest that close attention needs to be paid to the evolving distributional consequences of the public expenditure programme.

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Appendix I. Derivation of Conditions (7) to (9).

Totally differentiating (1) to (3) and noting from (2) that $(E_Q^P + E_Q^G - R_Q)dQ = 0$ we get

$$E_U^P dU + E_K^G dK = dA \tag{A1}$$

$$(R_{QQ} - E_{QQ}^P - E_{QQ}^G)dQ = E_{QU}^P dU + E_{QK}^G dK \tag{A2}$$

and

$$E_Q^G dQ + E_K^G dK = dA. \tag{A3}$$

Substituting from (A3) we derive the following expression for dU from (A1)

$$dU = \frac{E_Q^G}{E_U^P} dQ. \tag{A4}$$

Substituting (A3) and (A4) into (A2) we obtain

$$(R_{QQ} - E_{QQ}^P - E_{QQ}^G)dQ = \left(\frac{E_{QU}^P E_Q^G}{E_U^P} - \frac{E_{QK}^G E_Q^G}{E_K^G} \right) dQ + \frac{E_{QK}^G}{E_K^G} dA. \tag{A5}$$

From the market clearing condition for the non-tradable sector we know that $E_Q = E_Q^P + E_Q^G = R_Q$. From this we can define $\eta = \frac{E_Q^G}{E_Q^P + E_Q^G}$ as the government share in the total demand for non-tradables. We also define $\gamma = \frac{QE_Q^G}{E}$ as the share of government expenditure on non-tradables as a proportion of total (national) expenditure, and $\phi = \frac{E^G}{E}$ as the share of total government expenditure in national expenditure. Finally we define the following quantities: $\Sigma_{QQ} = \frac{QR_{QQ}}{R_Q} > 0$ is the elasticity of supply of non-tradables with respect to the real exchange

rate; $\Delta^P_{QQ} = \frac{QE^P_{QQ}}{E^P{}_Q} < 0$ is the private sector's elasticity of demand for non-tradables with respect to the real exchange rate; $\Delta^G_{QQ} = \frac{QE^G_{QQ}}{E^G{}_Q} < 0$ is the corresponding public sector elasticity of demand; $\Lambda^P = \frac{E^P E^P_{QU}}{E^P_Q E^P_U} > 0$ is the private sector's income elasticity of demand for non-tradables; and $\Lambda^G = \frac{E^G E^G_{QK}}{E^G_Q E^G_K} > 0$ the corresponding elasticity for the public sector (see Dixit and Norman (1980), chapter 2).

Multiplying and dividing by $QR_Q = Q(E^P_Q + E^G_Q)$ allows us to express the left hand side of (A5) as

$$\frac{E_Q}{Q}\left[\Sigma_{QQ} - ((1-\eta)\Delta^P_{QQ} + \eta\Delta^G_{QQ})\right] dQ. \tag{A6}$$

Turning to the right hand side of (A5), using the definitions of the income elasticities, collecting terms and multiplying and dividing by QE_Q the terms in dQ can be expressed as

$$E^G_Q\left[\frac{E^P_Q}{E^P}\Lambda^P - \frac{E^G_Q}{E^G}\Lambda^G\right] dQ = \frac{\gamma E_Q}{Q}\left[\frac{(1-\eta)}{(1-\phi)}\Lambda^P - \frac{\eta}{\phi}\Lambda^G\right] dQ. \tag{A7}$$

The term in dA follows from the expression for Λ^G Substituting this, (A6) and (A7) into (A5) gives (7). Conditions (8) and (9) follow by simple substitution.

Appendix II. Data and parameter calibration

No official social accounting matrix currently exists for Uganda. Hence, drawing on a range of official sources, we have created a representative baseline SAM, calibrated to the fiscal-year 2000/01. Despite its synthetic character this SAM is a reasonable representation of the principal structural features of the Ugandan economy. The cash-crop sector is a pure export sector, and private services completely non-tradable. By contrast, there is two-way trade in both the food and manufacturing sectors. Both are net importers, although the latter is significantly more import-intensive than the former. We take the view that in both sectors the export share in current output is low relative to its optimum (as a result of two decades or more of anti-export biases in trade policy) so that the elasticity of substitution between supplying domestic and export markets should be set relatively high, and certainly greater than unity. We experimented initially with a range of values between 1 and 5 settling eventually on a value of 2.

Aggregate investment demand is more or less equally intensive in services (construction) and manufactured goods, although government infrastructure investment is rather more service-intensive than is private sector investment. As discussed in Section 3, output is characterized by constant returns to scale in private factors (land, labour and capital), but increasing returns in the presence of public infrastructure capital, measured by αg. There are no reliable empirical estimates, either for Uganda or elsewhere, with which to calibrate this parameter. We therefore choose a value of $\alpha g = 0.5$ which has the property that public capital is as productive as private

capital in producing agricultural output but less productive than private capital in producing manufactured goods and services.[19]

As expected, given Uganda's level of income, private final consumption is dominated by food (58 percent) with the balance spread across manufactured goods (including petroleum products) and services. This balance is similar across the three household types although the food share in consumption is highest in the rural household (67 percent) and lowest in the urban-skilled household (42 percent). Consumers are assumed to have relatively low elasticities of substitution in consumption (the elasticities are set to 0.5 for each good), implying that the income effect of relative price movements dominates the substitution effect. Thus adverse terms of trade movements, for example, will lead to a depreciation of the import real exchange rate and vice versa for a positive terms of trade movements.

Government expenditure spans three broad categories. In the baseline approximately 40 percent is recurrent expenditure; a further 50 percent is categorized as infrastructure investment, and the balance as sector-specific public-sector capital formation.

[19] Sensitivity analysis based on alternative values for αg is available on request from the authors.

TABLE 1: SIMULATION RESULTS OF THE EFFECT OF A 12.5 PERCENT INCREASE IN NET AID FLOWS [1,2].

Experiment			1	2	3	4	5	6
Productivity Bias [3]				Neutral	E-bias	D-bias	D-bias	
Subsistence Consumption [4]							Food	
PRICES AND QUANTITIES		**Time Period**						
Export Weighted RER [5]		to t=1	-2.6%	-2.6%	-5.8%	0.9%	5.0%	-2.0%
		to t=5	-2.0%	-1.6%	-2.6%	-0.5%	0.2%	-1.8%
		to t = 10	-2.1%	-0.7%	-1.8%	0.4%	1.4%	-1.5%
Total Exports		to t=1	-6.2%	-6.2%	-6.7%	-5.7%	-2.8%	-6.7%
		to t=5	-6.4%	-2.6%	-3.3%	-1.9%	2.2%	-7.4%
		to t = 10	-6.7%	4.2%	3.2%	5.3%	11.7%	-7.9%
Manufacturing Exports		to t=1	-6.0%	-6.0%	-5.1%	-6.8%	-7.4%	-6.8%
		to t=5	-6.2%	-3.0%	-2.0%	-3.3%	-4.2%	-8.1%
		to t = 10	-6.9%	4.2%	4.7%	3.9%	2.3%	-9.0%
Cash crop Exports		to t=1	-6.9%	-6.9%	-8.5%	-5.2%	-1.0%	-6.9%
		to t=5	-7.0%	-3.1%	-4.9%	-1.1%	4.9%	-7.2%
		to t = 10	-7.2%	4.1%	1.6%	6.4%	16.1%	-7.7%
Total Imports		t=1	1.9%	1.9%	1.7%	2.1%	3.3%	1.7%
		t=5	1.8%	3.2%	3.0%	3.5%	5.2%	1.5%
		to t = ss	1.7%	5.8%	5.4%	6.2%	8.8%	1.3%
Total Domestic Goods Supply		to t=1	0.6%	0.6%	-0.6%	1.9%	2.0%	0.7%
		to t=5	0.5%	2.2%	0.9%	3.6%	3.7%	0.7%
		to t = 10	0.4%	5.1%	3.7%	6.7%	7.0%	0.5%
Real GDP		to t=1	0.1%	0.1%	0.0%	0.1%	0.3%	0.0%
		to t=5	0.0%	0.6%	0.6%	0.6%	0.6%	0.0%
		to t = 10	-0.1%	3.3%	3.1%	3.4%	3.6%	-0.3%
Private Investment		to t=1	-3.2%	-3.2%	-5.2%	-1.1%	0.8%	-4.2%
		to t=5	-2.6%	2.3%	0.2%	4.6%	7.4%	-4.9%
		to t = 10	-2.9%	11.2%	8.8%	13.8%	18.3%	-5.5%
FISCAL ACCOUNTS [2]								
Total Revenue		to t=1	0.0%	0.0%	-0.1%	0.1%	0.8%	0.0%
		to t=5	0.0%	0.0%	-0.1%	0.1%	1.1%	0.0%
		to t = 10	0.0%	0.0%	-0.1%	0.2%	1.6%	0.0%
Total Current Expenditure		to t=1	0.0%	-0.1%	-0.1%	0.0%	0.7%	0.9%
		to t=5	0.0%	-0.3%	-0.4%	-0.2%	0.7%	2.0%
		to t = 10	0.0%	-0.8%	-0.8%	-0.7%	0.6%	2.1%
Domestic Budget Balance		to t=1	-0.4%	-0.4%	-0.5%	-0.3%	-0.1%	-0.5%
		to t=5	-0.4%	-0.1%	-0.2%	0.1%	0.3%	-0.6%
		to t = 10	-0.4%	0.4%	0.3%	0.6%	1.0%	-0.6%
REAL DISPOSABLE INCOME								
	Rural	to t=1	-1.4%	-1.4%	-2.3%	-0.6%	-6.5%	-1.6%
		to t=5	-1.5%	0.2%	-0.9%	1.2%	-7.3%	-1.9%
		to t = 10	-1.8%	3.6%	2.2%	4.9%	-7.7%	-2.4%
	Urban - Unskil	to t=1	2.1%	2.1%	-1.1%	5.5%	10.7%	2.1%
		to t=5	2.1%	3.3%	0.1%	6.7%	14.4%	2.0%
		to t = 10	2.0%	5.1%	1.9%	8.6%	20.6%	1.9%
	Urban -Skilled	to t=1	1.8%	1.8%	-1.3%	5.1%	10.9%	2.1%
		to t=5	1.8%	3.1%	0.0%	6.4%	14.8%	2.3%
		to t = 10	1.9%	5.2%	2.0%	8.5%	21.5%	2.4%
	Total	to t=1	0.5%	0.5%	-1.7%	2.7%	3.3%	0.5%
		to t=5	0.4%	1.9%	-0.4%	4.2%	5.1%	0.4%
		to t = 10	0.3%	4.5%	2.1%	7.0%	8.6%	0.2%

NOTES

[1] All experiments consider a permanent increase in net aid inflows of 12.5%, equivalent to 1.97% of initial GDP. In Experiments 1 through 5 this increase is applied to infrastructure investment, raising infrastructure capital by 1.3% in the first year. By year 10 the infrastructure stock is 9.5% higher than in the baseline. In experiment 6 the aid is used to increase government current expenditure and sector-specific capital. This entails an initial increase in sector-specific capital stock by 5.6% (effective in t=2). Thereafter total expenditure is allocated between current and capital expenditure so as to maintain the capital-output ratio constant. This is consistent with an increase in government expenditure of 11.4%

[2] Values reported as changes relative to baseline except for fiscal measures which are reported as percentage points of GDP

[3] Denotes whether the productivity enhancement is biased towards domestic or export production.

[4] Indicates the presence of a sector-specific subsistence level of consumption (as %age of baseline consumption) .

[5] The real exchange rate is defined as (pe/pd) so that negative values indicate an appreciation.

TABLE 2. SUMMARY RANKING OF SIMULATION OUTCOMES BY KEY INDICATORS

(a) Impact Effect (t=1)

Ref	ERER	Elast	Ref	Exp	Elast	Ref	RGDP	Elast	Ref	PINV	Ref	YD-Rural	Ref	YD-Tot	Ref	BDEF
3 E	-5.8%	-0.46	3 E	-6.7%	-0.54	3 E	-0.02%	0.00	3 E	-5.2%	5 DS	-6.5%	3 E	-1.7%	3 E	-0.54%
1	-2.6%	-0.21	6	-6.7%	-0.53	6	0.00%	0.00	6	-4.2%	3 E	-2.3%	1	0.5%	6	-0.49%
2	-2.6%	-0.02	1	-6.2%	-0.50	1	0.06%	0.00	1	-3.2%	6	-1.6%	2	0.5%	1	-0.41%
6	-2.0%	-0.16	2	-6.2%	-0.50	2	0.06%	0.00	2	-3.2%	1	-1.4%	6	0.5%	2	-0.41%
4 D	0.9%	-0.07	4 D	-5.7%	-0.45	4 D	0.14%	0.01	4 D	-1.1%	2	-1.4%	4 D	2.7%	4 D	-0.28%
5 DS	5.0%	0.40	5 DS	-2.8%	-0.22	5 DS	0.30%	0.02	5 DS	0.8%	4 D	-0.6%	5 DS	3.3%	5 DS	-0.11%

[b] Long Run Effect (t=10)

Ref	ERER	Elast	Ref	Exp	Elast	Ref	RGDP	Elast	Ref	PINV	Ref	YD-Rural	Ref	YD-Tot	Ref	BDEF
1	-2.1%	-0.17	6	-7.9%	-0.64	6	-0.25%	-0.02	6	-5.5%	5 DS	-7.7%	6	0.2%	6	-0.58%
3 E	-1.8%	-0.14	1	-6.7%	-0.54	1	-0.13%	-0.01	1	-2.9%	6	-2.4%	1	0.3%	1	-0.37%
6	-1.5%	-0.12	3 E	3.2%	0.26	3 E	3.12%	0.25	3 E	8.8%	1	-1.8%	3 E	2.1%	3 E	0.28%
2	-0.7%	-0.06	2	4.2%	0.34	2	3.25%	0.26	2	11.2%	3 E	2.2%	2	4.5%	2	0.42%
4 D	0.4%	0.03	4 D	5.3%	0.42	4 D	3.38%	0.27	4 D	13.8%	2	3.6%	4 D	7.0%	4 D	0.56%
5 DS	1.4%	0.11	5 DS	11.7%	0.93	5 DS	3.61%	0.29	5 DS	18.3%	4 D	4.9%	5 DS	8.6%	5 DS	0.98%

Notes

[1] Ref denotes the experiments defined in the text and reported in Table 1. Each block ranks the set of experiments in ascending order of impact on the indicator.

[2] ERER denotes the export real exchange rate; **Exp** total exports ; **RGDP** real GDP ; **PINV** private investment; **YD-Rural** rural real disposable income ; **YD-Total** total real disposable income ; **BDEF** domestic budget deficit (after grants) and **Elast** the elasticity with respect to aid.

[3] E denotes export-bias in supply response ; **D** denotes a domestic-good bias in supply response ; **S** denotes the presence of subsistence consumption in food sector.

Appendix Table 1: Representative Uganda SAM Fiscal Year 2000/01

Macro-Aggregates (Factor Cost)

	Ush bn	%GDP
GDP	8036	100.0%
GNY	9409	117%
Exports		17.4%
Imports		47.0%
Trade		64.4%
Net Factor Income from abroad		15.5%
Current Account (before aid)		-14.1%
Aid		15.8%
Reserve Accumulation		1.7%
Private Consumption		103.5%
Private Investment		8.1%
Depreciation		8.1%
Private Savings		5.7%
Government Revenue		13.6%
Government Current Expenditure		18.4%
Current Budget Balance		-4.8%
Government Investment		7.0%
Overall Deficit (before Aid)		-11.7%

Sectoral Data

Sectors	X	XD	E	M	Import Duties	Net Exports	ND	ID	CD	Cons Taxes
Food Crops	5107	4984	123	631	13	-508	780	30	4818	80
Cash Crops	640	30	610	0	0	610	20	10	0	0
Manufacturing	3647	2982	665	3146	447	-2481	4184	549	1842	100
Services	5612	5612	0	0	0	0	3331	621	1660	175
Public Services	1345	1345	0	0	0	0	0	0	0	0
Total	16351	14953	1398	3777	460	-2379	8315	1210	8320	355
As share of Total										
Food Crops	31.2%	33.3%	8.8%	16.7%	2.8%	21.4%	9.4%	2.5%	57.9%	22.5%
Cash Crops	3.9%	0.2%	43.6%	0.0%	0.0%	-25.6%	0.2%	0.8%	0.0%	0.0%
Manufacturing	22.3%	19.9%	47.6%	83.3%	97.2%	104.3%	50.3%	45.4%	22.1%	28.2%
Services	34.3%	37.5%	0.0%	0.0%	0.0%	0.0%	40.1%	51.3%	20.0%	49.3%
Public Services	8.2%	9.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
As share of X by sector (factor cost)										
Food Crops	100.0%	97.6%	2.4%	12.6%		-10.2%	15.3%	0.6%	94.3%	
Cash Crops	100.0%	4.7%	95.3%	0.0%		95.3%	3.1%	1.6%	0.0%	
Manufacturing	100.0%	81.8%	18.2%	98.5%		-80.3%	114.7%	15.1%	50.5%	
Services	100.0%	100.0%	0.0%	0.0%		0.0%	59.4%	11.1%	29.6%	
Public Services	100.0%	100.0%	0.0%	0.0%		0.0%	0.0%	0.0%	0.0%	

Notes:

X	Total Domestic Production (at factor cost)
XD	Domestic Sales to Domestic Economy (X-E) (at factor cost)
E	Exports (fob)
M	Imports (cif)
CD	Private consumption demand (factor cost)
ND	Intermediate demand (factor cost)
ID	Investment demand (factor cost)

The SAM is specified in billions of Shillings with a nominal exchange rate ofUsh1750 per US$