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Aid, Spending Strategies and Productivity Effects

A Multi-sectoral CGE Analysis for Zambia

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Volker Clausen and Hannah Schürenberg-Frosch*

Aid, Spending Strategies and Productivity Effects – A Multi-sectoral CGE Analysis for Zambia

Abstract

Numerous econometric studies fail to detect a signicant and robust relationship between international aid and economic growth in the recipient countries. Dutch Disease effects might be responsible for this result. This paper examines the relation between aid and its effectiveness in a multi-sector multi-household Computable General Equilibrium (CGE)-framework. Given that international transfers to African countries increasingly take the form of general financial support to the government, different spending strategies and their macroeconomic, sectoral and distributional effects are evaluated in a two-stage simulation making a distinction between immediate direct effects and possible long-run effects from increased productivity. While the model simulates the effects of additional aid in Zambia it can be used as a blueprint for other African countries.

JEL Classification: O19, O55, F35

Keywords: Foreign aid, applied general equilibrium, Zambia, Dutch Disease, productivity

July 2009

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1. Introduction

The question whether international aid is an effective instrument to foster sustainable economic development has been on the agenda for a long time [see Friedman, 1958; Bauer, 1972, and others]. This debate gained momentum with Boone [1994] who surprisingly found that aid had no impact on economic growth in developing countries. More recently, Easterly [2003] and Rajan & Subramanian [2008] provide empirical evidence in the same direction. In a comprehensive meta-study of the aid effectiveness literature Doucouliagos & Paldam [2008] conclude that international aid has no significant influence on growth in the recipient countries.

In search for a possible explanation for the apparent ineffectiveness of international aid, several studies suggest that Dutch Disease effects weaken the impact of aid on growth [see e.g. Elbadawi, 1999; Rajan & Subramanian, 2005; Barder, 2006; Fielding, 2007]. Aid inflows tend to be accompanied by an appreciation of the real exchange rate, a loss of international competitiveness and a corresponding contraction of the export sector. On the other hand recent studies by Adam & Bevan [2006] and Agenor *et al.* [2008] argue that these conventional Dutch Disease effects may be overstated. They may disappear in a dynamic context when they are more than offset by large positive supply side effects. This holds as long as international aid is channeled into investment in the public capital stock and allows for productivity and output increases in the future.

The econometric finding of aid ineffectiveness, the potential role of Dutch Disease effects as well as different spending patterns of development aid call for a more disaggregate analysis. Against this background this paper analyzes the effects of additional aid flows in a Computable General Equilibrium (CGE) model. The CGE framework allows for a detailed sectoral analysis. The simulations in this paper discriminate between different spending strategies and consider different dimensions of aid effectiveness. Apart from that the setup clearly distinguishes between the negative side effects from a reallocation of resources at the sectoral level (i.e. Dutch Disease effects) and the potential positive effects from increased productivity.

CGE models have a long tradition in economics in general and in development economics in particular. Nevertheless, the list of references with respect to the effects of international aid in these models is surprisingly short. Bandara [1995], Vos [1998], Adam & Bevan [2002, 2006] and Agenor *et al.* [2008] use CGE models to investigate the effects of large capital inflows to specific countries. These studies concentrate either on the demand or the supply side. The individual model specifications vary and, correspondingly, also the simulation results. Furthermore, they typically focus on only one specific use of aid most often public investment. All studies find evidence for aid-induced Dutch Disease effects but differ in

their assessment of the strength of these effects.

Bandara [1995] shows in a static model for Sri Lanka that the effects of aid depend on the flexibility of production in the receiving economy. He considers different degrees of factor mobility across sectors which explain different output and price responses across sectors. Vos [1998] uses a four sector dynamic general equilibrium model for Pakistan with an integrated capital market. He finds that the strength of Dutch Disease depends on the nature of the international transfer. It is more severe if aid is paid in form of grants and directly transferred to the government compared to the effects of foreign direct investment(FDI) or international loans. Adam & Bevan [2002, 2006] use a four sector two factor dynamic model for Uganda. They conclude that initial Dutch Disease effects could be compensated over time if all aid is productively invested and leads to productivity gains but only if these favor the nontradeable sector. In addition Adam and Bevan find negative distributional effects. Agenor *et al.* [2008] use a dynamic one-sector-one-household approach with a very elaborate government sector. Most aspects of Dutch Disease are excluded from their model design as the highly aggregated setup does not account for sectoral reallocation. Nevertheless, they conclude that negative effects from aid could be avoided if the supply response is sufficiently large and the absorptive capacity of the recipient country is sufficiently high. However, the underlying model with only one representative household and one sector is clearly restrictive.

This paper provides a comprehensive account of the issues in a detailed CGE model based on a real world dataset. The simulation results are generated by an 11-sector-5-household static CGE for Zambia. Zambia is one of the 50 least developed countries and will probably receive substantially more aid in the near future [see OECD & AfDB, 2007]. The possible effects of these additional aid flows are analysed in a sequence of simulations.

In order clearly discriminate between the immediate effects from spending and the long-run productivity effects from public capital formation a two-stage approach has been chosen. The first stage only covers demand effects, the second stage adds productivity effects. The simulation results are grouped in three categories: At first, aggregate and sectoral effects are presented. It is shown that the specific structure of the Zambian economy induces large sectoral shifts in production and makes the Zambian export sector very vulnerable. This is clearly illustrated in the second category: the detailed trade balance effects. Countries with similar economic profiles are likely to experience comparably negative Dutch Disease effects from international aid. Furthermore, depending on the spending scenario, international aid may also have adverse effects on income distribution and make poor households worse off.

The remainder of this paper is structured as follows: The next section defines the terms

aid and different concepts of *aid effectiveness*. Section 3 describes the model. Section 4 gives an overview of the data and describes the parametrisation. Section 5 motivates and describes the different spending scenarios. Section 6 presents the simulation results. Section 7 concludes.

2. Aid and Aid Effectiveness

Most macroeconomic studies do not distinguish between different forms of aid as the underlying data on its specific uses are typically unavailable. The data set in our CGE model defines international aid as the amount of foreign grants reported in the government budget. Hence the CGE model only covers official development assistance (ODA) being paid to the government and reported in the budget.[1] This covers only a part, but still the majority of aid given to Zambia (about 70-80% of aid in recent years).[2]

Aid can be used for public consumption, public investment or for transfers to the private sector. Most previous CGE studies and also most theoretical analyses on aid effectiveness assume that aid is used for productive capital investment and increases public capital accumulation. However, a growing proportion of aid is provided as direct budgetary support [see OECD & AfDB, 2006, p.525] and does not necessarily increase public capital accumulation. For this reason this paper compares five different spending scenarios. The benchmark case refers to the actual composition of the government budget in Zambia in 2001. The respective shares of the three possible uses of aid are then modified in order to focus on the different spending strategies.

Our CGE model is a static model as most other CGE applications in the field and captures mainly the steady state impact of aid, leaving aside the adjustment dynamics.[3] It is based on a real data set from the base year.

The effectiveness of aid is measured in most macroeconomic studies only with respect to

[1] The aid variable does not cover private aid, humanitarian aid, technical assistance or tied aid and does not explicitly account for military aid and short-term credits even though parts of the base year aid might have belonged to these categories.

[2] This is not a major concern as the volume of base-year aid is only a scaling factor. In order to account for this measurement problem, different increases in aid are simulated.

[3] CGE models with a focus on development issues are often specified as static models partly because of generally low savings and investment rates in those countries. For this reason endogenous private capital accumulation plays a smaller role and the simulation results from a static model provide a broadly reliable guide to the ultimate long-term effects of development aid. Nevertheless, the paper needs to introduce some aspects of (quasi)-dynamics in order to evaluate the different spending scenarios on a comparable basis. The impact of spending may be short-term (such as on public consumption) or of a longer-term nature via the stock of public capital which generates lasting productivity effects. In order to take account of these features as well as of depreciation of the capital stock the paper makes some simplifying assumptions and captures these aspects with the scaling of the productivity parameter. See section 3.4 for further discussion and details.

economic growth [see Doucouliagos & Paldam, 2008]. This paper broadens the perspective and evaluates three different types of indicators. The simulations illustrate the effects of increased aid on sectoral and aggregate production, the trade balance as well as on welfare and income distribution. Following this broader assessment aid will be considered effective as long as it promotes growth and international trade and leads to (over-proportional) increases of the income of poor households, i.e. in the case of Zambia the income of small farmers and self-employed. It will be shown that there exists a trade-off between these objectives for Zambia.

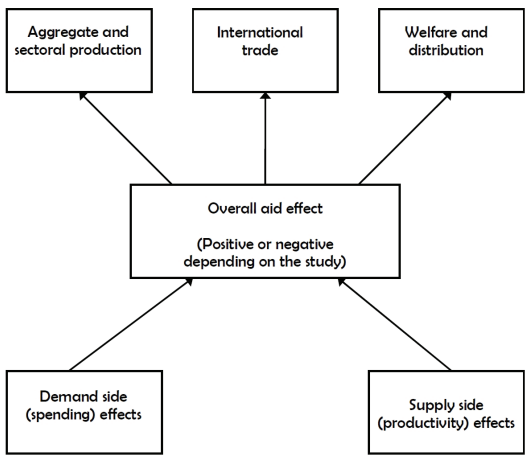

Figure 1: Decomposition of aid effects

Figure 1 provides a brief overview of the different types of aid effects. A first distinction can be drawn between demand and supply side effects. Demand side effects are mainly direct effects from the spending of aid in the recipient country. Governments tend to use aid mainly for the purchase of non-tradeable goods. The first and most direct effect from aid will be increased demand for non-tradeables. This increase in domestic demand leads to rising domestic prices of non-tradeables relative to tradeables, i.e. to an appreciation of the real exchange rate. The receiving government can use aid either for recurrent or for capital expenditure, the share of imported goods increases with the importance of capital investment in the aid-financed expenditure. Alternatively, the government could transfer the aid to the private sector where it allows for higher consumption or higher investment. The resulting increase in imports again depends on the type of spending.

The supply side effects mostly arise from productive investment and increased capital accumulation. The government may use the additional funds for public capital accumulation

as Adam & Bevan [2006] assume in their model of aid effectiveness. Aid may be invested in health and education programs which increase labour productivity. Or it may be used for infrastructure investment which increases total factor productivity [see Agenor *et al.*, 2008]. Aid could also be transferred to private investors and hence add directly to private capital accumulation. These productivity effects have the potential to increase domestic supply and to reduce Dutch Disease effects. In general the spending of additional aid incurs sectoral shifts in production. The direction of these sectoral reallocations depends on differences in factor intensity, the share of imported intermediates and productivity effects from aid.

Distributional effects from aid result from changes in the relative goods and factor prices. Undesirable distributional effects might occur as increased demand and prices might lead to a rise in the return to high-skilled labour which is mainly an income sources of wealthy households. On the other hand, the rise in domestic prices could be to the detriment of the poor.

The CGE model allows for a comprehensive assessment of the effects of different spending scenarios on aggregate and sectoral production, international trade as well as welfare and income distribution. In order to isolate these different effects a two-stage simulation has been done, where the first stage only includes direct spending effects and the second stage adds indirect effects on factor productivity through increased public investment. For the sake of simplicity, these productivity gains are implemented in a uniform fashion across sectors and factors of production.

3. The Applied General Equilibrium Model

The model draws on the Tanzania model by Thomas Rutherford [see Rutherford, 2003] and is written in GAMS/MPSGE vector syntax [see Rutherford, 1995]. Compared to standard developing country CGEs the model has a very detailed government account and allows for different uses of aid. Moreover, it includes a productivity parameter which depends endogenously on the amount of aid spent on public investment. In the following the basic features of the Zambia model and the parametrisation are described.

3.1. Production

Production in Zambia is disaggregated into eleven sectors of production, three of which are agricultural, five industrial and three are services. In each sector output is produced from a specific combination of intermediate inputs, capital, land and two different types of labour. The production process is modelled using a nested production function as shown in figure 2.

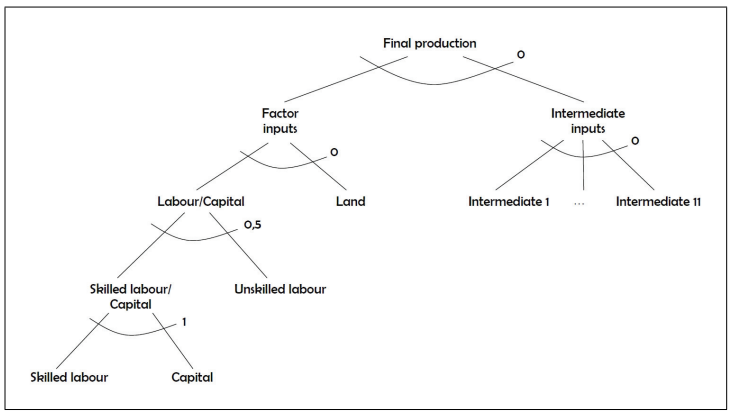

Figure 2: Nesting structure of domestic production xd(i)

Skilled labour and capital are imperfect substitutes in a Cobb-Douglas production function with a corresponding elasticity of substitution (eos=1). We assume the substitutability between unskilled labour and skilled labour/capital to be more limited (eos=0,5). The combination with land takes the form of a Leontief production function (eos=0). Substitution between different intermediates or between intermediates and factors of production is again ruled out by the assumption of Leontief production functions (eos=0).[4]

Zambia is modeled as an Armington economy. Domestic goods are imperfect substitutes for foreign goods. Domestically produced goods are combined with imported supply in a Constant Elasticity of Substitution (CES) function to form the Armington aggregate which is sold on domestic markets. Domestically produced goods may also be exported, but production of exports differs from production for the local markets. This is implemented using a Constant Elasticity of Transformation (CET) function. The structure of the supply side is shown in figure 3.

3.2. Demand

Domestic demand consists of household demand, government consumption, investment and intermediate demand. Intermediate demand is linearly linked to the quantity of output. Investment demand is linearly linked to the amount of savings. The households and the government are described below.

[4]Note that other nesting structures have been examined in robustness checks and do not have an influence on the qualitative simulation results.

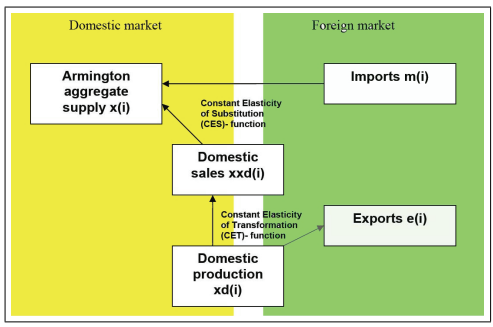

Figure 3: Supply side of the economy

The model has five household types which differ in their main source of income, their level of income, their income tax rate[5] and in their marginal propensity to save. Households generate income from labour, capital, land and entrepreneurial activities. Apart from these income sources households receive transfers from other households, from the government and from abroad. Income is used for tax payments, consumption, transfer payments and savings.[6] Details on the different household types are given in table 1.

Small and medium farms represent the largest and poorest group of the population. They earn most of their income from unskilled labour and spend almost 90% of it for food, most of their consumption is home-produced. These households receive the majority of public transfers. The second-largest and -poorest group are self-employed micro-entrepreneurs. These earn most of their income from entrepreneurial activities and receive only a minor part of public transfers. Home production is of less importance in their consumption bundle which has a high share of food as well. Households of formally employed constitute another fifth of the Zambian population. These households earn income from labour and entrepreneurial activities and receive a substantial amount of public transfers, too. Large-scale farmers and employers constitute the richest part of the population. While large farm households earn income from both forms of labour and to a smaller extent from capital and entrepreneurial activity, employers earn the majority of their income from enterprise earnings. Both spend less then half of their income on food.

The government generates income from taxes, public capital and aid. It spends its revenue for public consumption, transfers to households, subsidies, interest payments to the

[5] In contrast to the Tanzania model, income taxes rise in proportion with the income level and differ across households. This implies that the government will indirectly benefits from increased transfers.

[6] A substantial part of household consumption is directly satisfied from their own production of food, the so-called home consumption. It is important to include this into the model as this production is not marketed but must be accounted for.

	Small and medium farms	**Large farms**	**Self-employed**	**Formally employed**	**Employer**
% of population	57.5	0.1	21.5	20.0	0.9
Income tax rate	0.0	12.1	5.4	11.8	22.2
Savings rate	0.1	1.3	0.9	1.4	3.1
% of publ. transfers	40.1	0.0	19.0	38.1	2.9
Income from... (%)					
Unskilled labour	73.0	39.8	14.4	34.2	4.8
Skilled labour	3.6	35.9	2.6	18.9	3.1
Capital	11.1	4.1	0.6	0.3	0.08
Enterprise	0.0	18.6	78.4	41.1	90.7
Publ. transfers	5.8	0.0	2.6	4.0	1.2
Expenditure (%)					
Home production	61.0	43.2	12.8	4.1	3.2
Food	87.9	49.6	65.3	58.5	40.7

Table 1: Household groups and characteristics

rest of the world and public investment. Transfers, subsidies and interest payments are exogenously fixed. The only good the government consumes are public services. Public investment consists mainly of construction and to a smaller extent of capital goods. In contrast to most other CGE applications the government does not only act as redistributor but has a distinct consumption and investment function.[7] This allows for the identification of the specific effects from government spending compared to private spending. Only this disaggregated view on the government allows for a complete picture of Dutch Disease effects from aid. These might in fact differ from traditional Dutch Disease from resource booms or other windfall gains. By means of the government-specific consumption and investment functions it is even possible to distinguish the effects of different forms of increased government spending.

Savings are generated by households, enterprises and the rest of the world. Savings are used for private capital investment. Total investment is always chosen to equal total savings. Investment demand for the two investment goods is determined in a Linear Expenditure System (LES/Leontief).

3.3. Modeling of aid

Aid is specified as grants to the government which may use it for its own spending purposes or transfer it to the private sector. Aid is taken as a financial transfer from the rest of the

[7]To our knowledge a combination of government specific consumption and investment in one model has so far not been implemented in aid-focused developing country CGEs.

world which allows the country to finance additional net imports. This assumption implies an extension of the balance of payments from additional international aid [see Bandara, 1995, p.316-317]. This net trade balance will be held fixed across all following scenarios in order to allow for a valid comparison across policy scenarios.

The scaling up of aid is implemented using a multiplier with the initial level of aid in the government's income equation. The respective use of aid is modeled by the choice of the shares of the different components in the budget. The government may use the additional aid either for public consumption, public investment, transfers or for a combination of these elements.

3.4. Modeling of productivity effects

The productivity effects from increased public investment are captured as in Markusen [2002] by introducing a multiplier on factor endowments. An increase in total factor productivity leads therefore to an increase in the effective supply of factors. It is assumed that the increase in total factor productivity is uniform across all factors and also across sectors.[8] In the benchmark scenario the respective parameter is set to 1, which means that effective factor supply is equal to actual factor supply in the base year. In the counterfactual, public capital formation increases the effective supply of factors of production. The respective elasticity of total factor productivity with respect to public investment is taken from the literature. Our parameter choice is based on the numerous estimations of Hulten [1996]. He estimates this elasticity to be between 0.12 and 0.25 depending on the specification of the model. These two values have been used.[9]

3.5. Measuring welfare

In order to assess aid effectiveness the choice of the adequate welfare measure is crucial. Most CGE applications use the Hicks equivalent change in household income as the appropriate welfare measure.[10] It equals the percentage change in real private consumption. Note, however, that the presence of government spending requires additional measures. The Hicks equivalent does not include public spending if it does not enter the households' consumption bundle. Correspondingly, an increase in public consumption does not have a

[8] The public investment-induced productivity gains are some kind of "black box" here as the model does not answer how exactly public investment enhances productivity. It only assumes that public capital formation has a positive effect on total factor productivity. The results of the productivity scenarios should be interpreted as the medium-term reaction of factor productivity to public investment as the static model excludes the adjustment process which probably takes some time.

[9] Other values have been tested in robustness checks. Adam & Bevan [2006] use a much higher value of 0.5. This may be rationalised by multiperiod effects from investment in the public capital stock.

[10] See for example Rutherford & Tarr [2008].

direct impact on private welfare.[11] For the sake of comparison, we also provide a broader measure including public spending and present the percentage change in aggregate real private and public spending. While the Hicks equivalent as the conventional welfare measure may be interpreted as the lower bound, the broader measure including public consumption represents an upper bound. Ultimately, it depends on how much private households value public spending i.e. the degree of efficiency in public good provision in developing countries.

Concerning income distribution across households several relevant aspects are included in the CGE, such as changes in all goods prices, factor prices and incomes. Furthermore we include household-type specific consumption patterns and factor endowments. Finally the importance of home produced and consumed food is fully taken into consideration. Nevertheless, the distributional results have to be interpreted with some caution. The five different household types represent extremely different shares of the Zambian population. A comprehensive assessment of the distributional impact requires data on the basis of deciles of the population. Conventional measures of distribution such as Gini coefficient and Lorenz curve cannot be used for our dataset. In addition the income effects for small entrepreneurs might be biased as the distinction between capital income and entrepreneurial income is blurred in the base year data and therefore also in the model results.

4. Data and Parameterisation

4.1. Data

Zambia is very aid dependent as almost 30% of the government budget is financed by external assistance [see OECD & AfDB, 2007, p.552]. Public capital formation relies strongly on external support as it is financed up to 70-80% from external sources. In 2001 total ODA disbursed to the government from the OECD countries amounted to roughly 11% of the Zambian GDP [see SourceOECD, 2007]. The Zambian government draws the financing of its Poverty Reduction Strategy (PRS) largely upon increased aid flows even though these depend on the implementation of institutional and accounting reforms [see OECD & AfDB, 2007, p.552]. The Zambian aid receipts have been used for public capital accumulation especially in infrastructure but also for the health and education sectors as well as for administrative reforms. For Zambia the assumption by Adam & Bevan [2006] that most or all aid is used for public capital is not valid. Even though grants and ODA have recently increased relative to GDP, public capital accumulation has fallen relative to GDP. Increased aid has not resulted in increased public investment [see OECD & AfDB,

[11] This implicitly assumes that private households do not value the provision of public goods at all. Alternatively, one could measure welfare using a utility function including a public good component. Unfortunately, empirical estimates of utility function parameters for Zambian households are unavailable.

2008, p.619].

In 2006 the Zambian domestic production was structured as follows: 20% were produced in the agricultural sector, 32% in the industrial sector and 49% in the services sector.[12] Zambian exports rely mainly on three sectors: Mining, which contributed 4% to the 2006 GDP and roughly 60% to total exports, traditional agricultural products (coffee, tea, tobacco, sugar, cotton) and manufactured copper products (rods and wires). The main Zambian imports are capital goods, manufactured goods and processed food.[13] The main consumption goods are agricultural products, mostly food but also manufactured goods and private and public services.

Most parameters, i.e., expenditure shares for households, the government and the investment function, as well as parameters for production technologies and preferences can be computed directly from the data.[14] The Social Accounting Matrix (SAM) has been suitably aggregated for the purpose of this analysis. This data has been complemented with data from the national accounts for foreign aid inflows and interest payments.[15]

4.2. Parameterisation

For Zambia, like for most developing countries, estimated elasticities of substitution and transformation are unavailable. For convenience, Cobb-Douglas and Leontief functions are mainly used for the production functions. This conforms with most other CGE applications and also with empirical results confirming that substitutability between factors is very limited in developing countries [see Duffy & Papageorgiou, 2000; Agenor *et al.*, 2008]. The Armington function elasticities have been chosen as in other developing country applications between 0.4 for capital goods and manufacturing and 1.5 for agricultural products [see Dervis *et al.*, 1982].[16]

For exports it is assumed that in agricultural sectors the shift from domestic supply to export supply is easier than in the other sectors, whereas in manufacturing and capital goods production it is nearly impossible to change the sales market. Elasticities of transformation are specified between -0.9 in agricultural sectors an -1.7 in manufacturing and capital goods. World market prices are exogenous and act as a numeraire in the model.

For the assumed investment-elasticity of factor productivity two different specifications

[12] Data for 2006 taken from Kufa *et al.* [2008, p.3]. The Zambian production and consumption structure in the base year (2001) is given in table 3 in the appendix.

[13] See table 4 in the appendix for more information on the trade structure.

[14] The basic SAM has been provided by the International Food Policy Research Institute. It is described in detail by Thurlow *et al.* [2004].

[15] National accounts data has been taken from the statistical appendices of different IMF-Country reports on Zambia, mainly Akatu *et al.* [2006] and IMF [2005], and the Zambian Poverty Reduction strategy paper [see Government of the Republic of Zambia, 2002] as well as the Public Expenditure Reviews and the OECD African Economic Outlook [see OECD & AfDB, 2007, 2008].

[16] The elasticities of substitution are presented in table 8 in the appendix. Alternative specifications have been tested in robustness checks.

have been selected consistent with the values estimated by Hulten [1996].

5. Spending scenarios

The Zambia model is used to simulate alternative spending scenarios for the additional aid inflows. Results will be presented for a 45% increase which corresponds to about 2.5% of the Zambian GDP and lies in between the average annual increase in the recent past and the expected increase given in the Fifth National Development plan.[17] 45% has also been chosen for comparison with the results from Adam and Bevan who simulate an increase of aid for Uganda corresponding to roughly 2% of the GDP.[18]

Three core strategies are distinguished for the use of additional aid. It could be spent on public investment, enhancing the infrastructure, enlarging the public capital in health and education and aiming at a broad increase in total factor productivity. It could be used for public consumption i.e. public services especially on current expenditures for health and education to enhance the social and health situation and the living standard especially of the poor. Or it could be transferred to the private sector. All other possible strategies (i.e. forms of aid) represent hybrid forms of the above.

Most CGE applications on increased aid assume that the additional resources are entirely invested. For the sake of comparison this scenario is also simulated here. A growing proportion of aid is allocated in form of budgetary support [see OECD & AfDB, 2007], which means that a part of it will also be spent on recurrent expenditure. In addition, it can be observed in Zambia like in many other countries, that aid simply substitutes for the public investment budget of the government and raises indirectly the current expenditure as the tax receipts are now redirected towards recurrent purposes [see Fagernäs & Roberts, 2004]. In view of the growing importance of budgetary support and the possible shift in the use of tax receipts, it is very likely that aid will also increase recurrent expenditure. In consequence a hybrid scenario with a proportion of aid used for public consumption and for transfers to private households is simulated here as well. A pure public consumption scenario completes the spectrum of possible spending scenarios. The results of nine core scenarios will be presented being summarised in table 2.

[17] See Zambian Ministry of Finance and National Planning [2005, p.242-245].
[18] The qualitative results of the analysis remain robust for increases between 15% and 70%.

Stage 1 - **Direct spending effects**		
Index	**Scenario**	**Description**
NAIV	**Proportional increase**	Reference scenario. Government spending pattern from the benchmark SAM is retained. Budgetary support. Public consumption (58%), public investment (24%), transfers (18%).
PUBINV	**Public investment**	Additional aid is entirely invested by the government. Programme/Project aid. Infrastructure, health and sanitation, education.
PUBCONS	**Public consumption**	Additional aid entirely used for government consumption. Aid finances current expenditure on health, education and public administration.
PRIVINV	**Private investment**	Additional aid fully transformed into private investment (e.g. micro-credits).
TRANS	**Transfer scenario**	Additional aid fully transferred to private households and used for consumption and savings.
Stage 2 - **Scenarios with productivity effects**		
Index	**Scenario**	**Description**
NAIV_LOW	**Proportional increase**	Strategy corresponds to scenario NAIV. 1% increase in public investment $\Rightarrow$ 0.12% productivity effect.
NAIV_HIGH	**Proportional increase**	Strategy corresponds to scenario NAIV. 1% increase in public investment $\Rightarrow$ 0.25% productivity effect.
PUBINV_LOW	**Public investment, low productivity**	Strategy corresponds to scenario PUBINV. 1% increase in public investment $\Rightarrow$ 0.12% productivity effect.
PUBINV_HIGH	**Public investment, high productivity**	Strategy corresponds to scenario PUBINV. 1% increase in public investment $\Rightarrow$ 0.25% productivity effect.

Table 2: Spending scenarios

6. Simulation results

This section presents the key simulation results starting with the aggregate and sectoral effects on production, the trade balance effects and closing with the welfare and distributional effects. First the demand driven effects are presented, in the second part of this section, a productivity response to public investment is included. The sensitivity analysis reveals to which extent the assumed share of investment spending in the use of aid as well as the assumed strength of the productivity effects influence the results.

6.1. Stage 1 - Demand driven effects

Due to the exogenous fixed supply of all factors of production, an increase of spending from aid is bound to leave the economy without noteworthy aggregate output effects.[19] The simulations confirm that aid has no significant effect on real GDP as long as it is used for non-investment purposes or, if it is invested, lacks to have any effects on productivity. At a disaggregated level only few sectors strongly benefit from the additional aid flows whereas most sectors' production remains largely unchanged or diminishes. The expansion of the public investment (*construction*) and consumption sectors comes at the expense of the contraction of the two main exporting sectors *mining* and *agricultural exports*. Figure 4 shows the percentage changes in sectoral production. The mining sector which is the most important export sector and contributes about 60% to the Zambian exports, suffers from a severe decrease in production. In most scenarios the exporting sector *agricultural exports* suffers, too. The decline in the production of the mining sector leads to a decline in its exports and an increase in its imports.[20]

The sectoral production and trade effects result from a movement of productive resources from the exporting sectors to the non-tradeable sectors *construction* and *public services*. The mining sector, in particular, suffers from a fall in its used capital and in its employed work force, especially of skilled labour. Mining production is very capital intensive and employs a high share of the Zambian capital stock. The sector loses up to 10% of its capital stock and up to 15% of its skilled labour force. Given the importance of the mining sector for the Zambian economy this result should be taken very seriously. The factor reallocation is shown for skilled labour in figure 5.

If only a small proportion of aid is used in a way that increases factor productivity, like e.g. budgetary support, most sectors are hit by negative effects on their sectoral production, exports and employment. In these cases only those sectors benefit which are

[19] In the robustness checks this assumption has been abolished by introducing unemployed unskilled labour, nevertheless this does not affect the qualitative results shown here as unskilled labour is not a perfect substitute for skilled labour or capital. Unemployment has some consequences for distribution but it has been left out of the basic models for the sake of simplicity.

[20] Sectoral trade effects are not shown here.

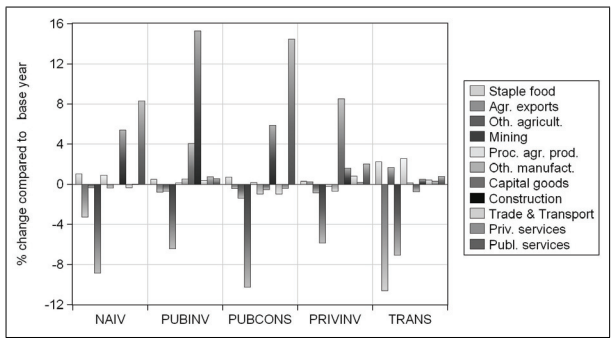

Figure 4: Effect of aid on sectoral production

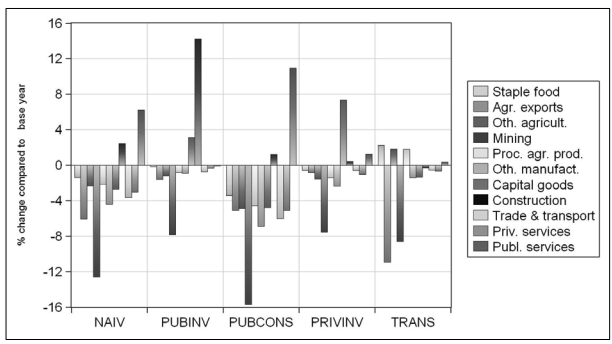

Figure 5: Effect of aid on the sectoral use of skilled labour

directly affected by government spending, namely construction and public services. The additional private income does not translate into noteworthy effects for the other sectors and exporting sectors are clearly worse off. The sectoral simulation results provide a more complete picture of the effects from increased public spending financed by aid compared to the aggregate results. The shift of production and factor use from exporting to domestic sectors clearly documents considerable Dutch Disease effects from international aid.

As regards to the trade balance effects, the increase in international aid allows for an increased current account deficit. The increased deficit could either allow for increased imports, like e.g. Heller [2005] proposes, or for reduced exports. In all scenarios a mixture of both arises but some scenarios are biased in favor of increased imports whereas especially the consumption scenarios (NAIV, PUBCONS and TRANS) lead to decreasing exports. Figure 6 shows that the consumption scenarios in particular lead to decreasing exports whereas in the full investment scenarios (PUBINV and PRIVINV) imports rise

substantially. This is due to the fact that public services are a non-tradeable domestic good whereas investment goods are partly imported.[21]

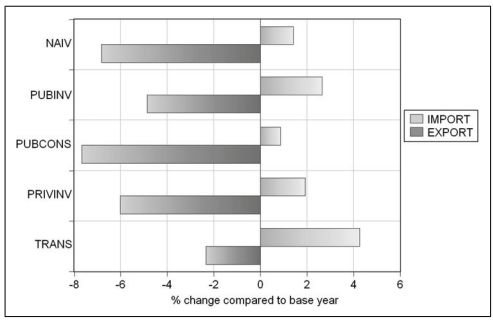

Figure 6: Effect of aid on the trade balance

If aid leads to an increased demand for non-tradeable goods it will raise their relative price as production capacities are limited. This price increase or real appreciation attracts factors of production to the non-tradeable sectors and leads to a reduction in exports. The appreciation is less severe in the private investment scenario but it is of noteworthy size in all scenarios. Results for the real exchange rate are shown in figures 14 and 15 in the appendix. It follows that even if aid is mainly invested some Dutch Disease effects are likely. This might result from the specific structure of exports in Zambia which is highly concentrated and specialised. There exist only two important export sectors which produce about 90% of the Zambian exports. These sectors sell their whole production only on world markets without an alternative to sell in domestic markets.

Concerning welfare, an increase in international aid raises the Hicksian equivalent even if it is not or unproductively invested. The strength of the welfare effect depends on the use of aid. The effect is higher in public investment and transfer scenarios. Figure 7 summarizes the welfare effect in the different scenarios. Note that if aid is completely spent on public consumption or on private investment it has a negative effect on the Hicks equivalent change in income. This is due to the fact that the Hicks equivalent only measures welfare of private households. In contrast the broader welfare measure including public spending (on consumption and investment) rises in almost all scenarios except for spending on private investment.

[21] Torvik [2001] and Adam & O'Connell [2004] argue that Dutch Disease and the downward pressure on the export sector could be aggravated through negative learning by doing effects. A decline in output in the exporting sector causes a fall in productivity in these sectors and a further loss of international competitiveness. These additional, mutually reinforcing effects of Dutch Disease remain outside the scope of the present analysis.

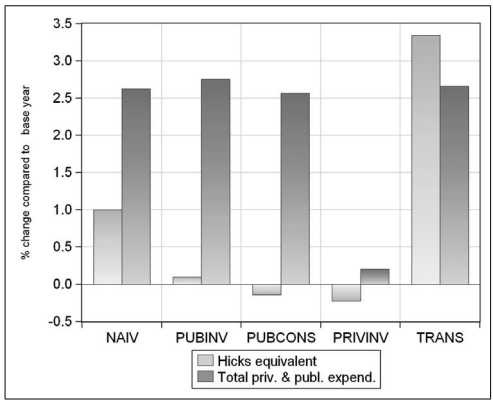

Figure 7: Effect of aid using alternative welfare measures

Even though only 24% of aid is invested in the NAIV scenario, the effect on the Hicksian equivalent is relatively strong. This follows from the fact that 18% of aid are directly transferred to private households and thus directly add to private welfare. The same is true for the TRANS scenario in which all aid directly enters private spending.

Adam & Bevan [2006] point out in their simulations of disaggregated welfare effects that additional aid always leaves the rural households relatively worse off. Figure 8 shows the changes in the Hicksian equivalent for different household types across scenarios. The distributional effects clearly depend on the assumed spending pattern. In the consumption-focused scenarios (NAIV, PUBCONS and TRANS) income effects favour the rural households (57.6% of the population) and run against self-employed households (21.5% of the population) and employers (1% of the population). In contrast, in the investment-focused scenarios (PUBINV and PRIVINV) the distribution is more balanced. Nonetheless, across all scenarios self-employed benefit only underproportionally from aid-induced welfare gains or are even worse off in real terms. The same is true for employers but this is only a small group.

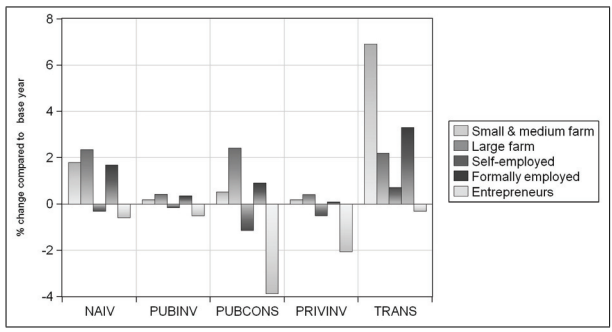

Figure 8: Effects of aid on household incomes

6.2. Stage 2 - productivity effects

It has recently been argued by Adam & Bevan [2006] and Agenor *et al.* [2008] that aid-induced Dutch Disease effects like the ones shown above may be compensated by large positive effects on the supply side as the overall productivity rises. It is assumed that aid is used for the provision of public infrastructure which increases the labour productivity as well as the access to markets. We therefore introduced a productivity response to public investment. This is relevant in the budgetary support scenario (NAIV) and in the public investment scenario (PUBINV). We present the respective reference cases without productivity effects from the previous section and add two productivity simulations for each of the two scenarios. If some or all aid is invested and if public investment is assumed to have a stimulating effect on total factor productivity, it has positive effects on GDP. This holds even if only a small part of the aid is invested, like in the scenarios NAIV_LOW and NAIV_HIGH in which only 24% of the additional aid are invested. Unsurprisingly, the effect on real GDP is strongest in the case in which all additional aid is invested and where total factor productivity is expected to have a high elasticity of 0.25 with respect to public investment (scenario PUBINV_HIGH).

The enhanced productivity alleviates the restriction on factor supply and hence dampens the rise in the prices of increasingly demanded goods. The real exchange rate response to aid should therefore be weakened in these scenarios. Even though the real appreciation is less severe if aid is assumed to enhance productivity, the effect is not overturned. This stands in contrast with Adam & Bevan [2006] where much stronger productivity effects where assumed and where a real depreciation occurs in some cases.

The aggregate results show that the Dutch Disease effects are not fully neutralised. This is also confirmed at the disaggregate level. A general production effect across all sectors is

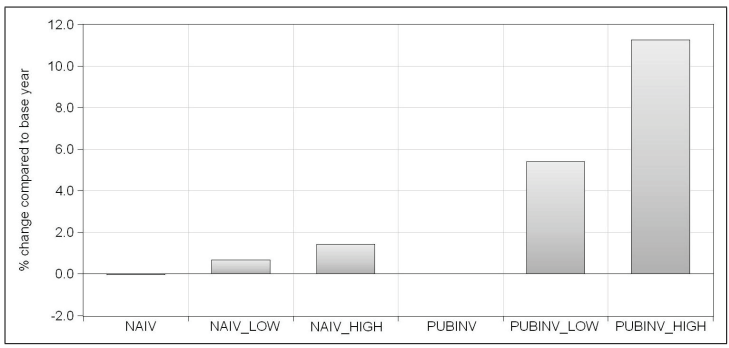

Figure 9: Effect of aid on real gdp with productivity effects

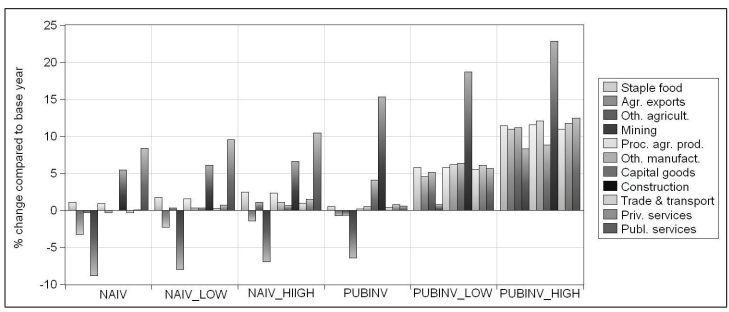

Figure 10: Effect of productive aid on sectoral production

only found as long as all aid is invested and generates large productivity effects. However, even in the scenarios with productivity effects, the exporting sectors benefit only underproportionately from aid. Figure 10 shows the effects on sectoral production.

The productivity gain from public investment allows for a general increase in production. As a consequence exports may rise in line with imports. This is illustrated in two cases in figure 11. It is shown that positive effects on exports require a high proportion of aid spent on investment accompanied by sufficiently high productivity effects.

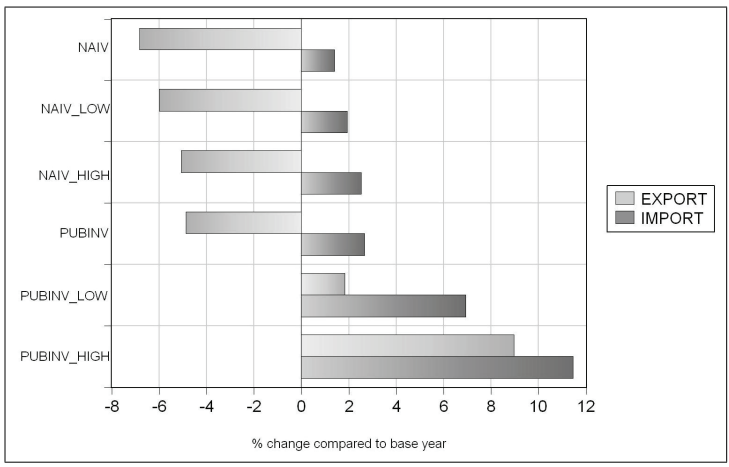

Figure 11: Effect of productive aid on the trade balance

Figure 12 shows the effects on welfare and income distribution. The relative position of rich households (i.e. large farms and employers) and self-employed improves with the strength of the assumed productivity effects and the share of public investment. It can be concluded that the government may have to compensate poor rural households if it invests most of the aid productively.[22]

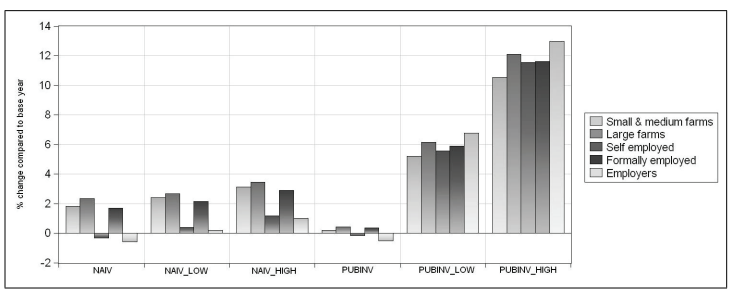

Figure 12: Effect of productive aid on real household incomes

[22]The distributional results from the public investment scenarios are consistent with those in Adam & Bevan [2006].

7. Conclusions

This paper evaluates by means of a multi-sector-multi-household CGE model for Zambia the aggregate and sectoral effects of international aid, its trade balance effects as well as the implications for income distribution. At the aggregate level, the effect of international aid on aggregate production is generally fairly small, unless a high proportion of aid is invested and leads to gains in total factor productivity. If aid is spent for other purposes, it clearly induces considerable Dutch Disease effects. While the spending of aid leads to an expansion of some sectors in the economy, in particular the production of non-tradeable goods, it generally hurts the exporting sectors via a substantial real appreciation. A more detailed analysis of sectoral reallocation shows that the most important export sector *mining* suffers strongly from the real appreciation and the migration of its production factors to other sectors. Even if the total effective supply of factors increases due to public investment and gains in total factor productivity, the mining sector benefits only underproportionately and experiences a relative decline. As this sector is quantitatively very significant for the Zambian economy this effect should be taken very seriously. These simulation results for production and trade generally lend support to the view of Heller [2005] who asks for aid in order to eliminate bottlenecks on the supply side by investment and increased imports of capital goods. A high proportion of aid should be invested especially with the aim to enhance productivity. Moreover, the investment projects ought be targeted in favour of the exporting industries in order to reduce Dutch Disease effects. However, in recent years the Zambian public capital formation has stagnated or even decreased relative to GDP even though aid and GDP have increased.

Given the growing importance of plain budgetary support in the Zambian aid receipts, the scenarios with a mixed spending pattern have to be regarded as most realistic. If aid leads to a proportional increase in all public spending categories, direct positive effects from increased demand are largely compensated at the aggregate level by negative effects in the two main export sectors. Note, however, that there is a direct effect on private welfare due to increased direct transfers to households. Looking at the pure public consumption strategy the simulation results illustrate that it has neither positive effects on production nor on household welfare.

The distributional results vary significantly across simulation scenarios depending on the type of spending and the assumed strength of productivity effects. While an increase in public transfers favours predominantly the poor rural households, we find that the benefits of public investment spread more evenly across the household types. In the scenarios with public investment and productivity effects households which earn income from entrepreneurial activities (self-employed and employers) are better off. In comparison with Adam & Bevan [2006] who find that rural households are always worse off, our setup

shows that the income effect of rural households depends on the assumptions concerning the spending pattern and the size of productivity effects.

In summary, our CGE framework allows for a comprehensive assessment of aid effectiveness on the basis of three indicators: Aggregate and sectoral production, trade balance and welfare and income distribution. The simulations reveal a fundamental policy trade-off. A pro-growth-pro-trade-strategy calls for an investment-focused spending pattern which, however, does not immediately improve the economic situation of the poorest income groups. In contrast a public-transfer-scenario immediately changes the situation of the poorest households for the better without any lasting growth effects. Put differently, policy makers in developing countries as well as international donors have to decide between short-term and long-term objectives.

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A. Appendix

A.1. Descriptive statistics of the Database

Sector	Share in total output	Share in priv. consumption	Share in total dom. demand
Staple Food	7.74%	17.57%	3.53%
Agr. Exports	1.53%	0.00%	0.84%
Oth. Agriculture	7.34%	16.24%	4.90%
Mining	7.71%	0.00%	1.10%
Processed Agr.	14.54%	33.56%	15.97%
Oth. Manufact.	10.46%	13.00%	14.26%
Capital Goods	5.56%	0.00%	11.76%
Construction	4.53%	0.70%	4.47%
Trade and Transport	22.83%	7.63%	24.20%
Priv. Services	10.05%	4.76%	11.38%
Publ. Services	7.71%	6.53%	7.59%

Table 3: The Structure of production and demand in Zambia 2001

Sector	Share in total exports(%)	Share in total imports(%)	Exports/Output (%)	Imports/Demand (%)
Staple food	0.08	0.11	0.12	0.63
Agr. exports	8.34	1.50	64.03	16.70
Oth. Agriculture	3.74	3.94	5.97	14.86
Mining	59.01	1.36	89.69	3.45
Processed agr.	2.06	12.28	1.66	15.24
Oth. manufacturing	20.09	29.68	22.51	36.00
Capital goods	0.68	31.66	1.44	53.79
Construction	0.00	0.00	0.00	0.00
Trade and transport	0.00	8.67	0.00	7.20
Private services	5.99	10.81	6.98	18.02
Public services	0.00	0.00	0.00	0.00
All sectors	100.00	100.00	17.49	15.08

Table 4: The Structure of trade in Zambia 2001

	activities	commodities	factors	households	enterprises	government	taxes	rest of the world	investment	totals
a		29567.19		2499.52						32066.71
c	20014.62			8241.05		1703.68		3759.55	2627.05	36345.95
f	11844.24									11844.24
h			5977.87	169.49	5365.07	452.81		6.84		11972.09
e			5866.37			105.77				5972.14
g					82.64		2244.75	754		3081.389399
t	207.85	876.88		947.04	212.98					2244.75
row		5901.8				124				6025.882
s				114.98	311.45	695.13		1505.49		2627.05
tot	32066.71	36345.95	11844.24	11972.09	5972.14	3081.39	2244.75	6025.88	2627.05	

Table 5: The Macro SAM for Zambia 2001 (in billion Zambian Kwacha)

	Staple food	Agr. exports	Other agriculture	Mining	Processed agricult.	Other manufact.	Capital	Constr.	Trade/ transport	Priv. serv.	Publ. serv.
Staple food	0.09				0.08	0.01					
Agr. exports		0.05			0.06						
Oth. Agricult.			0.02	0.01	0.14						
Mining				0.01		0.07		0.06			
Processed agr.	0.12		0.01	0.02	0.13	0.04		0.06	0.04	0.05	0.09
Oth. manufact.	0.05	0.12	0.09	0.13	0.04	0.20	0.02	0.34	0.12	0.04	0.08
Capital goods	0.01		0.05	0.15	0.01	0.05	0.12	0.19	0.04	0.02	0.06
Construction				0.01		0.01		0.07	0.02	0.01	0.23
Trade/transp.	0.25	0.37	0.30	0.23	0.34	0.38	0.73	0.03	0.07	0.09	0.03
Priv. serv.		0.01	0.02	0.02	0.02	0.02		0.13	0.24	0.26	0.06
Publ. serv.											0.02
Unskl. labour	0.35	0.26	0.42	0.01	0.07	0.02	0.05	0.03	0.14	0.14	0.14
Skilled labour	0.01	0.01	0.03		0.02		0.02	0.02	0.03	0.08	0.14
Capital	0.07	0.13	0.07	0.41	0.09	0.22	0.06	0.06	0.29	0.32	0.15
Land	0.03	0.05	0.01								

Table 6: Input coefficients

	Staple food	Agr. exports	Other agriculture	Mining	Processed agricult.	Other manufact.	Capital	Constr.	Trade/ transport	Priv. serv.	Publ. serv.
Unskl. labour	0.69	0.54	0.73	0.08	0.37	0.13	0.34	0.29	0.29	0.27	0.31
Skilled labour	0.04	0.03	0.06	0.02	0.09	0.04	0.12	0.12	0.08	0.14	0.29
Capital	0.21	0.34	0.19	0.90	0.54	0.84	0.53	0.59	0.63	0.60	0.40
Land	0.06	0.09	0.02								

Table 7: Factor intensity

Sector	STFOOD	TREXP	OTHAG	MIN	PROCAG	OTHMAN	CAPG	TRADE	SERV
$\rho_{ces}(i)$ (CES)	1.5	1.5	1.5	1.3	1.5	0.4	0.4	0.2	0.9

Table 8: The choice of elasticities for the trade structure in the Zambia model

A.2. results

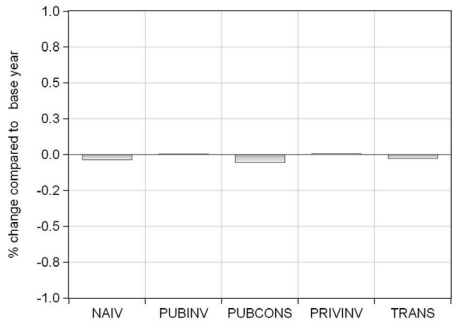

Figure 13: Effect of non-productive aid on real gdp

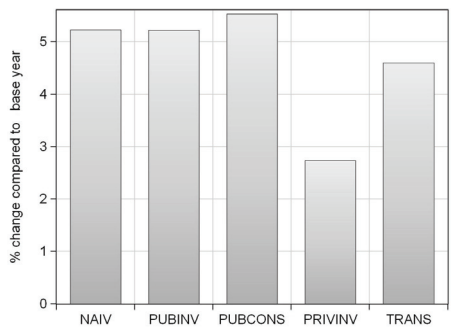

Figure 14: Effect of aid on the export weighted real exchange rate

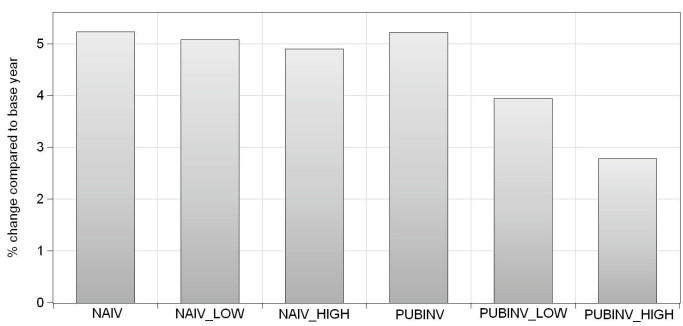

Figure 15: Effect of productive aid on the export weighted real exchange rate