Modeling the effects of aid-financed education programmes on sectoral production and income distribution - A CGE application to Tanzania

Preliminary exposé

Hannah Schürenberg-Frosch*

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1 Motivation

Universal primary education ranges prominently among the Millennium Development Goals and is thus regarded as an important component of human development. In addition, education is widely believed to allow a country to access a higher steady state growth path by accumulating human capital. Consequently, education is one of the key pillars in the development strategies of all African countries and is also one of the main areas in which development aid is given on a large scale. Spending aid on education is also seen as a way to prevent *Dutch Disease* by reducing bottlenecks in the economy [See Heller, 2005].

Empirical cross-country evidence such as Barro [1999] and Barro & Sala-i-Martin [2003] confirms that human capital measured by *years of schooling* has a positive influence on growth due to increased productivity of workers. Even though this finding is considered as "weak" by authors such as Schultz [1999]; Pritchett [2001] and Topel [1997], consensus prevails that very low education hinders economic development. Schooling does not only have direct positive effects on human development like lower child mortality and better health status. It also provides the population with the skills required for democratic participation and a strong civil society. Pritchett [2001] suggests that the seemingly low productivity payoff in terms of wage increases for higher skilled workers might partly be explained by low demand for these skills and thus emphasizes the importance of considering the demand side of the labor market as well. Schultz [1999] emphasizes the differences between primary and higher education in terms of social costs and distributional impact

*University of Duisburg-Essen, Universitätsstr. 12, D-45117 Essen, Tel.: +49 201 183 3010, hannah.schuerenberg-frosch@uni-due.de

and concludes that Africa might have put too much weight on higher education. This is also in line with findings that primary education in general produces the highest social rate of return [See also Dreher *et al.*, 2008]. An additional argument is that female primary education has a positive influence on child nutrition and children's health status and thus indirect positive effects on labor productivity. In addition, distributional aspects should be considered as well given the fact that reducing poverty is another main objective of aid policy. Gupta *et al.* [1999] and Gupta & Verhoeven [2001] add that the efficiency of public investment and public spending is important for the success of large scale investment in education.

2 Research design

Against the background of the summarized empirical literature the efficiency of public investment planning, the structure of the labor force and the structure of production and thus demand for labor need to be integrated in the analysis. In addition a distinction of primary, secondary and higher education is required. The distributional as well as structural consequences in reaction to investment in education should be regarded as well. Jung & Thorbecke [2003], Agenor *et al.* [2008] and Cloutier *et al.* [2008] suggest that a Computable General Equilibrium (CGE) model could provide additional insights in these respects. While Cloutier *et al.* [2008] investigate the effects of a cut in education expenditure in Vietnam, Jung & Thorbecke [2003] and Agenor *et al.* [2008] investigate the effect of an increase in public capital in education. While Agenor *et al.* [2008] assume that only educated labor is used in production, Jung & Thorbecke [2003] in their model for Tanzania and Zambia directly model the choice between different skill levels. They construct a recursive dynamic model where the endogenous skill choice of the labor force does not only depend on the wage differential but also on the level of public capital in education. They find that increasing public capital in education by 15% has moderate growth effects between 0.1 and 0.2% per year. Concerning wage effects, however, they find that the production structure of the economy, the initial labor force structure as well as unemployment in the benchmark and targeting of the new investments have strong impacts on the results. Comparing two countries the wage effect lies between +4.7% and -4.8% depending on the skill level, the initial labor force structure and the assumptions of the model. Given the fact that their model is highly aggregated as they are comparing two countries, the effects on sectoral production are not analyzed detailedly.

This paper is based on the general idea by Jung & Thorbecke [2003] but adds a number of important major and minor aspects to the model. We use a model which is loosely based

on the IFPRI recursive dynamic model as described in Thurlow [2004][1] but implemented in GAMS/MPSGE and formulated as a mixed complementarity problem (MCP). We add the following features:

- Major changes:
  - Jung & Thorbecke [2003] do not explicitly account for the financing of new schooling facilities, the increase in public capital in education is exogenous in their model. We directly model the increase in public capital as financed by aid i.e. an external transfer to the government. Moreover an improvement in education does not only require an increase in the availability of schools but also induces increases in public recurrent expenditure as it increases the demand for teachers. We therefore introduce the requirement for teachers in the production function for human capital.
  - The endogenous skill choice in Jung & Thorbecke [2003] is made from one period to the next. This neglects the fact that the lag between the increase in education facilities and the increase in educated labor supply takes several years. We therefore include a longer lag here.
  - In African developing countries the skill choice is not only dependent on the difference between the unskilled labor wage and the skilled labor wage but also involves forgone family income from child labor. We have chosen a dataset which incorporates child labor. Thus we are able to include the endogenous choice between sending the child to school and making it work in the subsistence agriculture of the household.
  - The datasets used in Jung & Thorbecke [2003] have been aggregated to a very high level of aggregation (3 sectors, 4 households) in order to be able to compare the two countries in the application. As the provision of additional education has large-scale impacts on the sectoral production structure as well as on distribution, we keep the disaggregated structure of our dataset, which means that our model includes 39 sectors and 13 production factors as well as 12 household types (disaggregated by region, education of household head and income). The production factors are mainly different labor types highly disaggregated with respect to their skills (child labor, unskilled adults, not finished primary school, not finished secondary school, secondary and higher education each for female and male), two types of capital, subsistence composite and land. The data is for Tanzania in 2000.
  - Jung & Thorbecke [2003] chose the elasticity of the skill choice with respect to public capital in education to be 0.5 for all types of education based on the estimated social rates of returns to education for Sub-Sahara Africa by

[1] See Arndt *et al.* [2010] and Thurlow & Wobst [2006] for applications based on this model.

Psacharopulos (1994). However these social rates of return have been challenged by some authors like e.g. Bennell [1996], who argues after an investigation of a number of country studies that there are large differences between the African countries and that the social rates of return to education are overestimating the beneficial effect of education due to labor market structures. We therefore adopt a different approach for linking the capital input to the output of the production function for human capital. We investigate three large-scale aid-financed programs in the education sector that have been realized in Tanzania in the last decade and translate their educational targets into model units. This also allows us to make an assumption about the aforementioned public recurrent spending requirements involved.

- Minor points:
  - Jung & Thorbecke [2003] assume capital to be completely sector-specific while labor is perfectly mobile across sectors. This is a valid assumption for highly aggregated models but has to be relaxed in our disaggregated setup. We model capital as mobile across very comparable sectors. Given the high degree of disaggregation in our labor classes we limit the mobility of agricultural workers only to agricultural and food processing sectors.
  - Some minor changes are made concerning the government sector, household consumption and production as well as elasticities and functional specifications. These are mainly required by the structure of the data. We additionally adopt a different model closure, in accordance with Thurlow [2004], holding world market prices and the external balance fixed and allowing investment to adjust to changes in savings.

In the model briefly described above we simulate a number of different scenarios. In the scenarios we either simulate a uniform investment in all different levels of education or a focused investment in only one level. We compare the effects on labor supply and the production structure. We also alter the regional focus of the investment with some scenarios being rural-targeted whereas others being uniformly distributed on urban and rural areas (the same is done in Jung & Thorbecke [2003]). Both, the level of education as well as the regional focus might have strong implications for distribution as e.g. Dreher *et al.* [2008] point out. Given the fact that aid flows are known to be very volatile especially aid flows for specific sectors, we compare a stable investment setup with moderate increases per year with a large increase in aid in only one year.

3 Expected results

Increased availability of schools will in the short term lead to reduced relative supply of child and subsistence labor while the supply of unskilled, low skilled and skilled adults

remains constant. Thus the increasing demand for high skilled labor for teaching will result in a movement of skilled workers from other sectors to the public sector and to rising wages of high skilled workers. Thus the immediate income effects should be in favor of non-poor high-skilled households. Production in high skilled labor intensive sectors will shrink to the benefit of the public sector.

Only in the medium to long term the supply of low skilled and high skilled workers will increase relative to the supply of unskilled workers and thus the bottleneck in educated labor will be removed. We expect these lagged effects to be in favor of rural and poor households who are thus enabled to earn income from non-agricultural activities.

If the investment is concentrated in the primary school sector the supply of low skilled labor grows relative to unskilled and skilled workers, which favors low skilled intensive activities like food processing and basic manufacturing.

Given the lag in the provision of skilled labor, a stable and rather small aid inflow will reduce the first round anti-poor distributional outcome whereas a large investment in the first year would lead to considerable movements of high skilled labor from productive activities to the public sector.

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