The Macroeconomic and Welfare Implications of Public Spending Choices: A Computable General Equilibrium (CGE) Analysis for Madagascar

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Abstract

This paper builds on the theoretical framework proposed by Ferroni and Kanbur (1991) to analyse the optimal allocation of public expenditure in an economy benefitting from debt relief. It then uses the framework in a dynamic empirical simulation-based application to Madagascar. Results suggest that investment in public infrastructure is both the growth maximising and welfare maximising strategy subject to there being a sufficiently high degree of externalities to public infrastructure.

1 Introduction

The optimal allocation of public spending is a long-standing policy dilemma in Low-Income Countries (LICs), many of which are forced into austere fiscal consolidation exercises at some point or another. Recent multilateral aid efforts, including the Enhanced Heavily Indebted Poor Countries (HIPC) debt relief initiative, have brought this dilemma to the fore. They have incidentally exposed the lack of consensus, both within the theoretical literature and among policy-makers themselves, on the expenditure categories to which scarce government resources in LICs should be allocated. In particular, the debate concerns the optimal allocation of government resources to social spending and infrastructure spending, often in the context of achieving the twin objectives of growth and poverty reduction. The Enhanced HIPC initiative, for example, comes with an explicit requirement that governments use the savings on debt servicing to increase 'pro-poor' social spending.\(^1\) But this approach, especially

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\(^1\)See for example Poverty Reduction Strategy Papers (PRSPs) for various Enhanced HIPC beneficiaries.

This paper builds on the work by Paternostro et al (2005) to address the gap in the current literature on the optimal allocation of public spending. It proposes a theoretical framework, which combines elements from growth theory and public economics, to identify the relevant considerations which a Low-Income Country government may face in deciding on the composition of public expenditure. In the paper, I cast the government’s problem in the context of debt relief and nest the theoretical framework within a Computable General Equilibrium (CGE) macroeconomic model calibrated to Madagascar data to assess the quantitative significance of the factors identified. I consider five public expenditure configurations. In experiment 1 all savings on debt servicing are used to increase public infrastructure. Experiment 2 considers the opposite scenario where all savings are use to finance increased public provision of health and education. Experiments 3(a)-3(c) are intermediate cases, where the weight on public infrastructure is 0.6, 0.5 and 0.4, respectively. Experiment 4 and 5 provide for net income transfers to the private sector which results in the relaxation of financing constraints for investment and the budget contraint of households respectively. Core simulation results indicate that public spending choices which allocate proportionately more resources to infrastructure spending are also those which maximise growth and discounted intertemporal welfare, but that spending choices which relax investment financing and household budget constraint tend to maximise static intratemporal welfare in the immediate years following the debt relief shock. A sensitivity analysis with respect to key parameters suggest that these results are very sensitive to the degree of externalities generated by public infrastructure. If externalities are low, then allocating resources to public infrastructure is no longer optimal. It also indicates that for some values of key parameters, such as the intertemporal discount factor, the growth and welfare maximising outcomes diverge.

The remainder of the paper is organised as follows: Section 2 summarises related theoretical and empirical work. Section 3 presents the theoretical framework and highlights the main features of the simulation model. Section 4 provides some background information about Madagascar together with a description of data and key parameters. Experiments and results are presented and discussed together with a sensitivity analysis in section 5. Section 6 concludes.

2 Related Literature

The theoretical literature on the optimal allocation of public spending can be divided into two distinct strands. Barro’s (1990) seminal work paved the way for an approach, rooted in growth theory, which provides for analysis of the effect on steady state growth rates of various aspects of fiscal policy. The key element here is an endogenous growth model, in which government spending is ‘productive’ and complementary to private sector investment. Barro (1990)
analyses, among other scenarios, the case where the government can also, alongside ‘productive spending’, spend on services which are ‘utility-enhancing’ for households. He concludes that depending on how the government spending is financed and on the form of the production function, growth-maximising and welfare-maximising shares of productive expenditure (in total government expenditure) need not coincide. Agénor (2005) and Agénor and Neanidis (2006) extend Barro’s work along several dimensions, providing among other things for greater disaggregation of government expenditure categories (for example, infrastructure investment, health spending, education spending) and complementarities between them. They argue that for certain model parameterisations, there may be a case for a ‘big push in infrastructure investment’ relative to other forms of public expenditure.

Ferroni and Kanbur (1991) propose a microeconomic framework which emphasises the respective marginal contributions to individual welfare of either social spending or ‘productive’ spending. They articulate simple, yet plausible, interrelationships between an agent’s ‘basic needs attainment’, income and welfare on one hand and exogenously determined social and ‘productive’ spending by the government on the other. This enables them to express individual welfare only in terms of the two categories of government expenditure. Ferroni and Kanbur (1991) thus propose, a marginal allocation rule for the restructuring of government expenditure which depends on the magnitudes of parameters such as (i) the respective productivities of social spending and income in the ‘basic needs attainment’ function (ii) the respective productivities of basic needs and ‘productive’ spending in the income function and (ii) the valuation of ‘basic needs attainment’ and income in the agent’s welfare. Ferroni and Kanbur (1991) argue that the marginal allocation rule can be combined with Poverty Indices and Poverty lines to yield a restructuring of government expenditure that is ‘poverty-conscious’.

In the empirical literature, analyses of the effect of government spending have either been conducted using econometric techniques or dynamic simulation models. Econometrics-based work have tended to be ‘growth-centric’ in their approach, but have not so far yielded definitive conclusions about the effects of varying public expenditure composition on growth. The sample and time period under consideration appear to matter, as do the classification and disaggregation of public expenditure. Devarajan et al (1996), for example, use panel data for 43 countries from 1975 to 1985 and find that increasing the share of current expenditure has positive and statistically significant effects on growth, while increasing the share of capital expenditure has a negative effect. The authors argue that their results indicate that both the respective productivities of the various forms of expenditures and their initial shares matter, and imply that developing country-governments have been overallocating resources to capital expenditure relative to current expenditure. Recent work by Gupta

\[2\] Note that this classification by Ferroni and Kanbur (1991) is slightly misleading, as it could imply that social spending is unproductive. However, in their framework, social spending is indirectly productive, entering the production function via the ’Basic Needs Attainment’ term (pg 97).
et al (2005) which examines fiscal expansions and contractions in 39 LICs with IMF-supported programs during the period 1990-2000 only partially supports these findings. Gupta et al (2005) do find that allocating government resources to more productive uses (from certain selected forms of current expenditure such as wages and salaries) is growth-enhancing. However, their results also indicate that protecting capital expenditure is key to promoting growth, amid fiscal consolidation.


Agénor et al (2004) develop a macroeconomic simulation framework with a single household and calibrate it to Ethiopian data to capture the links between foreign aid, the level and composition of government expenditure and growth and poverty. They consider among other scenarios, an experiment whereby the composition of spending is changed by reducing government current consumption by 7 per cent, and increasing the shares of public infrastructure (0.7 per cent) and outlays on health (3.5 per cent) and education (2.8 per cent). The authors conclude on the basis of their results that the effect of such a policy on growth and poverty is limited over the simulation horizon, as the supply side effects of the policy tend to be gradual and muted by the adverse effect on aggregate demand.

Jung and Thorbecke (2003) use a multi-sector CGE model to examine the macroeconomic and distributional consequences of raising public investment on education in Tanzania and Zambia under of the HIPC initiative. They find evidence of growth effects through the human capital accumulation process and the supply of skilled labour. The authors also argue that an increase in public expenditure on education should be matched by supporting public investment in physical capital in order to maximise the growth benefits.

Adam and Bevan (2006) and Lévy (2006) focus on the role of government spending to offset Dutch Disease. In their most stylised static form, each of their respective models is conceptually similar to the 1-2-3 model of Devarajan et al. (1993), i.e., one country, two producing sectors (tradables and non-tradables) and three goods (domestic goods, exports and imports). The authors reach broadly similar conclusions from applications to Aid inflows in Uganda (Adam and Bevan) and a resource boom in Chad (Lévy). Their results show that public investment can overturn Dutch Disease and the growth maximising level of public investment is not necessarily distributionally neutral or welfare-maximising.

\(^3\)Recent country-specific policy-based research have also made use of the MAMS model developed by the World Bank (see for example, Lofgren and Diaz-Bonilla, 2006) and the SPAHD model developed by Agénor and others (2006). Both are macro-simulation models which feature an explicit MDG/ Human Development Module to track the effect of public spending on the relevant indicators.
3 Theoretical Framework

The theoretical framework developed in this section is a stylised dynamic macroeconomic framework which spells out a few relevant considerations for Low-Income Country government deciding on the optimal allocation of net resources flows from debt relief or aid. It is summarised by equations 1 to 9 below.

Equation 1 illustrates the public spending choices facing a country receiving debt relief, modelled here as a reduction in foreign interest obligations $F$: It can spend the money on 'Social Services' (interpreted here as public health and education) $E$, on infrastructure spending $I$, or on net transfers to the private sector, $NT_{rP}$. By net transfers is meant cash transfers to households or a reduction in public sector borrowing requirements, which by the savings-driven investment closure rule, results in more resources being available for investment by the private sector.

$$ -F = E + I + NT_{rP} $$

I make two assumptions about the productive or supply-side effects of social spending $E$ and infrastructure spending $I$. First I assume that social spending by the government adds to the human capital stock of agents (individuals or households) through a human capital production function, which is a Constant Elasticity of Substitution (CES) composite of public spending on health and education and the agents’ spending on private health and education. Thus

$$ IPH_{it} = AP\theta E_{p_{it}}^{1-\frac{1}{\sigma}} + (1 - \theta)(\zeta E_{g_{it}}^{1-\frac{1}{\sigma}})^{\frac{1}{1-\sigma}} $$

where AP is a shift parameter, $\theta$ is an Armington share, the subscripts $p$ and $g$ denote private and public services respectively, $\zeta$ is an index of quality of government services and $\nu$ is the elasticity of substitution between $E_p$ and $E_g$. The subscript $i$ denotes the appropriate unit of analysis.

Human capital stocks for each unit is updated using the Perpetual Inventory Method as follows:

$$ H_{it+1} = H_{it}(1 - \delta_h) + IPH_{it} $$

A similar process applies for the stock of public infrastructure where:

$$ K_{gt+1} = K_{gt}(1 - \delta_g) + I_{gt} $$

Next, consider the Aggregate production function for the economy, which is a Cobb-Douglas exhibiting constant returns to scale to land, labour (augmented by human capital) and private capital, but there are externalities to public infrastructure.

This yields equation 5

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4 In what follows, time subscripts are dropped where appropriate.

5 I consider here only two dimensions of human capital stock, namely health and education. A more sophisticated specification could include various other dimensions such as nutrition and measures of labour mobility (Woßmann, 2003)
\[ Y_t = \text{Land}^{\alpha_1} (H_t L_t)^{\alpha_2} K_{pt}^{1-\alpha_1-\alpha_2} K_{gt}^{\alpha_2} \]  

(5)

I follow Ferroni and Kanbur (1991) in defining a measure of 'basic needs attainment' for each microeconomic unit, the specification in Equation 6 differs from theirs in that it is the stock of human capital, rather than government spending that enters as an argument

\[ B_{it} = \bar{B}_i H_{it}^{\beta_h} y_{it}^{\beta_y} \]  

(6)

\( B_{oi} \) is a shift parameter and \( \beta_h \) and \( \beta_y \), the Note that for analysis involving several agents, heterogeneity can be introduced either through the \( B_{oi} \) (e.g. asset endowment) and/or the parameters \( \beta_h \) and \( \beta_y \) (e.g. if agents differ in their abilities to map 'capabilities' into actual outcomes).

I also define a measure of individual welfare, as in Ferroni and Kanbur (1991), \( w_{it} \), which is increasing in 'basic needs attainment' and individual income. Equation 7 illustrates.

\[ W_{it} = \bar{W}_i B_{it}^{\beta_h} y_{it}^{(1-\mu_i)} \]  

(7)

Where the \( \mu \) parameters can be interpretation as measures of valuation of each of the argument in the welfare function.

It can be shown, subject to making a number of simplyfying assumptions, that the dynamic macroeconomic framework described by Equations (1)-(7) can be manipulated to yield marginal allocation rules broadly comparable to the one from Ferroni and Kanbur’s (1991) microeconomic approach.\(^6\)

For a more general specification however, I define two Social Welfare Functions. Equation 8 describes an intratemporal welfare function, which is a CES in individual welfare and can be used to capture inequality aversion by the policymaker. Equation 9 depicts the intertemporal Social Welfare Function and can be used to show willingness on the part of the policy-maker to substitute welfare across time periods.

\[ \Omega = \left[ \sum_{i=1}^{n} \chi_i W_i^{\rho} \right]^{-1/\rho} \]  

(8)

Units of analysis are as before indexed by \( i \), \( \chi_i \) is the weight of each unit in the intratemporal social welfare function \( \Omega \), and the parameter \( \rho \) captures inequality aversion by the policy-maker. Higher values of \( \rho \) denote a greater degree of inequality aversion, and the special case of \( \rho = -1 \) indicates that the policy-maker does not care about inequalities in welfare.

\[ \Pi = \left[ \sum_{s=1}^{t} \frac{\beta^{s-1} \Omega_{1-\sigma}}{1-\sigma} \right] \]  

(9)

\(^6\)The assumptions includes full depreciation in each period so that stocks equal expenditure flows; exogenous determination of expenditure on privately provided health and education; and homogenous agents.
where $s$ is a time index and $1/\sigma$ is the intertemporal elasticity of substitution.

The theoretical framework presented in this section has combined elements from growth and public economics to highlight some of the relevant considerations when determining optimal public spending choices by the government. They are the effect of these spending choices on the supply-side through factor accumulation and growth, the extent of complementarities or externalities arising from each form of expenditure and welfare effects. In addition, factors such as agent heterogeneity and inequality aversion by the policy maker may influence the optimal allocation of public expenditure.

From an intertemporal perspective, a policy-maker’s willingness to substitute welfare across periods suggests that there potentially exist an optimal sequencing of public expenditure choices over time.

### 3.1 Simulation Model

The CGE model presented in this section incorporates the elements described in the theoretical framework above. It draws heavily on the Adam and Bevan (2006) model for Uganda and belongs to the class of recursive dynamic models.

Recursive dynamic models comprise within-period modules and between period modules. The within period modules are solved sequentially to provide updated values of parameters for the between period modules. In these models, there is no role for forward-looking expectations. Agents are assumed to be myopic, ignorant or to naively assume that the present is the best guide to the future. An important implication of this is that agents do not make intertemporally optimal decisions about savings and investment.

Recursive dynamic models thus seek to trace out the path of the economy given a series of static optimisation decisions which are linked through updating equations for stock variables and certain parameters. Equations (3), (4) and (9) provide examples.

This treatment of dynamics has drawn a number of criticisms to CGE models, more so because it appears to be at odds with the relatively complex optimisation by consumers and producers for within-periods decisions (Devarajan and Go, 1998). However, as explained by Lofgren and Robinson (2004), the absence of forward-looking expectations can be a valid assumption, especially when information asymmetries, market imperfections and credit constraints matter sufficiently to obscure agents’ knowledge of the future.

### 3.2 The Set-up

This section is intended as an introduction to the main features of the basic version Madagascar model.

#### 3.2.1 Within-Period Module

*Production*
The model distinguishes between private and government activities. The private sector is organised into 5 activity groups, namely, Primary Sector Tradables, Non-Tradables, Secondary Sector, Tertiary Sector, Human Capital Services (Education and Health Services) and Commercial Margins. The government also provides Human Capital Services and Other Services. This provides for 8 activity sectors in all, and translates into 7 commodities available for final consumption. The reasons for this asymmetry is that the commercial margins sector does not provide marketable commodities but instead reflect the costs of taking goods to markets, which in Madagascar, are significant.

For all tradable goods, production maps into domestic supply and exports according to a Constant Elasticity of Transformation (CET) function. Aggregate supply, on the other hand, is described by a CES composite, drawing on the Armington (1969) assumption of imperfect substitutability between domestically produced and imported goods.

Production in each sector is characterised by a Cobb-Douglas technology as in equation 10, with land \((L_a)\), Human Capital augmented labour \((HL)\) and sector-specific capital \(K_p\) and economy-wide government infrastructure \(K_g\) as factor inputs. Government infrastructure is thus also assumed to have public goods characteristics, as described in the previous section.

**Prices**

Transaction costs are assumed to drive a wedge between the supply price and the demand price. Following Lofgren et al. (2002), transaction costs are modelled as a fixed quantity of commercial margin inputs entering the each unit of produce sold domestically, imported, or exported. This exogeneity of transaction costs with respect to government spending does not provide for an additional dimension along which to directly explore the optimal use of savings on debt servicing. Transactions costs matter however in that they influence the real exports and imports exchange rate in response to shocks, thus affecting incentives to import, export or sell on the domestic market.

**Factors**

Four factors are identified in the model. Land is used only in the two agricultural sectors while labour, sector-specific capital and economy-wide government infrastructure enter as inputs, with varying intensities, in all sectors. The agricultural sectors are most intensive in rural labour, the energy sector in capital and the services sector in urban labour. Except for government sector capital and public infrastructure, all factors are owned by the two household types in the model (rural and urban). The pattern of ownership thus defines a baseline functional distribution of income against which the distributional incidence of macroeconomic shocks are examined.

**Final Demand**

Final demand for marketed goods and services in the model comprises four elements. They are: demand for the transaction costs commodity (commercial margins), investment demand, government’s final demand and households’

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7 Note that the terms "tradable" and "non-tradable" are used in the context of external trade. Non-tradables include traditional agriculture and construction.
consumption. Transaction costs fully exhaust the output of the commercial margins sector. Sector-specific investment demand is determined by the size of the differential between the sectoral gross profit rate and average gross profit rate in the economy. Government final demand includes the total output of the public ‘other services’ and ‘human capital services’ sectors. Households’ consumption is thus defined, by a Stone-Geary Linear Expenditure System (LES) as illustrated in Equation (10), over all marketed privately-produced output.

\[ q_i = \varphi_i + \frac{\theta_i}{\rho_i} (Y - \sum_j p_j \gamma_j) \]  

(10)

Where \( \varphi_i \) gives the quantity of subsistence consumption, \( Y \) is total income and \( \theta_i \) are budget shares governing the allocation of supernumerary income (i.e., expenditure over and above the subsistence consumption requirements).

Subsistence consumption is assumed to vary across household types and commodity groups. The commodities subject to subsistence consumption are agricultural products, for both rural and urban households.

**Macroeconomic Closure Rules**

A neoclassical closure will be used for all the experiments, reflecting the macroeconomic situation in low-income small open economies. This closure rule has three elements. The government current account is characterised by, flexible government savings with fixed direct tax rates. Fixed foreign savings and flexible exchange rates ensure external current account adjustment. Finally, investment is savings-driven, being constrained to be determined by the sum of private, government and foreign savings.

### 3.2.2 Between-Period Module

Dynamics, or the linking of economic decisions over the simulation period, are captured both by updated values for some model variables which get carried forward from one simulation period to the next, as discussed above.

### 4 An application to Madagascar

#### 4.1 Background

Madagascar is one of the poorest countries in Sub-Saharan Africa (SSA). In 2005, it ranked 192 out of 208 based on the World Bank’s Country Ranking of per capital Gross National Income (GNI). With GNI per head of USD290, Madagascar was just behind Mozambique (USD 310), at par with The Gambia, and it preceded Uganda (USD 280).\(^8\) Human development indicators (HDI) were also low, as can be inferred from Table 1.

\(^8\)Gross National Income calculated using the World Bank Atlas Method (Source: World Development Indicators Database as at 1 July 2006).
Table 1. Madagascar: GNI per capita and Selected HDI

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
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<tbody>
<tr>
<td>GNI per capita (Current US$)</td>
<td>240</td>
<td>250</td>
<td>220</td>
<td>280</td>
<td>290</td>
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</table>

**Selected Human Development Indicators**

<table>
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<tr>
<th></th>
<th>2000</th>
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<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life expectancy at birth (Total Years)</td>
<td>54.79</td>
<td>n.a.</td>
<td>55.31</td>
<td>55.48</td>
<td>55.65</td>
</tr>
<tr>
<td>Literacy rate, adult total ¹</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
<td>70.68</td>
</tr>
<tr>
<td>Immunisation rate, measles ²</td>
<td>56</td>
<td>57</td>
<td>58</td>
<td>59</td>
<td>59</td>
</tr>
</tbody>
</table>

Notes: n.a.: not available; GNI per capita in 2005 was US$290

1. Percentage of people 15 and above
2. Percentage of children aged 12-23 months

Source: World Development Indicators Database

Table 2 provides a summary of the structure of the Malagasy economy and of the evolution of key macroeconomic indicators including external debt for the period 2000 to 2004.

Table 2. Madagascar: Selected Economic Indicators

<table>
<thead>
<tr>
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<th>2000</th>
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<th>2004</th>
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<tbody>
<tr>
<td>GDP at market prices (annual % change at 1984 prices)</td>
<td>4.7</td>
<td>6.0</td>
<td>-12.7</td>
<td>9.8</td>
<td>5.3</td>
</tr>
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</table>

**Value Added % of GDP**

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<tr>
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<th>2000</th>
<th>2001</th>
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<th>2003</th>
<th>2004</th>
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<tbody>
<tr>
<td>Agriculture</td>
<td>29.1</td>
<td>28.6</td>
<td>31.7</td>
<td>29.2</td>
<td>28.8</td>
</tr>
<tr>
<td>Industry</td>
<td>14.5</td>
<td>14.7</td>
<td>14.4</td>
<td>15.4</td>
<td>16.0</td>
</tr>
<tr>
<td>Services, etc. ¹</td>
<td>56.4</td>
<td>56.7</td>
<td>53.9</td>
<td>55.5</td>
<td>55.2</td>
</tr>
<tr>
<td>Exports of Goods and Services</td>
<td>30.7</td>
<td>29.1</td>
<td>16.0</td>
<td>23.1</td>
<td>31.7</td>
</tr>
<tr>
<td>Imports of Goods and Services</td>
<td>38.1</td>
<td>32.3</td>
<td>22.6</td>
<td>32.1</td>
<td>48.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation, GDP Deflator (%)</td>
<td>7.2</td>
<td>7.3</td>
<td>15.3</td>
<td>2.8</td>
<td>14.3</td>
</tr>
<tr>
<td>Overall Fiscal Balance (commitment basis, excl. grants)</td>
<td>-6.8</td>
<td>-8.2</td>
<td>-7.7</td>
<td>-9.3</td>
<td>-13.1</td>
</tr>
<tr>
<td>Total external debt ² (Current US$ million)</td>
<td>4120</td>
<td>4052</td>
<td>4433</td>
<td>4847</td>
<td>5142</td>
</tr>
<tr>
<td>Total external debt to GDP (%)</td>
<td>106.4</td>
<td>89.5</td>
<td>97.9</td>
<td>88.7</td>
<td>117.7</td>
</tr>
<tr>
<td>Total external debt to Exports (%)</td>
<td>346.8</td>
<td>308.0</td>
<td>611.3</td>
<td>412.6</td>
<td>366.0</td>
</tr>
</tbody>
</table>

Notes

1. The services sector includes commercial margins. In 1999, the contribution of commercial margins to valued added was 23.4 per cent.
2. After traditional debt relief (Naples flow rescheduling of 1997).
3. The sharp deterioration of all indicators in 2002 is due to the political crisis.
4. Indicators for 2004 reflect a severe depreciation of the currency and adverse weather.

Sources: IMF Country Report 05/321, World Development Indicators Database, Dorosh et al. (2003) data set, and author’s computations.
Madagascar’s total external debt represented 108.3% and 437.5% as a percentage of GDP and exports respectively in 1999, the year in which it qualified for consideration under the Enhanced Heavily Indebted Poor Countries (HIPC) multilateral debt relief initiative. At Decision Point in 2000, the country secured savings on debt service of USD59 million per year, on average, over the period 2001-2019 (1.1 per cent of GDP on average)\(^9\). Equivalently, the amount of debt relief approved at Decision Point for Madagascar was USD 822 million in Net Present Value Terms\(^10\). Madagascar reached Completion Point under the Enhanced HIPC in 2004. In practical terms, this meant that most of the precommitted amount of debt relief would accrue over the period 2004-2019. Another wave of debt relief was granted to Madagascar in 2005 under the G8’s Multilateral Debt Relief Initiative (MDRI)\(^11\), which provides for the complete writing off of all outstanding debts post Enhanced HIPC Completion Point.

Debt relief under both the Enhanced HIPC and the MDRI differ from debt relief efforts of the 1980s in two important respects. The fact that they are mostly concerned with the sovereign debt of Low-Income Countries (LICs) is one of them. Another is that their primary aim is not to cure Low-Income Countries of the debt overhang in order to maximise their chances of meeting remaining debt obligations. Rather, debt relief is associated with an explicit poverty reduction objective, epitomised in the equally explicit requirement that recipient governments use the savings on debt servicing to increase social expenditures and target these to the poor. In the Malagasy context, this represents nothing short of a challenge to fiscal policy given the pervasiveness of poverty.

Poverty Analysis conducted by the IMF and IDA (International Development Association) in the context of the Enhanced HIPC indicates that about 70 per cent of people lived in poverty in 1999. It also suggests the existence of urban-rural poverty divide in Madagascar, with 80 per cent of the poor living in rural areas (IMF and IDA, 2000). Different causes are identified for rural and urban poverty. Limited access to irrigated land, public infrastructure such as electricity and roads are closely linked to rural poverty. By contrast, urban poverty, which accounts for 16 per cent of total poverty, is associated with labour markets and education. These findings suggest that varying the composition of debt-relief financed government expenditure can have very different implications for distribution and poverty. The policy experiments discussed in the next section are designed against this background, although the focus is not on poverty \textit{per se} but on welfare of rural and urban households.

Table 3 below summarises some of the indicators of poverty, based on the headcount index, while table 4 gives a measure of inequality in this distribution in 1999 based on a regional disaggregation of households.


\(^10\)This was later revised upwards to USD 836 million in NPV terms when the country reached Completion Point in 2004. (IMF Country Report 04/406).

\(^11\)See the factsheet by the IMF (2006).
Table 3. Poverty in Madagascar

<table>
<thead>
<tr>
<th></th>
<th>1993</th>
<th>1997</th>
<th>1999</th>
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<tbody>
<tr>
<td>Poverty</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National</td>
<td>70.0</td>
<td>73.3</td>
<td>71.3</td>
</tr>
<tr>
<td>Urban</td>
<td>50.1</td>
<td>63.2</td>
<td>52.1</td>
</tr>
<tr>
<td>Rural</td>
<td>74.5</td>
<td>76.0</td>
<td>76.7</td>
</tr>
</tbody>
</table>

Notes:
2. The poor are defined as those who spent 313,945 Malagasy Francs (USD 164) or less in 1993 prices.

Table 4. Distribution of Household Income in 1999

<table>
<thead>
<tr>
<th>Household Type</th>
<th>Number (FMG bn)</th>
<th>Total Income (FMG bn)</th>
<th>Annual Avg Inc. per household FMG</th>
<th>Annual Avg Inc. per household USD1 (Mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>670,656</td>
<td>9,575</td>
<td>14,277,066</td>
<td>2,272</td>
</tr>
<tr>
<td>Rural</td>
<td>2,192,364</td>
<td>13,761</td>
<td>6,276,786</td>
<td>999</td>
</tr>
</tbody>
</table>

Notes:
1. Based on the period average FMG/USD exchange rate for 1999 (IMF Country report 03/07)
2. Mean Income per household at USD1,297 for 1999.
Sources: Dorosh et al. (2003) data set and author’s computations.

4.2 Data and Choice of Parameters

The baseline data used in to calibrate the model has been kindly provided by Paul Dorosh and Steven Haggblade. Dorosh et al (2003) draw data from various sources, most notably from the National and Balance of Payments accounts and the 1999 Enquête Permanente auprès des Ménages (EPM or Household Survey) to construct a 34-sector, 20-producing factors and 16-household groups Social Accounting Matrix (SAM) for Madagascar with 1999 as the base year. This SAM underpins their analysis of "Economic Motors for Poverty Reduction", in which they investigate the poverty implications of investment in four key activity sectors using the static version of the IFPRI Standard CGE model (Lofgren et al, 2002). A note on the Social Accounting Matrix and its aggregation is provided in Appendix 6.

To keep the analysis of the questions at hand tractable, I aggregate the data into an 8-sector, 5-producing factors and 2 household groups SAM which I supplement with additional data sources where appropriate. For example, I use the World Bank’s 2005 Public Expenditure Review for Madagascar to disentangle government production of human capital services from other public services.

Most parameters are computed in GAMS\(^\text{12}\), the simulation software, by

\(^\text{12}\)General Algebraic Modeling Software.
calibrating the base year data to the relevant functional forms and equations. Exceptions include key parameters such as the Armington elasticities of substitution and transformation, the degree of externalities from public infrastructure, the partial elasticities of basic needs attainment with respect to human capital stock and income, the valuation of basic needs attainment and income in social welfare, the inequality aversion parameter and the intertemporal elasticity of substitution of welfare. For these parameters, I use, where available, estimates commonly employed in the literature (for example, Adam and Bevan (2006) and Lévy (2006)). I then test the robustness of my results by conducting a sensitivity analysis with respect to changes in the value of these non-estimated, non-calibrated parameters. Table 5 below describes the value of key parameters used in the core simulations.

<table>
<thead>
<tr>
<th>Description</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_g$</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>$\beta^a$</td>
<td>0.97</td>
<td>0.97</td>
</tr>
<tr>
<td>$\beta_{hi}$</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td>$\beta_{yi}$</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>$\mu$</td>
<td>0.67</td>
<td>0.67</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>$\rho$</td>
<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### 4.3 Policy Experiments

The policy experiments in this section are designed to capture the public expenditure choices for the government of a small open economy benefitting from debt relief, as per the theoretical framework articulated in Section 3.

Experiments 1 and 2 are bipolar counterfactual exercises, considering the cases when all the savings on debt servicing are entirely spent on public infrastructure or publicly provided health and education respectively. Experiment 3(a)-3(c) are intermediate scenarios, with the weight on public infrastructure at 60, 50 and 40 per cent respectively. In experiment 4, debt relief is matched by an equal reduction in the government’s borrowing requirements, thus enabling the private sector to increase investment out of available resources. Finally, Experiment 5 examines the effect of using savings on debt servicing to make cash transfers to households.

Two sets of core simulation experiments are run. The simulation horizon is in each case 1999-2015. The baseline is defined by a static steady state, and unless otherwise stated, all numerical results in Appendix 4 are expressed as percentage deviations from this baseline. Results are reported for selected macroeconomic variables and welfare for years the immediate (2000) and long-run effects (2015) as well as intermediate years 2004 and 2009.

A brief description of the modelling of debt relief in the simulation model.
and a discussion of the main macro-poverty linkages for each experiments are provided below. A discussion of the results from numerical simulations follow.

4.3.1 Modelling debt relief

Annual average debt relief equivalent to 1.1 per cent of Madagascar’s GDP in 1999 translates into a 70 per cent reduction in the value of the baseline foreign interest payments. In terms of magnitude, the debt relief shock may appear trivial. However, there are a number of reasons for not literally modelling debt relief as recurring annual reductions in foreign interest obligations equivalent to 70 per cent of the baseline. The most compelling is a technical one. Such magnitudes could generate an endogenous regime switch. The economy would turn from a net debtor to the rest of the world to a net creditor, and the equilibrating mechanisms of the model would be altered. In addition, it is conceivable that the effects of debt relief on foreign interest obligations could be muted by offsetting influences, which could be either be endogenous or exogenous to the model. I abstract from detailed analysis of these considerations and characterise debt relief by the following dynamic equation for foreign interest obligations.

\[ fint_{t+1} = fint_t (1 + \phi) \] (11)

where \( \phi \) is a parameter which captures the yearly net change in foreign interest obligations, inclusive of debt relief. For the analysis, we want to consider negative values of \( \phi \) since these imply some amount of realised savings on debt-servicing which can be used to increase public spending. A value of \( \phi \) of \(-0.3\) is used throughout the simulation horizon. This value of \( \phi \) considered correspond to cumulative net reductions of 99 per cent in foreign interest obligations at the end of the simulation period.

5 Results

5.1 Core Simulations

The model calibrates to a zero-growth\(^\text{13}\) steady state in the baseline, replicating the SAM values over the entire simulation horizon (1999-2009) in the absence of any shocks.

Tables 5a, 5b and 5c report the baseline values of some of the main indicators of interest, classified under the headings of macroeconomic data, sectoral data, and factors and households.

\(^{13}\)There is no growth in population and labour supply.
### Table 5a: Macroeconomic Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorption</td>
<td>25,555</td>
</tr>
<tr>
<td>Private consumption</td>
<td>20,845</td>
</tr>
<tr>
<td>Government consumption</td>
<td>1,837</td>
</tr>
<tr>
<td>Private investment</td>
<td>1,730</td>
</tr>
<tr>
<td>Government fixed investment</td>
<td>1,143</td>
</tr>
<tr>
<td>Net exports</td>
<td>-2,182</td>
</tr>
<tr>
<td>GDP at market prices</td>
<td>23,373</td>
</tr>
<tr>
<td>Net indirect taxes</td>
<td>2,175</td>
</tr>
<tr>
<td>GDP at factor cost</td>
<td>21,198</td>
</tr>
<tr>
<td>Foreign interest obligations</td>
<td>325</td>
</tr>
<tr>
<td>Government deficit(-)/surplus(+)</td>
<td>-1337</td>
</tr>
</tbody>
</table>

**Real Export Exchange Rate**

1. Real Export Exchange Rate is the ratio of domestic export price to domestic supply price

**Real Import Exchange Rate**

2. Real Import Exchange Rate is the ratio of domestic import price to domestic demand price

All figures in FMG billion except exchange rates.

### Table 5b: Sectoral Data

<table>
<thead>
<tr>
<th>Value Added to GDP</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Sector Tradables</td>
<td>17.01</td>
</tr>
<tr>
<td>Non Tradables</td>
<td>14.82</td>
</tr>
<tr>
<td>Secondary Sector</td>
<td>13.27</td>
</tr>
<tr>
<td>Tertiary Sector</td>
<td>23.73</td>
</tr>
<tr>
<td>Human Capital Services</td>
<td>1.91</td>
</tr>
<tr>
<td>Commercial Margins</td>
<td>23.44</td>
</tr>
<tr>
<td>Public Human Capital Services</td>
<td>2.01</td>
</tr>
<tr>
<td>Other Public Services</td>
<td>3.80</td>
</tr>
</tbody>
</table>
Table 5c: Factors and Households Data

<table>
<thead>
<tr>
<th>Factor remuneration</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural labour</td>
<td>4,914</td>
</tr>
<tr>
<td>Urban labour</td>
<td>5,184</td>
</tr>
<tr>
<td>Sector-Specific capital</td>
<td>7,621</td>
</tr>
<tr>
<td>Land</td>
<td>3,479</td>
</tr>
</tbody>
</table>

Institutional Income

| Rural households                     | 13,678 |
| Urban households                     | 9,658  |

Consumption

| Rural Households                     | 13,115 |
| Urban Households                     | 7,730  |

All figures in FMG billion

In all subsequent experiments, the shocks intervene at the end of 1999. A subset of numerical results from the core simulations are reported for values of $\phi$ of $-0.3$ in Tables 6-10 in Appendix 4. In all cases, the impact effect (1 year after the shock takes place) and the accumulated net effects in 2004, 2009 and 2015 on macroeconomic variables and welfare are presented.

For both sets of simulation, Experiment 1 (‘the big push in infrastructure’) is the both the growth and (intertemporal) welfare-maximising strategy. A difference between the results of the two simulations arise in the value of the Social Welfare functions only due to the different assumptions about the degree of inequality aversion.

The macroeconomic indicators are indicative of the creation of a ‘virtuous circle’ effect, arising from the assumption of the externality effect of infrastructure. Intuitively, the effect of investment in public infrastructure is an across the board increase in productive capacity which raises the returns to private factors and over time, causes the relative prices of domestically produced commodities to fall. This is borne out by the results, which indicate that private investment grows strongly throughout the simulation period, being 33.73% above its baseline value by 2015. Average wages also take an upward trend, being initially higher for rural labour (0.85 per cent and 3.19 per cent against 0.46 per cent and 2.94 per cent for Urban labour). In later years, the growth rate of wages is strongest for urban households and by 2015, average wages are 9.49 per cent and 11.39 per cent above the baseline for rural and urban households respectively. As a result, by 2015, real GDP is 10.73% higher over its baseline value.

Results from Experiment 1 also confirm earlier findings that Adam and Bevan (2006) and Lévy (2006) about public infrastructure reversing Dutch Disease. The immediate impact of the investment in public infrastructure is a slight appreciation of the real export and import exchange rates and worsening of the trade balance. However, at the end of the simulation period both exchange rates are depreciated (by 0.46 per cent and 1.75 per cent) relative to the baseline and
the trade balance indicates an improvement over the baseline of 20.89 per cent.

The combined cumulative effect of Experiment 1 on real GDP and 'basic needs attainment', as shown in Table 9 of Appendix 4, translate into discounted intertemporal welfare being highest under this configuration, regardless of the assumed degree of inequality aversion of the government. However, a comparison of period by period welfare gains shows that the effect on static intratemporal welfare the immediate years following the shocks is actually higher under Experiments 4 and 5 (net transfers to the private sector financing investment and consumption, respectively). This illustrates the point made in section 3 about the possible existence of optimal sequencing of public expenditure choices.

Considering Experiments 2 (spending on public health and education only) and the intermediate Experiments 3(a)-3(c) reinforces the conclusion that a public spending program that allocates proportionately more resources to infrastructure investment relative to increasing public health and education provision is more ‘pro-growth’ and yields higher improvements in intertemporal welfare. A ranking of these four public spending choices, in ascending order, in terms of their effects on growth and discounted intertemporal welfare would be: Experiments 2, 3(c), 3(b) and 3(a). The corresponding respective weights on public infrastructure investment are 0, 0.4, 0.5 and 0.6 respectively. The results about the immediate effect on intratemporal welfare still endure however.

An explanation of the difference in the growth and welfare outcomes of Experiments 1-3(c) can be found in an analysis of the welfare indicators. Results for Experiment 2, for example, shows that increased provision of social services by the government has much lower growth and complementarity effects (with private factors), and as such is not effective in reversing Dutch Disease. In terms of end-of-simulation horizon magnitudes, real GDP is 2.96 per cent above the baseline; private investment is up by 16.89 per cent and the real export and real import exchange rates are appreciated relative to their baseline values by 1.49 per cent and 1.77 per cent. Thus this particular public expenditure configuration is limited in its ability to raise households' incomes and 'basic needs attainment', and as a result, welfare. It is worth noting however, at this stage, that the results discussed so far could be sensitive to the assumptions about the degree of externalities from public infrastructure. It is plausible that in the presence of lower externalities from public infrastructure (for example, due to congestion costs), the observed differences in growth and welfare outcomes may be smaller or even reversed. This is considered in the sensitivity analysis.

The results on macroeconomic variables from Experiments 4 and 5 are in line with what would be expected. To the extent that Experiment 4 enables the accumulation of factors of production (private sector capital), it has a higher growth effect that Experiment 5 (2.64 per cent and 0.27 per cent, respectively), the immediate effect of which is merely a relaxation of the budget constraint of households. There are, as expected no offsetting effects, on Dutch Disease as the real export and import exchange rates remain appreciated relative to their baseline value. For experiment 4, there appears to be diminishing returns to private sector investment. This result may at first seem to be counterintuitive considering that LICs are more often than not characterised by acute shortages.
of private capital. However, it needs to be viewed against the backdrop of the static steady-state baseline, which features a zero-labour supply growth assumption. The effect of these two experiments on period-by-period welfare in the immediate years following debt relief can be traced to the evolution of the Household variables in Table 6 (Appendix 4). For rural households, the immediate effects of both experiments 4 and 5 on the average wage, disposable income and consumption are highest than under any other public expenditure configuration. Urban households similarly experience the highest immediate increase in disposable income and consumption under experiment 5. Further, for urban households, the immediate effects of experiment 4 on these variables are comparable to those from experiment 1.

6 Concluding Remarks

This paper has developed a theoretical framework that can be used to determine the optimal allocation of public expenditure and tested the quantitative significance of the relevant factors thus identified using a CGE model calibrated to Madagascar data. Five Public Spending configurations were analysed. In experiment 1, all savings on debt servicing are use to increase public infrastructure. Experiment 2 considered the other end of the spectrum, with debt relief financing increased public provision of health and education. Intermediate cases with the weight on public infrastructure is 0.6, 0.5 and 0.4 were examined in experiments 3(a), 3(b) and 3(c), respectively. Experiment 4 and 5 examined the effect of net income transfers to the private sector which result in the relaxation of financing constraints for investment and the budget constraint of households respectively. The main results that emerge from the model simulations are that public spending choices which allocate proportionately more resources to infrastructure spending are also those which maximise growth and discounted intertemporal welfare, but that spending choices which relax investment financing and household budget constraint tend to maximise static intratemporal welfare in the immediate years following the debt relief shock.

The results also confirm previous results by Adam and Bevan (2006) and Lévy (2006) about how public infrastructure can be used to reverse Dutch Disease. A sensitivity analysis with respect to key parameters has indicated that the degree of externalities to public infrastructure is crucial. Hence, it would appear that a ‘big push’ in infrastructure is only warranted for sufficiently high degree of externality. For LICs such as Madagascar, it is not inconceivable that large externalities to public infrastructure, for example roads, exist so that allocating public investment to infrastructure might be optimal.

Another insight from the sensitivity analysis is that for values of some parameters, for example the intertemporal discount factor, the growth maximising and welfare maximising outcomes differ. This suggests that the existence of possible trade-offs in the allocation of public spending.

These results must of course be considered against the assumptions and limitations of the simulation model used to generate them. The most important
limitations of the model concern the many simplifications made in specifying model dynamics. The modelling of debt-relief and the calibration to a static steady-state baseline with zero labour supply growth, and the absence of leads and lags in the process of physical and human capital formation are prominent examples. Additionally, notwithstanding the suitability of the recursive dynamic structure to characterise a Low-Income Country, it does seem a bit at odds with asset accumulation by households and modelling that the public expenditure allocation process consist a series of separate static decisions. These are limitations which further research will seek to address.

References


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