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Fiscal Space and Public Spending on Children in Burkina Faso

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Abstract:
Despite high growth rates in recent decades, Burkina Faso is still a poor country. The government acknowledges the need for a stronger commitment to reach the Millennium Development Goals (MDGs), particularly regarding the reduction of poverty. At the same time, the Burkinabe budget deficit has grown in recent years in response to various crises which have hit the country. There are strong pressures to rapidly reduce this budget deficit, but there are active concerns about how this will be achieved. The country thus faces difficult choices: how to ensure better living conditions for children, attain the millennium goals and ensure they have a better future in the present budgetary context?
To answer this question, three policy interventions were identified: (i) an increase in education spending, (ii) a school fees subsidy and (iii) a cash transfer to households with children under the age of five. The same total amount is injected into the economy in each of the three cases, facilitating comparison between the three scenarios. The discussions also made it possible to identify the three financing mechanisms that appear most realistic: (i) a reduction in subsidies, (ii) an increase in the indirect tax collection rate and (iii) an extension of the timeframe to reduce the public deficit to ten years rather than five.
The results indicate that increased public education spending helps raise school participation and pass rates, thus increasing the supply and education level of skilled workers, leading to a reduced incidence and depth of both monetary and caloric poverty. School fees subsidies have more differentiated effects on education: they promote children's entry into school to a greater degree, but are less effective at inducing them to pursue their studies. Finally, the supply of skilled workers increases slightly, but their average level of education is lower than in the reference scenario. This type of intervention has a beneficial impact on poverty, greater than under increased public education spending.
Cash transfers have a limited impact on educational behaviour, and thus on the supply of skilled workers, but substantially reduce the incidence and depth of poverty.
The results are qualitatively similar under each financing approach. In sum, if the objective is to achieve improved education and economic performance, the best intervention appears to be to focus on increased public education spending. However, if reducing child poverty is prioritized, it is cash transfers to families that appear more suitable. Regardless of the intervention considered, the most suitable financing mechanism appears to be a temporary increase in the public deficit, because it is accompanied by a smaller negative effect on the quality of life of the most destitute.

Keywords: Child Poverty, Dynamic General Equilibrium, Micro-Simulation, Burkina Faso

JEL Classification: I32, D58, C50, O55

1. Introduction

Burkina Faso has experienced consistently high economic growth over the last two decades. Between 2000 and 2008, the annual average growth rate was in the range of 5%. Since 2000, this growth has become more regular and has fluctuated less, thanks to macroeconomic stability and improved management of public finances, but has been strongly tempered by annual population growth of 3.1% over 1996-2006 (MEF (2010)). Per capita GDP grew by an annual average of around 2.4% over 2000-2008. Despite relatively solid economic performance, Burkina Faso remains a poor country, and is very far behind in terms of infrastructure and human development. Rural areas, where the majority of the poor and vulnerable reside (52.3% of the rural population is poor, as opposed to 20% in urban areas, INSD 2003), continue to lag urban areas in terms of development due to structural weaknesses following external shocks and unequal access to public and private services.

The government recognizes the need for a stronger commitment to achieve the Millennium Development Goals (MDGs), particularly to reduce poverty by 2015. Since the beginning of the 2000s, Burkina Faso has made commendable efforts to promote development and to reduce poverty by developing a strategic framework for the fight against poverty (CSLP). However, the results of implementing the CLSP over 2000-2003 indicate that the related activities were undermined by the weakness of sectoral policies and insufficient budget allocations.[2]

To remedy these situations, the CSLP was revised in 2003 and includes four strategic axes with specific objectives and action areas that have been developed into Priority Action Plans (PAPs). Compared to the 2000 CSLP, the revised CSLP introduced innovations, such as including the "social protection of the poor" as an action area, addressing the MDGs and expanding priority sectors. These priority sectors most notably concern education, health, drinking water, rural development (including food security), the fight against HIV/AIDS and social protection.

The second generation CSLP thus allowed the Burkinabe government to provide itself with a new point of reference for development: the Strategy for Accelerated Growth and Sustainable Development (SCADD), for 2011-2015. The principal axes of the SCADD are: (i) improvement of macroeconomic stability; (ii) acceleration of economic changes in rural areas through promotion of land reform, production of cotton, microfinance and the creation of informal employment; (iii) development of human capital by expanding the coverage of the first level of education, access to health services and the fight against demographic growth; and (iv) improved governance by supporting more efficient and transparent use of public resources.

Moreover, the national workshop on social protection in 2010 proposed the development of a national social protection policy; this policy was finalized in January 2012 and incorporated into the new SCADD. The goal is to fill in the gaps of isolated and small-scale social programs, which are not subjected to any monitoring.

Thus, in order to lay the foundations of growth and sustainable development as per the SCADD, the government would need to invest more in social sectors which significantly accelerate economic development. Child poverty is a huge social and economic loss because it has long term (and often irreversible) effects on individuals and their future children. In other words, poverty can be transmitted from one generation to the next. The intergenerational effects are not limited to the child itself: they also significantly reduce economic growth. For example, child malnutrition brings major costs in terms of the acquisition of basic knowledge and production as

[2] Ministry of Economy and Finance (MEF), 2010.

an adult; this has an important impact on national economic growth. Public social spending has an undeniable impact on child wellbeing, in the long run contributing to the economic growth of a nation. However, governments do not always have suitable tools to allow them to set priorities among sectors and to make important choices concerning allocations of their limited budget between a large number of programs. To do this, they must evaluate how each area of spending differently influences the wellbeing of the population and economic growth in the long run. Moreover, in order to develop a credible plan for current spending and investment, the financing strategy of these programs is an integral part of an in-depth analysis.

The Burkinabe budget deficit has grown in recent years in response to a number of crises which hit the country in 2009 and 2010. Pressures to rapidly reduce budget deficits are strong, but there are active concerns about how this will be achieved. In effect, eliminating (or reducing) public spending that is largely focused on children may have consequences on their current level of wellbeing, on attainment of the MDGs, and thus on the economy of Burkina Faso in the longer term. The country thus finds itself faced with difficult choices: how will it ensure improved living conditions for children, attain the millennium goals and ensure a better future in such a budgetary context?

It is in this context that governments are called upon to establish priorities among the different requests for funding, all the while under their own financial and fiscal constraints. Establishing these priorities will require them to evaluate how each area of spending differently affects long term development.

Moreover, the sustainability and impacts of public spending on different programs certainly depend on the financing mechanism(s) put into place. Governments should therefore be able to simulate the impacts of the alternatives available to them.

The goal of this study is to evaluate the impacts of public policies on the rates of poverty, school participation and economic growth in Burkina Faso. Particular attention is paid to policies benefitting children. Given the budget constraints mentioned above, the policy reforms analyzed in this study are paired with each of a number of different financing mechanisms. Both the proposed public policies and the financing scenarios were developed following discussion with the local committee.

This paper presents the results of three different scenarios which increase public spending on children, in each case financed by one of three financing mechanisms. The first scenario is an increase in government education current spending. The second scenario is an education price subsidy. The third scenario deals with a cash transfer to households with a child aged 0-5. Each of these scenarios is financed either by a decrease in production subsidies, a higher tax collection rate, or by extending the timeframe to reduce the deficit to GDP ratio. The scenarios are comparable because they involve a similar increase in the budget.

The next section consists of an analysis of the poverty and the types of vulnerability and risks affecting children, in addition to a brief review of the existing social protection framework in Burkina Faso. This is followed by two sections, which respectively present a literature review and the methodology used. The simulation results are then covered before we conclude.

2. Analysis of the situation of children in Burkina Faso

Children account for 53% of the population of Burkina Faso, 81% of which live in rural areas (INSD, 2009). They suffer from or are exposed to relatively precarious living conditions.

2.1. Child monetary poverty

In Burkina Faso, children are more vulnerable than adults and are thus more susceptible to living in poverty. This fact is shown for the first time in Batana et al. (2012), who reveal that children are 20 percent more likely than adults to live in poverty.

In addition to vulnerabilities associated with social conditions, there are also vulnerabilities linked to economic shocks and natural disasters which affect children directly or indirectly via household survival strategies. For example, the 2009 and 2010 floods, which had major impacts on the Centre and Boucle de Mouhon regions, affected child poverty through loss of housing and stoppages in schooling, all the while exposing them to illness (cholera, diarrhoeal disease, malaria) and displacements. Also, food commodity price increases in 2008 led families to reduce their consumption and to look for new adaptation strategies such as the emigration of children or recourse to child labour. The effect of these various factors and external shocks on children must be accounted for in order to implement an effective response.

2.2. Child education

Major progress has been accomplished in child education since 2000, particularly with respect to the supply of and access to universal primary education; the gross enrollment ratio in primary school went from 40% in 2000 to 74.8% in 2009, and the number of registered students doubled to 2 million.[3] However, the recent rapid increases in the number of registered students, following the elimination of school fees for primary education, may actually constitute a significant challenge with respect to education quality. Rapid population growth also puts pressures on the system's capacity. In effect, average per capita public spending has not stopped falling since 2003 and student-teacher ratios have barely budged,[4] while the gap between the total number of school-aged children and the number registered in school has gradually declined.

2.3. Child health

Illness is a factor which may intensify vulnerability by limiting the productive capacities of the patient and by diverting a share of household resources towards health care.

In Burkina Faso, a large share of individuals is excluded from health care, particularly in rural areas. Major improvements have nevertheless been achieved: the child vaccination objectives were largely exceeded and the number of health centres and personnel have both increased rapidly.

Despite significant progress in the coverage of health, with a reduction in the average distance to reach a Health and Social Promotion Centre (CSPS), more than one in six children dies before

[3] If we look at net education rates, we see that one in two children of age to enter the first level of schooling has not yet done so.

[4] World Bank (2009).

the age of five in Burkina Faso – 342 deaths per day – and more than one-third also suffer from delayed height and weight growth. The rates of infant and child mortality were respectively 81‰ and 184‰ in 2003, and in 2010 were 65‰ and 129‰ (INSD et al. 2004, 2011).

Important regional disparities persist in relation to the coverage of health infrastructure. In effect, even though the national average distance went from 9.1 km in 2002 to 7.6 km in 2008, we still observe certain districts with an average distance of more than 18 km in 2007 (Ministry of Health, 2008).

In terms of nutrition, stunting among children declined from 43.1% of children under the age of five in 2003 to 35.1% in 2009, with more noteworthy progress in rural areas. Moreover, important progress was accomplished to reduce wasting among children, with the share falling by nearly half, although the level still remains above the "severe" standard according to the WHO norm. Important progress has also been accomplished in terms of reducing chronic child malnutrition. A strategic plan covering 2010-2015 was adopted in order to reduce hunger and illness linked to nutritional deficiency diseases.

2.4. Social protection in Burkina Faso

Up to the end of 2011, Burkina Faso did not have a national social protection policy – this policy is now finalized. Aside from reduced costs for the use social services, there is no institutionalized program of social transfers in Burkina Faso, i.e., there are no direct transfers from the state to households to support their consumption. There are, however, small-scale transfer programs such as the cash transfers in the Nahouri province that targeted 8 000 children in its pilot phase over 2008-2010. The provisional results of this program show that cash transfers have a significant positive effect on child health and education indicators.

A suitable social protection framework is needed to deal with all sorts of vulnerabilities faced by children and their households. However, the midterm review of the CSLP in October 2008 concluded that the strategy did not include a social protection policy for the poorest. As a result, a key decision was made in 2010, following the national workshop on social protection, to develop a national social protection policy and to incorporate it into the new SCADD. Moreover, following the study by Balma et al. (2010) on the effects of the economic crisis and their simulations in terms of social policy, a social protection component was introduced to the national action plan in order to face this crisis. This helps improve the development of policy in Burkina Faso for better coordination between economic and social policies.

2.4.1. Social protection and education

In terms of social protection in the education sector, the law on free for primary education is very important to ensure that the poorest can access to education system. However, its implementation remains unequal. As a result, many children do not go to school. A comparative analysis of the impact of eliminating school fees should be carried out. The supply of free kits and textbooks to all students is an important policy to improve access to and the quality of education. The current school canteen program has debatable impacts, given that their effective coverage and the costs incurred by the communities vary considerably and/or are completely unknown. Overall, a recent study on the effectiveness of free education in Burkina Faso showed that one on five parents still pays school fees, three in five parents pays for school canteens, and nearly one in five students did not receive free school textbooks for the 2010-2011 school year.[5]

[5] CN-EPT BF, 2011.

2.4.2. Social protection, health and nutrition

The main areas of progress for health and social protection concern exemptions for certain services and subsidies for emergency obstetric and neonatal care (SONU). In principal, these programs are national in coverage and cost the state more than 535 million CFA per year. In practice, their actual implementation is not ensured and many among the population are not informed of these benefits they have rights to (Ridde and Bicaba, 2009).

Many programs exist to promote food security on the supply side, including sale at "social prices" and free distribution of foodstuffs. A new program to distribute food vouchers in the cities of Ouagadougou and Bobo-Dioulasso is also in place, financed by the World Food Program WFP). This program focuses on household demand by increasing their purchasing power. However, the preliminary results show that, even though 30 000 households have benefitted from this program over the last year, the anticipated effects remain mixed: an examination of the outcomes by the IMF shows that the 2008 subsidies for food products largely benefitted the richest in the population, an analysis that has been updated for the for the rice price subsidy in 2010.[6]

3. Literature review

The adoption of the Poverty Reduction Strategy Papers and the Millennium Development Goals (MDGs) implies a need for more detailed study of the impacts of public policies and social reforms. Numerous studies evaluate the consequences of fiscal reforms and public spending on vulnerable populations (poor households, orphans and other vulnerable children, etc.). This section presents an overview of the literature pursuing this objective and different approaches used, allowing us to effectively situate the scientific contribution of the present study.

Child wellbeing is affected by fiscal and budgetary policies, notably by providing them with public services such as health and education, and by improving the household economy (Waddington, 2004). The pioneering studies in the analysis of the impacts of fiscal reforms on wellbeing use benefit incidence analysis and marginal benefit incidence analysis for the benefits associated with product tax reforms, as done by Ahmad and Stern (1984). This last approach has seen numerous applications, including contributions from Yitzhaki and Thirsk (1990), Yitzhaki and Slemrod (1991), Mayshar and Yitzhaki (1996), Ray (1997) and Makdissi and Wodon (2002).

Bibi and Duclos (2004) extend the preceding approach in order to identify the direction of fiscal reforms when the objective is to reduce poverty. Their approach, illustrated with Tunisian data, consists of deriving the cost-benefit ratio of an increase in a consumption tax by minimizing a poverty indicator.

Recent fiscal reforms in Africa following trade liberalization have rekindled interest for analysis of the impacts of fiscal reform on social welfare (Sahn and Younger, 2003; Chen, Matovu and Reinnika, 2001; Rajemison and Younger, 2000; Alderman and del Ninno, 1999). Moreover, these analyses prove to be particularly interesting because they can be used for analysis of fiscal changes induced by new policy regimes, as well as their impacts on the most vulnerable populations. Benefit incidence analysis has the advantage of requiring little data, making it relatively easy to carry out (Ray, 1997, p.367). This is particularly suitable for developing countries where little data is available.

[6] IMF Staff Report. July 2010.

However, this approach is limited to measuring the direct effect of the fiscal reform: it determines whether the reform is progressive or regressive. It thus ignores the effect that the reform may have on individuals or their potential response.

Some authors (Glewwe, 1991; Gertler and Van Der Gaag, 1990,), aiming to address the shortcomings of this approach, are interested in econometric estimations of the impact of fiscal policies on wellbeing by controlling for other variables which may influence the estimations.

The two preceding approaches (marginal incidence and econometric analysis) are partial equilibrium analyses, and thus do not capture the feedback effects induced by other sectors or actors in the economy (a policy to increase public education spending could have indirect effects on the agricultural sector, for example). These effects need to be considered because public policies have indirect effects on the economy as a whole.

Computable general equilibrium (CGE) models are the most comprehensive tool to study the impacts of public policies on different agents in the economy. Many studies use this tool to analyze the impact of public policies (trade liberalization, fiscal reforms, increased public spending) in developing countries. In order to capture intrahousehold differences, these studies combine a macro component with a microeconomic model (Decaluwé et al., 1999; Cogneau and Robillard, 2001 and 2004; Cockburn, 2006; Bourguignon et al., 2003; Boccanfuso et al., 2003).

To our knowledge, application of these tools to Burkina Faso is sparse. Gottschalk et al. (2009) use the MAMS model to create fiscal space and to analyze the impact of creating this fiscal space on the MDGs. They identify three mechanisms to create fiscal space: establish priorities in public spending, increase foreign borrowing, or increase government revenues, the last of which only amount to 13.5% of GDP. The fiscal space can then be used to increase spending on health, education and infrastructure. The authors show that it is difficult to discern between the three specified mechanisms, and that trade-offs are thus necessary at the national level. Furthermore, investment in infrastructure is not only beneficial for growth, but also for attainment of the MDGs. The structural constraints of the country should, however, be kept in mind, notably the fact that learning and the training of personnel takes time.

4. Methodology

For each of the simulations, an integrated macro-micro framework can be used to generate detailed results for a large range of indicators. The results of each of the simulations are compared to a reference, or "non-intervention," scenario on the basis of historical trends and the available data. The following subsection presents the macroeconomic framework used, followed by the microeconomic analysis; we then present the different scenarios analyzed.

4.1. Macroeconomic analysis

The model for Burkina Faso was constructed using the standard PEP 1-t model (Decaluwé et al, 2010). In order to account for country-specific characteristics as well as the Millennium Development Goals (MDGs) we have made the following modifications.

4.1.1. Demand

Household demand is a two-level nested function. The first level represents demand for each food product and the aggregate product that groups together all non-food commodities. Demand in this first level, represented by equations 1 and 2 below, is characterized by an AIDS-type (*Almost Ideal Demand System*, (Deaton and Muellbauer, 1980)) function. In the standard

PEP 1-t model, the demand function is characterized by an LES-type (*Linear Expenditure System*) function. We propose to use an AIDS-type function, which is much richer in that it allows us to better account for cross-price elasticities.[7] Note that the set of price and income elasticities were estimated econometrically using the 2009 Integrated Survey on Burkinabe Household Living Conditions (EICVM) survey.

Demand for the "non-food product" is then distributed among its components following a Cobb-Douglas-type function (equation 3). Equation 4 determines the aggregate price of non-food products. Finally, equation 5 gives us a Stone price index.

1. $$\frac{C_{ia,t} PC_{ia,t}}{CTH_t} = \alpha_{ia}^{C} + \sum_{iaj} \gamma_{ia,iaj}^{C} \ln PC_{iaj,t} + \gamma_{ia,CNALIM}^{C} \ln PCNA_t + \beta_{ia}^{C} \ln\left[\frac{CTH_t}{pop_t \, PIXSTO_t}\right]$$

2. $$\frac{CNA_t PCNA_t}{CTH_t} = \alpha_{CNALIM}^{C} + \sum_{iaj} \gamma_{CNALIM,iaj}^{C} \ln PC_{iaj,t} + \gamma_{CNALIM,CNALIM}^{C} \ln PCNA_t + \beta_{CNALIM}^{C} \ln\left[\frac{CTH_t}{pop_t \, PIXSTO_t}\right]$$

3. $$PC_{ina,t} C_{ina,t} = \gamma_{ina}^{CNA} CNA_t \; PCNA_t$$

4. $$PCNA_t = \frac{1}{A^{CNA}} \prod_{ina} \left[\frac{PC_{ina,t}}{\gamma_{ina}^{CNA}}\right]^{\gamma_{ina}^{CNA}}$$

5. $$\ln PIXSTO_t = \sum_{ia} \left\{\frac{PC_{ia,t} C_{ia,t}}{CTH_t} \ln PC_{ia,t}\right\} + \frac{PCNA_t \, CNA_t}{CTH_t} \ln PCNA_t$$

With:

$C_{i,t}$:	Household consumption of product *i*
CNA_t :	Household consumption of non-food products
CTH_t :	Household consumption budget
$PC_{i,t}$:	Consumption price of product *i* (including taxes and margins)
$PCNA_t$:	Price index of non-food products
$PIXSTO_t$:	Stone price index
A^{CNA} :	Cobb Douglas scale parameter – non-food products
α_i^C :	AIDS function parameter
β_i^C :	AIDS function parameter

[7] With an AIDS function, cross-price elasticities can be positive or negative. See Sadoulay and de Janvry (1995) for a detailed explanation of the use of different demand functions and specifically the properties of an AIDS function compared with an LES function. See as well Savard (2004) for an application of a of a AIDS function in a CGE.

$\gamma_{i,ij}^{C}$: AIDS function parameter

γ_{ina}^{CNA} : Share of non-food products

4.1.2. Debt and interest

The model accounts for domestic and foreign debt and the related interest. Interest paid by the government on domestic debt is simply calculated as the product of the domestic interest rate and the debt stock (equation 6). Following the rules of national accounts, this interest appears as an income for households (equation 7).

6. $INT_t^{DOM} = ir^{DOM} DEBT_t^{DOM}$

7. $YH_t = YHL_t + YHK_t + YHTR_t + INT_t^{DOM}$

With:

$DEBT_t^{DOM}$: Domestic (i.e., domestically held) public debt

INT_t^{DOM} : Interest on domestic public debt

ir^{DOM} : Interest rate on domestic public debt

YH_t : Total household income

YHK_t : Household capital income

YHL_t : Household labour income

$YHTR_t$: Household transfer income

The government also has the option of taking on debt on foreign markets. It pays interest to the rest of the world, calculated in the same manner as for domestic interest. This interest is a source of income for the rest of the world.

8. $INT_t^{ROW} = ir^{ROW} DEBT_t^{ROW}$

9. $YROW_t = e_t \sum_m PWM_{m,t}\ IM_{m,t} + \lambda_{ROW}^{RK} \sum_j R_{j,t}\ KD_{j,t} + \sum_{agd} TR_{ROW,agd,t} + INT_t^{ROW}$

With:

$DEBT_t^{ROW}$: Public foreign (i.e., foreign held) debt

e_t : Nominal exchange rate

$IM_{m,t}$: Quantity imported of product *m*

INT_t^{ROW} : Interest on public foreign debt

ir^{ROW} : Interest rate on public foreign debt

$KD_{j,t}$: Demand for capital by sector *j*

$PWM_{m,t}$: World price of imported product *m* (in currency)

$TR_{ag,agj,t}$: Transfers from agent *agj* to agent *ag*

$YROW_t$: Income of the rest of world

λ_{ag}^{RK} : Share of capital remuneration received by agent *ag*

Government savings is thus calculated as the balance of government revenues and transfers to other agents, current public spending on goods and services, public investment and domestic and international interest paid to various agents.

10. $SG_t = YG_t - \sum_{agng} TR_{agng,GVT,t} - G_t - IT_t^{PUB} - INT_t^{DOM} - INT_t^{ROW}$

With:

G_t : Current public spending on goods and services

IT_t^{PUB} : Public investment

SG_t : Government savings

YG_t : Total government revenues

The change in the level of debt from one period to another is calculated by subtracting the budget balance (equation 11). A positive balance thus reduces total debt, while if the government runs a deficit this adds to total debt. We assume that the domestic public debt-to-GDP ratio is fixed, reflecting the government's limited ability to borrow from domestic agents. Thus, all additional financing needs must be met through an increase in foreign debt.

11. $DEBT_t^{TOT} = DEBT_{t-1}^{TOT} - SG_{t-1}$

$DEBT_t^{TOT}$: Total public debt

4.1.3. The Millennium Development Goals

To model the MDGs, we essentially follow the approach proposed by Lofgren et al (2006). Regarding education, we specify the behaviour of students at a given academic cycle. We model the seven following educational behaviours:

- The primary entry rate, i.e., the share of children of age to enter primary school and who are actually registered (*entree*)
- The promotion rate, i.e., the share of students who successfully finish a given year of a level of education (*reussi*). This rate covers both students who pass a non-terminal year in a cycle (*reussi_ctn*) and those who pass the final year of the academic cycle in question (*reussi_grd*)
- The repetition rate, i.e., the share of students repeating a given year in an academic cycle (*redouble*)
- The dropout rate, i.e., the share of students who drop out of school in a given year (*abandon*)
- The transition rate, i.e., the share of students who, once they have completed an academic cycle, pursue further studies at a higher cycle (*grd_sup*)
- The share of students who, once they have completed an academic cycle, enter the labour market (*grd_fin*)

All of these shares have been calibrated using data published in the annual report on education statistics.[8] They are then determined endogenously within the model.

Following the MAMS maquette, the primary entry rate, the promotion rate and the transition rate are determined by a logistic function. The *edj* indicator represents the two levels of education accounted for in the model. The first cycle of education (or level 1) includes the primary school as well as the first four years of secondary school. The second level of education (level 2) includes the three final years of secondary school as well as post-secondary education.

$$12.\ SHR_{edj,\lg,t} = ext_{edj,\lg} + \frac{\alpha^{ED}_{edj,\lg}}{1+\exp\left\{\gamma^{ED}_{edj,\lg} + \beta^{ED}_{edj,\lg}\left(SHR^{I}_{edj,\lg,t} - SHR^{0}_{edj,\lg}\right)\right\}}$$

With:

$SHR_{edj,\lg,t}$: Share of student in level *edj* with behaviour *lg (entree, reussi, grd_csup)*

$SHR^{0}_{edj,\lg,t}$: Initial share of students in level *edj* with behaviour *lg*

$SHR^{I}_{edj,\lg,t}$: Intermediary share of students in level *edj* with behaviour *lg*

$\alpha^{ED}_{edj,\lg}$: Parameter (logistic function – education)

$\beta^{ED}_{edj,\lg}$: Parameter (logistic function – education)

$\gamma^{ED}_{edj,\lg}$: Parameter (logistic function – education)

$ext_{edj,\lg}$: Maximum value that the indicator can take (logistic function – education)

In the preceding expression, only $SHR^{I}_{edj,\lg,t}$ is endogenous, the other components of the expression being parameters. This intermediary variable makes it possible to account for factors which influence the modelled behaviour through a logistic function.

$$13.\ SHR^{I}_{edj,\lg,t} = SHR^{0}_{edj,\lg}\left\{\begin{array}{l}\left[\frac{EDQ_{edj,t}}{EDQ^{0}_{edj}}\right]^{\sigma^{EDQ}_{\lg}}\left[\frac{KD_{edj,t}}{KD^{0}_{edj}}\right]^{\sigma^{KD}_{\lg}}\left[\frac{KD^{INF}_{t}}{KD^{INFO}}\right]^{\sigma^{KD}_{\lg}}\left[\frac{W_{'LSK',t}\,/\,W_{'LUSK',t}}{W^{0}_{'LSK'}\,/\,W^{0}_{'LUSK'}}\right]^{\sigma^{WP}_{\lg}} \\ \left[\frac{MDGVAL_{'MDG4',t}}{MDGVAL^{0}_{'MDG4'}}\right]^{\sigma^{MDG4}_{\lg}}\left[\frac{PT_{edj,t}\,/\,PIXCON_{t}}{PT^{0}_{edj}\,/\,PIXCON^{0}}\right]^{\sigma^{PT}_{\lg}}\left[\frac{CPC_{t}}{CPC^{0}}\right]^{\sigma^{CH}_{\lg}}\end{array}\right\}$$

With:

CPC_{t} : Real per capita consumption

CPC^{0} : Real per capita consumption in base period

$EDQ_{edj,t}$: Education quality index in level *edj*

[8] For primary schooling: http://www.cns.bf/IMG/pdf/Annuaire_2009_2010_MEBA.pdf
For secondary : http://www.messrs.gov.bf/SiteMessrs/statistiques/ANNUAIRE-2008-2009-SECONDAIRE.pdf

EDQ_{edj}^{0} : Education quality index in level *edj* in base period

$KD_{j,t}$: Capital stock in sector *j*

KD_{j}^{0} : Capital stock in sector *j* in base period

KD_{t}^{INF} : Infrastructure stock

KD^{INFO} : Infrastructure stock in base period

$MDGVAL_{MDG4,t}$: Value of MDG4 indicator

$MDGVAL_{MDG4}^{0}$: Value of MDG4 indicator in base period

$PT_{edj,t}$: Production price in education sector

$PT_{edj,t}^{0}$: Production price in education sector in base period

$PIXCON_{t}$: Consumer price index

$PIXCON^{0}$: Consumer price index in base period

$W_{l,t}$: Wage rate of type *l* workers

W_{l}^{0} : Wage rate of type *l* workers in base period

As the above expression shows, the change in each of these three behaviours depends on the education quality index, the stock of capital in the respective education sectors, the infrastructure capital stock in the economy, the wage differential between skilled and unskilled workers, a health indicator represented by MDG4,[9] the price of education and finally per capita consumption. The value of each of these arguments is determined endogenously within the model. Moreover, elasticities estimated econometrically in the microeconomic model are used to account for the impact of a change in these indicators on participation and pass rates.

Thus, we assume that an improvement in the education quality index will, all else equal, positively impact the different behaviours regarding education. Similarly, it is reasonable to suppose that an increase in the capital stock in the education sectors (such as an increase in the number of schools) would favourably impact these three behaviours. This impact would be larger for a higher elasticity.

The following equation defines the education quality index. It is calculated as the supply of services in the different levels of education divided by the number of students enrolled in the corresponding cycle.

14. $$EDQ_{edj,t} = \frac{XST_{edj,t}}{NST_{edj,t}}$$

With:

$NST_{edj,t}$: Total number of students in level of education *edj*

$XST_{j,t}$: Aggregate production of sector *j*

[9] Child mortality.

The level of infrastructural development also plays an important role, particularly in Africa. Investment in infrastructure, such as building roads, would also have a positive impact because it would reduce the distance or time required to go to school.

The wage differential between skilled and unskilled workers is the fourth factor influencing student behaviour. It is easy to see, for example, that if wages are much higher for skilled workers than for unskilled workers, students will have an incentive to pursue their studies in order to become skilled and to enjoy a higher future wage.

The fifth argument of the function, the child mortality rate, is actually a proxy for child health. A low child mortality rate thus acts as an indicator of good child health, a factor influencing the capacity of children to integrate, succeed and pursue his/her studies.

The sixth argument is a proxy for the financial accessibility of education (school fees). While the Burkinabe government takes responsibility for a major share of children's school fees, a remaining share is the responsibility of the household, and this share may be an obstacle for households of more modest means. Reducing the cost of education would therefore have a beneficial impact on the different behaviours linked to education.

Finally, the last argument of this function is the per capita consumption, which illustrates the assumption that if the overall financial situation of the household improves, the education behaviours also improve. Real per capita consumption is calculated at constant prices, according to the following equation:

15. $$CPC_t = \frac{\sum_i PC_i^0 C_{i,t}}{POP_t^H}$$

With:

$C_{i,t}$: Household consumption of product *i*

PC_i^0 : Consumer price of product *i* (including taxes and margins) in base period

POP_t^H : Population

The following equations determine the other educational behaviours. Some of them are determined as residuals. The share of students having completed a level of education and deciding to leave school to enter the labour market is thus determined as:

16. $$SHR_{edj,GRD\_FIN,t} = 1 - SHR_{edj,GRD\_CSUP,t}$$

Similarly, the share of students completing the final year of a level of education evolves in proportion to the graduation rate of the level of study in question.

17. $$\frac{SHR_{edj,REUSSI\_GRD,t}}{SHR_{edj,GRD,t}} = \frac{SHR^0_{edj,REUSSI\_GRD}}{SHR^0_{edj,GRD}}$$

Also, the share of students passing a non-terminal year of a level of study is determined as the difference between the overall pass rate and the graduation rate in the final year of the level of study:

18. $SHR_{edj,REUSSI\_CTN,t} = SHR_{edj,REUSSI,t} - SHR_{edj,REUSSI\_GRD,t}$

Following the MAMS maquette, the share of students who do not pass and then repeat a year is proportional to its level in the initial period.

19. $SHR_{edj,REDOUBLE,t} = \frac{SHR^{0}_{edj,REDOUBLE}}{\left(1 - SHR^{0}_{edj,REUSSI}\right)}\left(1 - SHR_{edj,REUSSI,t}\right)$

We can determine the share of students who drop out as a residual. In effect, at the end of a given school year, a student may either pass the year (promotion rate), or fail. In the case of failing a year, he/she may either restart it (repetition rate) or drop out of school (dropout rate). The sum of these three rates should therefore be equal to 1. The dropout rate is calculated as a residual:

20. $SHR_{edj,ABANDON,t} = 1 - SHR_{edj,REUSSI,t} - SHR_{edj,REDOUBLE,t}$

The number of new students registered in level 1 is calculated by multiplying the number of children of age to enter school by the entry rate.

21. $NST^{N}_{EDUC1,t} = SHR_{EDUC1,ENTREE,t} POP^{H6}_{t}$

With:

$NST^{N}_{EDUC1,t}$: Number of new students in level 1 education

POP^{H6}_{t} : Population of age to enter primary school

As for the second level of study, the new students in year *t* are those who completed level 1 and who decided to continue their studies in the following level. In our study, the new students in level 2 are students who completed the first level of study and continued to the second.

22. $NST^{N}_{EDUC2,t} = NST_{EDUC1,t-1} \cdot SHR_{EDUC1,REUSSI\_GRD,t-1} \cdot SHR_{EDUC1,GRD\_CSUP,t-1}$

$NST^{N}_{EDUC2,t}$: Number of students in level 2 education

The number of old students enrolled in a cycle in a given period is calculated by summing the number of students in the cycle in the previous year that either repeated a year or passed a non-terminal year within the level of study.

23. $NST^{O}_{edj,t} = NST_{edj,t-1}\left(SHR_{edj,REUSSI\_CTN,t-1} + SHR_{edj,REDOUBLE,t-1}\right)$

With:

$NST^{O}_{edj,t}$: Old students enrolled in cycle *edj*

Finally, the total number of students enrolled in a cycle is the sum of old and new students.

24. $NST_{edj,t} = NST^{O}_{edj,t} + NST^{N}_{edj,t}$

Improving the quality of education induces more students to pursue their studies, with a positive impact on labour supply in the country. In effect, investing in education now would positively impact the supply of skilled workers tomorrow. Thus, the equations below, which describe the labour supply of skilled and unskilled workers, account for interactions with the education system.

The supply of skilled workers in a given period is thus given as the number of skilled workers in the preceding period who did not retire, plus students who completed level 1 of schooling and left school to enter the labour market, and students in level 2 who drop out of school as well as those who completed level 2.

25. $$\begin{aligned} LS_{LQ,t} &= \left(1 - ret_{LQ}\right) LS_{LQ,t-1} + NST_{EDUC1,t-1} \cdot SHR_{EDUC1,REUSSI\_GRD,t-1} \cdot SHR_{EDUC1,GRD\_FIN,t-1} \\ &+ NST_{EDUC2,t-1} \cdot SHR_{EDUC2,ABANDON,t-1} + NST_{EDUC2,t-1} \cdot SHR_{EDUC2,REUSSI\_GRD,t-1} \cdot SHR_{EDUC2,GRD\_FIN,t-1} \end{aligned}$$

With:[10]

$LS_{l,t}$: Total supply of type *l* worker

ret_l : Retirement rate of type *l* worker

The supply of unskilled workers is the sum of: unskilled workers in the previous period who did not retire, students in level 1 who dropped out of school before completing that level and children who have not entered primary school.

26. $$\begin{aligned} LS_{LNQ,t} &= \left(1 - ret_{LNQ}\right) LS_{LNQ,t-1} + NST_{EDUC1,t-1} \cdot SHR_{EDUC1,DROP,t-1} \\ &+ \left(1 - SHR_{EDUC1,ENTREE,t-1}\right) POP_{t-1}^{H6} \end{aligned}$$

The following equation is used to calculate an indicator for MDG2, and measures the share of children of primary school age who are actually enrolled in primary school.

27. $$MDGVAL_{MDG2,t} = \frac{\left\{\begin{array}{l} POP_t^{H6} \cdot SHR_{EDUC1,ENTREE,t} + POP_{t-1}^{H6} \cdot SHR_{EDUC1,ENTREE,t-1} \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) \\ + POP_{t-2}^{H6} \cdot SHR_{EDUC1,ENTREE,t-2} \cdot \left(1 - SHR_{EDUC1,ABANDON,t-1}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) \\ + POP_{t-3}^{H6} \cdot SHR_{EDUC1,ENTREE,t-3} \cdot \left(1 - SHR_{EDUC1,ABANDON,t-2}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t-1}\right) \\ \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) + POP_{t-4}^{H6} \cdot SHR_{EDUC1,ENTREE,t-4} \cdot \left(1 - SHR_{EDUC1,ABANDON,t-3}\right) \\ \cdot \left(1 - SHR_{EDUC1,ABANDON,t-2}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t-1}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) \\ + POP_{t-5}^{H6} \cdot SHR_{EDUC1,ENTREE,t-5} \cdot \left(1 - SHR_{EDUC1,ABANDON,t-4}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t-3}\right) \\ \cdot \left(1 - SHR_{EDUC1,ABANDON,t-2}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t-1}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) \end{array}\right\}}{\left\{POP_t^{H6} + POP_{t-1}^{H6} + POP_{t-2}^{H6} + POP_{t-3}^{H6} + POP_{t-4}^{H6} + POP_{t-5}^{H6}\right\}}$$

In Burkina Faso, primary school includes six years, starting with CP1 and continuing with CP2, CE1, CE2, CM1 and CM2.

With:

[10] See p.32 for the definition of the sets.

$MDGVAL_{mdg2,t}$: Value of MDG2 indicator

The model also accounts for two health-related objectives: maternal mortality (MDG4) and child mortality (MDG5). For these two indicators, we use a logistic function to describe the evolution of the values of these two mortality rates.

28. $$MGDVAL_{mdgn2,t} = ext^{MDG}_{mdgn2} + \frac{\alpha^{MDG}_{mdgn2}}{1+\exp\left\{\gamma^{MDG}_{mdgn2} + \beta^{MDG}_{mdgn2}\left(MDGVAL^{I}_{mdgn2,t} - MDGVAL^{0}_{mdgn2}\right)\right\}}$$

With:

$MDGVAL^{I}_{mdgn2,t}$:	Intermediary value of MDG indicator
$MDGVAL^{0}_{mdgn2}$:	Value of MDG indicator in base period
ext^{MDG}_{mdgn2}:	Minimum value the health indicator can take
α^{MDG}_{mdgn2} :	Parameter (logistic function – other millennium objectives)
β^{MDG}_{mdgn2} :	Parameter (logistic function – other millennium objectives)
γ^{MDG}_{mdgn2} :	Parameter (logistic function – other millennium objectives)

In the preceding expression, only the intermediary variable is endogenous. This variable is determined with the help of numerous arguments. It depends most heavily on per capita public health spending. An increase in public health spending would thus have a positive effect on reducing maternal and child mortality. The second argument of this function represents the level of qualification among the population. In effect, we know that a more educated population is more able to provide care for itself and to care for young children. The third argument is the value of MDG7, the percentage of the population with access to drinking water. This argument is not explicitly modelled: it is an exogenous variable. An increase in this rate would have a beneficial impact on maternal and child mortality. The final argument of this function is real per capita consumption, which in some form represents the wealth of households.

29. $$MDGVAL^{I}_{mdgn2,t} = MDGVAL^{0}_{mdgn2}\left\{\begin{array}{l}\left[\dfrac{CG_{SANTE,t}\,/\,POP^{H}_{t}}{CG^{0}_{SANTE}\,/\,POP^{HO}}\right]^{\sigma^{HLT}_{mdgn2}} \left[\dfrac{LS_{LQ,t}}{pop_t\ LS^{0}}\right]^{\sigma^{EDU}_{mdgn2}} \\ \left[\dfrac{MDGVAL_{MDG7,t}}{MDGVAL^{0}_{MDG7}}\right]^{\sigma^{WAT}_{mdgn2}} \left[\dfrac{CPC_t}{CPC^{0}}\right]^{\sigma^{CH2}_{mdgn2}}\end{array}\right\}$$

4.2. Description of the database

4.2.1. The SAM

We constructed a SAM for the year 2009 using the input-output table of that year.[11] While other SAMs have already been published for Burkina Faso, they do not include major changes in recent years. Growth in the mining sector has been substantial, particularly its exports. Also, we would like the data, particularly data linked to the public budget, to reflect the current situation of the economy.

In addition to the input-output tables, further data was needed, either to complete the SAM or to disaggregate it as appropriate for the issues being studied. To do this, we used data published by the INSD, the IMF, budgetary data and the 2005 Burkina Faso SAM.

The final SAM includes two types of workers (skilled and unskilled), one household, 24 products and 17 sectors. The products are grouped into two large categories: food products (maize; rice; millet, sorghum and other cereals; fruits, vegetables and tubers; oils, fats and sugar; condiments and salt; beef, chicken, fish, eggs and milk products; and beverages and coffee) and non-food products (forestry; extractive industries; cotton; electricity, gas and water; oil; other manufactured products; construction; trade; transportation services; postal and telecommunications services; financial services; other trade services; level 1 education services; level 2 education services; health and social services; and other public administration services).

The sectors include both the private sector (crops; livestock; forestry; extractive industries; beverages, coffee and tobacco; electricity, gas and water; other manufacturing sectors; construction; trade; transportation services; postal and telecommunications services; financial services; and other trade services) and the public sector (level 1 public education services, level 2 public education services; health and social services and other public administration services).

4.2.2. Education data

We separate the education system into two levels:

- Level 1 education includes students in primary school and those in the first cycle of secondary. Students who complete the first level of secondary school are considered as skilled workers when they enter the labour market. However, students who do not manage to complete this level enter the labour market as unskilled workers.
- Level 2 education includes students in the second level of secondary school and students enrolled in higher education.

We have determined the participation and pass rates (covered above) for each level of education using the annual reports published by the appropriate ministries.[12] These rates are then calculated endogenously in the model.

[11] Automated Forecasting Instrument (IAP), Burkina Faso

[12] For primary: http://www.cns.bf/IMG/pdf/Annuaire_2009_2010_MEBA.pdf. For secondary: http://www.messrs.gov.bf/SiteMessrs/statistiques/ANNUAIRE-2008-2009-SECONDAIRE.pdf. For higher education: http://www.messrs.gov.bf/SiteMessrs/statistiques/ANNUAIRE-2008-2009-SUPERIEUR.pdf

4.2.3. The initial values of the Millennium Development Goals

Some of the data in the model does not come from the SAM, and we must assign a value for the base period, in this case 2009. The total population of Burkina Faso in 2009 and the population growth rates are both taken from the Population Division, Population Estimates and Projections Section (from UNDESA) database for 2009-2033. As for the values relating to the MDGs, we take the values published in SCADD (2010).

4.2.4. Values of other variables and parameters in the model

The elasticities of the MDGs (see section on the description of the model) and those on household consumption were estimated econometrically using the EICVM 2009 survey (see Table 1) following the approaches presented in detail in section 2. For elasticities related to trade and in the production function, we have taken the values used by Balma et al (2011).

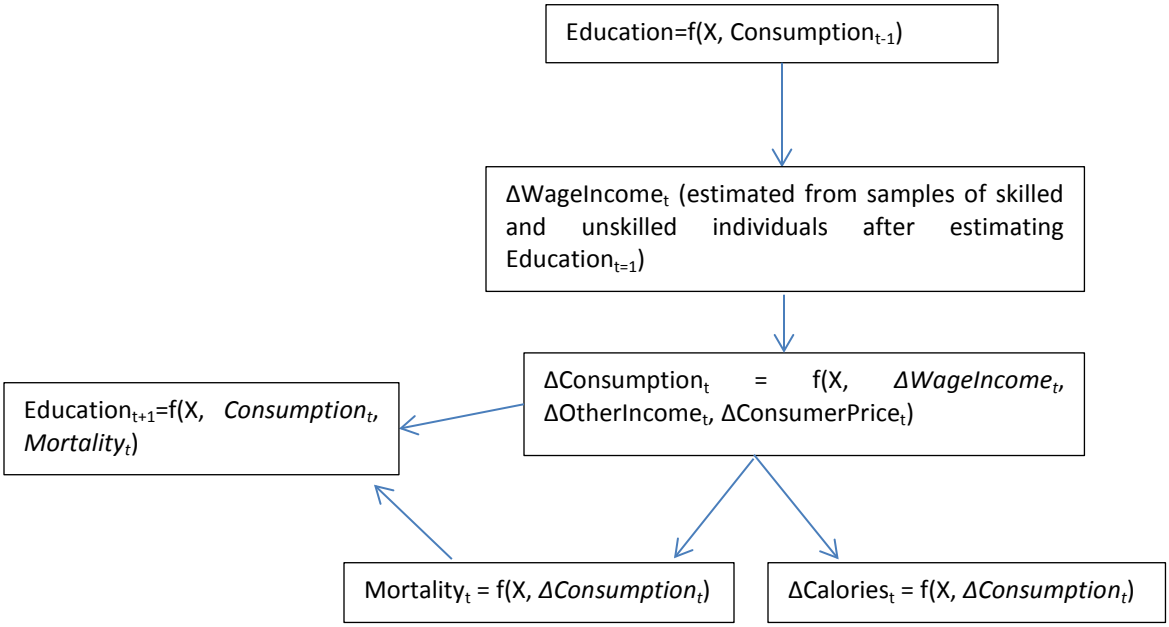
Table 1: Estimated elasticities

	Primary school entry (see section 2.1.2)	Transition from level 1 to level 2 (see section 2.1.4)	Promotion rate (see section 2.1.3)	Mortality (under 5 years) (see section 2.5)
Wage differential	0	0.019	0.021	n.a.
Educational and other infrastructures	0.664	0.256	0.652	n.a.
Child health[1] (major handicap)	-0.022	-0.012	-0.011	n.a.
Per capita consumption	0.192	0.042	0.022	-0.042
Equation quality[2]	1.1	0.9	0.5	n.a.
School fees	-0.416	0.0	0.0	n.a.
Access to improved sanitation	n.a.	n.a.	n.a.	-0.023
Access to prenatal care	n.a.	n.a.	n.a.	-0.125
Mother's level of education (completed lvl 1 or higher)	n.a.	n.a.	n.a.	-0.014
	Income elasticity			
Millet, sorghum, other cereals	1.073			
Maize	0.255			
Rice	1.270			
Beef, chicken, fish, eggs and milk products	1.120			
Oils, fats and sugar	0.932			
Fruits, vegetables and tubers	0.666			
Beverages and coffee	0.944			
Condiments and salt	0.276			
Non-food goods	1.218			

Note: [1] At the macro level, we use MDG4 to proxy child health. The micro model estimates the elasticity of child health using the "major handicap" variable; [2]Elasticities from MAMS model.

4.3. Microeconomic analysis

Figure 1: Schema followed for estimation in the micro component (for example, at time t=1)



The above schema (figure 1) shows the procedure and the order followed in estimating the micro component of the model. The following methodological notes are presented in the same order. We begin with the analysis of the education sector, which also helps to define the new sample of skilled and unskilled individuals in time *t=1,2,…* As indicated in the schema, education in time *t* is assumed to be a function of consumption in time *t-1*. We then estimate the change in wage income in time *t* (we assume other sources of income are not affected by the simulated changes in education). After estimating the changes in income, we can predict the changes in real consumption in time *t*, which also depends on changes in consumer prices. The new vector of real consumption in time *t* ultimately influences child mortality and caloric consumption in time *t*. Finally, we use the new figures for the consumption vector and mortality in time *t* to estimate education in time *t+1*, which in turn determines the sample of skilled and unskilled workers in time *t+1*.

Before going into more detail about the subcomponents of the micro analysis, it is important to mention the demographic assumptions: the sample in the base year (the year of the household survey used in this study) is assumed to be constant across time and simulation scenarios. In other words, the age of individuals is held constant, as is household structure.

4.3.1. Education

Base models and estimation coefficients

The goal in this section is to estimate the behaviour of children with respect to entry into primary school, passing the first cycle of education, and the choice to enter the second cycle for

those who complete the first. Remember that the first cycle of education includes the primary school as well as the first four years of secondary school. The second cycle of education includes the three final years of secondary school as well as post-secondary education.

These models provide us with coefficients and elasticities to pass on to the macro model and allow us to identify the determinants of different education-related results, such as those presented above, and to exactly predict which children will be affected by the fiscal and social policies modelled in this study.

Entry to primary school

The probability of entering primary school is estimated from a sample of children aged 6-8 years using a probit model. Even though the legal age for school entry is 7 years, we also include those aged 6 years (because the survey only provides this information in years, with no information on month of birth) and those aged 8 years (because it is common in Burkina Faso for a child to delay school entry by a year). Among these children, only those who did not attend primary school in the previous year are retained.

$$probit(\pi_i) = \alpha + \beta_v X_i + \varepsilon_i$$

With:

$$\pi_i = E\left(Y_i \middle| X_i\right)$$

where Y_i is a binary variable taking a value of 1 if the child attended the first year of primary school in the survey year but not in the previous year, and 0 otherwise. The vector X_i includes the *V* individual, household and community socioeconomic characteristics of child *i*. The explanatory variables introduced in this model specification are specific to the school entry model, and are: whether the child has a birth certificate, whether the child attended preschool, the number of children aged 6-8 (the age used to estimate primary school entry) in the same household, the distance between the primary school and the child's residence and primary school fees. This last variable is introduced in order to estimate the price elasticity of demand (or better, of the average probability) to enter school and to provide important guidance to policy makers. They were constructed by taking the median value of school fees paid directly by households in each census zone.

Other explanatory variables that are common to the three education models are: sex of child, age (and age squared), urban/rural residence, education level of household head as well as his/her age group and sex, real per capita household consumption and whether the child suffers from a major handicap.

Completing the first cycle of education

As above, the probability of completing the first cycle of education is estimated using a probit model. To carry out this analysis, we take a sample of children up to the age of 25 inclusive who completed the final year of the first cycle in the previous year. Even if the expected age to obtain a diploma (*Brevet d'Étude du Premier Cycle*, BEPC) is 17, we opted for a sample that includes a larger age group because few people reach this level in Burkina Faso and because here we are not specifically interested in the child's age upon graduation.

Y_i is a binary variable taking a value of 1 if the child's highest completed the first cycle of education and is 0 otherwise, regardless of whether the child pursues further studies. In

addition to the explanatory variables included in all three of the education models, the variables which are specific to this model are distance to secondary school from where the child lives and the ratio between income earned by a skilled worker and that of an unskilled worker. This last variable was constructed using median values of skilled and unskilled workers in each census zone.

Continuation to the second cycle of education

The probability of continuing on to the second cycle is estimated with a probit model. To do this, we retained a sample of children aged 16-25 inclusive, with a CAP diploma or higher and who were not working.

Y_i is a binary variable taking a value of 1 if the child attended class *2nde* or higher and had obtained a CAP diploma or higher, and is 0 otherwise. The explanatory variables are the same as in the model in the previous section.

Simulations

After estimating the coefficients, we replace the values for certain explanatory variables in the models presented in section 2.1.2 with their simulated values, and then predict the probability of entry into primary school. More specifically, real per capita consumption and school fees (this latter, for the entry model only) are replaced with the relevant (simulated) values.

In order to determine the change in primary school entry, the sample here (children aged 6-8 years) is then ordered with respect to the individual probability of entering primary school. We then use the predicted changes to assign a new status to the relevant children: for example, if the macro model predicts a 3% increase in the primary entry rate, we only change the variable Y_i to a value of 1 for the 3% of children who did not go to school in the base year and who had the highest probability of entering school.

The newly skilled individuals are either those who graduated from the first cycle and do not continue their studies or who complete or drop out of their studies at the second cycle of education. They are chosen randomly from the appropriate sample (respectively among people who graduate and those who continue on to the second level of education) using simulated changes in the macro model for both cases. In these two cases, we do not have enough observations to use an econometrically estimated behavioural model to determine who enters the labour market.

4.3.2. Sources of income

The following sources of income are used in the micro model. The predicted changes, as well as consumption prices, ultimately influence child welfare, whether in terms of monetary or caloric consumption or in terms of education and health.

Wages

The analysis of the changes in employment status in the wage sector (which accounts for just 4.1% of workers) and of observed and potential wages is carried out on the sample of individuals aged 15-65 inclusive who work in the wage sector or who do not work at all. We thus assume that the other types of workers (self-employed workers, apprentices or domestic workers) are not eligible to work in the wage sector (otherwise stated, the model assumes intersectoral immobility). Two models are specified, one for each level of qualification (skilled or unskilled).

The equations used to estimate the wage rate in the skilled (*q*) and unskilled (*nq*) sectors are defined as follows:

$$\ln w_i^q = \alpha_q + \beta_{vq} X_i + \varepsilon_i$$

$$\ln w_i^{nq} = \lambda_{nq} + \vartheta_{vnq} X_i + \upsilon_i$$

Where $\ln w_i^q$ and $\ln w_i^{nq}$ are the logarithms of wages earned by individual *i*, who is either skilled or unskilled, as defined in the section on education. The first regression is estimated on the sample of individuals defined at the beginning of this section and who are skilled, while the second is estimated on unskilled individuals. The vector X_i includes the following explanatory variables for individual *i*: sex of the individual, whether he/she is the household head, region of residence, age and age squared, and level of education and its square.

These equations are estimated using a standard Heckman-type selection model. When wage rates in a specific sector are only observed if the individual works in this sector, a selection problem arises. This is more of an issue when the error term in the wage equation is correlated to the error term in the equation which predicts the probability that the individual works in a given sector. In the presence of selection bias, the ordinary least squares estimators of the constant and the explanatory variables are biased and not consistent. The Heckman procedure provides consistent estimators and can estimate the wage equation in a sector under the condition that the individual actually works in the sector. Using maximum likelihood techniques, we jointly estimate the wage equations and the probability of employment (or selection) for both skilled and unskilled workers. The employment probability equation is estimated using the following explanatory variables: marital status of the individual, age and age squared, sex, education level, region of residence and the number of children living with him/her. The marital status and the number of children are necessary instruments to correct for selection problems.

We then predict the wage rate and the probability of employment in the two sectors for each individual in the retained sample. The changes simulated by the macro model are then integrated into the micro component. More specifically, the individuals are ordered by their probability of being employed in one of two sectors. If there is an increase (decline) in the employment rate, then individuals with a higher (lower) probability and who do not work (work) in the relevant sector become workers (non-workers). Clearly, the analyzed samples (skilled and unskilled) must be updated at the beginning of each simulation scenario by importing the predicted status changes from the primary school pass model. Then, the change in the wage rate is applied to observed wages (or predicted for individuals who for some reason or another did not report their income). Finally, the changes in the wage sector are calculated at the per capita and household levels.

Self-employment

The per capita changes in income among the self-employed[13] (34.4% of workers) are derived by applying the changes in the sectoral value added from the macro model (net of changes in labour demand). The sectors were classified following the categories in the input-output table. The income of individuals working as caregivers, apprentices/interns or volunteers (respectively 54.3%, 6.9 and 0.2% of workers) is assumed constant.

[13] Among the self-employed, no response was given for income in about 40% of cases; these were replaced by estimated (region-specific) values using a Heckman selection model.

Auto-consumption of food commodities

Finally, changes in the value of auto-consumption of food commodities are also accounted for in the calculation of real household income. Food auto-consumption is calculated using consumption prices and their simulated changes by category of food consumption (as identified in the consumption section).

4.3.3. Consumption and poverty[14]

General theoretical principles

The objective of this section is to present the reference theoretical framework that we adopted to compare the welfare of households when there are numerous consumption options following changes in the prices of consumption goods. To achieve this goal, we fix a reference price system, $\mathbf{p}^r$, and we use the equivalent income concept as defined by King (1983). Specifically, let $x_{c,h}$ be exogenous nominal income (corrected, if necessary, by household size, differences in the needs of adults and children, and the economies of scale associated with intrahousehold consumption) for household h living in strata c and $\mathbf{p}_c$ the price system they face. This price system is assumed to be fixed in each stratum but varies between strata.

For a given budget constraint ($\mathbf{p}_c$, $x_{c,h}$), the equivalent income is defined as the level of income that allows them to attain the same level of utility under the reference price system as they obtained with ($\mathbf{p}_c$, $x_{c,h}$):

$$v(\mathbf{p}_c, x_{ch}) = v(\mathbf{p}^r, e_{c,h})$$

where $v(.)$ is the indirect utility function and $\mathbf{p}^r$ is the reference price system. The indirect utility function can be re-written to obtain equivalent income as a function of original expenditures:

$$e_{c,h} = e(\mathbf{p}^r, \mathbf{p}_c, x_{c,h})$$

where $e_{c,h}$ is the equivalent income of household h in strata c, facing price system $\mathbf{p}_c$, and with a nominal per capita (or per adult equivalent) income of x_{ch}. The equivalent income ($e_{c,h}$) is the level of income which, at reference price system $\mathbf{p}^r$, provides the same level of utility as obtained with income level $x_{c,h}$ and price system $\mathbf{p}_c$. Given that $e_{c,h}$ is a precise monetary measure of the utility function, the properties of the equivalent income function may be derived from those of $v(.)$. This implies that the function $e(\mathbf{p}^r, \mathbf{p}_c, x_{c,h})$ is increasing with respect to $\mathbf{p}^r$ and $x_{c,h}$, decreasing with respect to $\mathbf{p}_c$, is concave and homogenous of degree one with respect to reference prices, and has continuous first and second derivatives in all its arguments.

The calculated equivalent income depends on the choice of the reference price system. As emphasized by King (1983), many options are possible for $\mathbf{p}^r$. In this study, we opt to set prices at their level in the base year (which corresponds with the survey year of the 2009 EICVM), $\mathbf{p}^0$:

$$p_k^r = p_k^0 = \frac{1}{C}\sum_{c=1}^{C} p_{c,k}^0$$

where C is the total number of strata.

[14] This section is largely drawn from Bibi, Cockburn, Coulibaly and Tiberti (2009).

The first use of the equivalent income function is to predict changes in individual welfare following simulations of fiscal and social policies proposed in this study. A natural measure of the value of a given change in $\mathbf{p}_c$ and $x_{c,h}$ for an individual is the change in his/her equivalent income. For $\mathbf{p}^r = \mathbf{p}^0$, King (1983) shows that this measure of the change in welfare is given by the equivalent gain:

$$EG_{c,h} = e(\mathbf{p}^0, \mathbf{p}_c^1, x_{c,h}^1) - e(\mathbf{p}^0, \mathbf{p}_c^0, x_{c,h}^0)$$

The equivalent gain is the amount of money a household considers as equivalent to the impact in the change in its budget constraint from ($\mathbf{p}_c^0$, $x_{c,h}^0$) to ($\mathbf{p}_c^1$, $x_{c,h}^1$).

In terms of poverty, we define z_e as the minimum real income required per capita (or per adult equivalent) to escape poverty. In other words, z_e is an equivalent poverty line given by:

$$z_e = e(\mathbf{p}^0, \mathbf{p}_c^0, z_c^0)$$

where z_c^0 is the poverty line specific to strata *c* and evaluated for price system $\mathbf{p}_c^0$.

It is common to express measures of poverty in terms of normalized poverty gaps, g_{hc}, defined for an individual as

$$g_{c,h} = \max\left(\frac{z_e - e(\mathbf{p}^0, \mathbf{p}_c, x_{c,h})}{z_e}, 0\right)$$

$\mathbf{g} = (g_1, g_2, \ldots, g_h, \ldots, x_H; n_1, n_2, \ldots, n_h, \ldots, n_H)$ is thus the vector of poverty gaps.

An important class of poverty measures is the FGT class of indices (Foster, Greer and Thorbecke, 1984), defined as:

$$P_\alpha(z_e, \mathbf{x}) = \frac{1}{N}\sum_{h-1}^{H} n_{c,h} g_{c,h}^\alpha$$

$$= \frac{1}{N}\sum_{h=1}^{H} n_{c,h}\left(\frac{z_e - e(\mathbf{p}^0, \mathbf{p}_c, x_{c,h})}{z_e}\right)^\alpha I\left(e(\mathbf{p}^r, \mathbf{p}_c, x_{c,h}) < z_e\right)$$

where α can be considered as a measure of aversion to poverty, or to inequality among the poor: a larger value of α gives a higher weight to a loss of income experienced by a relatively poorer individual. The $P_0(\mathbf{x}, z_e)$ measure of poverty gives the incidence of poverty (the poverty rate), $P_1(\mathbf{x}, z_e)$ gives the average poverty gap (or the normalized poverty deficit) and $P_2(\mathbf{x}, z)$ is often described as the severity of poverty.

Approach to estimate real consumption: substitutability or non-substitutability between consumption goods

In terms of the effect of changes in consumer prices on real household consumption (which reflects purchasing power), it is assumed that, in the reference situation (the survey year) and thus prior to the simulation scenarios presented in this study, each household *h* has exogenous

per capita (or per adult equivalent) nominal income of $x_{c,h}^0$ and faces price system $\mathbf{p}_c^0$. Following changes in consumer prices, each household *h* may have the same nominal per capita (or per adult equivalent) income ($x_{c,h}^1 = x_{c,h}^0$) but faces a new price system $\mathbf{p}_c^1$. We seek to compare levels of consumption, and thus poverty, when households face different price systems. The literature offers us many ways to do this, depending on whether or not we account for substitutability between goods.

If we do not account for substitutability, we can follow the approach which assumes that prices change uniformly across household types, regardless of their consumption habits or sociodemographic characteristics, and then construct a consumer price indicator. Alternatively, we can construct an indicator of the price index for each household by weighting the price index for each category of consumption by the budget share that the household allocated to this category. Finally, if we wish to follow an approach which is more based on microeconomic theory, we may use a price index constructed with a Cobb-Douglas utility function. The following section aims to present a theoretical and empirical approach to estimate real consumption when accounting for substitutability between food and non-food goods.

Approach based on microeconomic theory: Accounting for substitutability between goods

Under this more suitable theoretical assumption (of substitutability), we go beyond the simple assumption that households respond to price changes with a proportional reduction in the quantities consumed of the affected goods (fixed budget shares). By estimating the overall household response, in terms of substitution between food and non-food goods, we obtain a more realistic measure of the impacts on poverty, allowing us to analyze the nutritional impacts in greater detail (see following sections). Better yet, it becomes possible to predict the changes in the household consumption basket following a change in prices.

To make the estimates of demand behaviour as flexible and as consistent as possible with economic consumer theory, we estimate the following demand system:

$$w_{j,c,h} = a_j + \sum_{k=1}^{K} b_{j,k} \ln p_{k,c} + c_j \ln \frac{x_{c,h}}{z_c} + e_j D_{c,h} + \mu_c + \varepsilon_{j,h}$$

With:

$$b_{j,k} = b_{k,j}; \sum_{j=1}^{J} a_j = 1; \sum_{j=1}^{J} b_{j,k} = \sum_{j=1}^{J} c_j = \sum_{j=1}^{J} e_j = 0$$

where $w_{j,c,h}$ is the budget share allocated to good *j* by household *h* living in strata *c*, $p_{j,c}$ is the price of this good in strata *c*, $D_{c,h}$ is a vector of sociodemographic characteristics and z_c is the poverty line in strata *c*.

This equation is an Almost Ideal Demand System (AIDS), as proposed by Deaton and Muellbauer (1980), in which budget shares are linear in b_{jk} and c_k. The estimation strategy follows Deaton (1997) and uses spatial price variations in Burkina Faso to estimate price (b_{jk}) and income (c_k) parameters. The model may also include explanatory variables explicitly linked to household

sociodemographic characteristics in order to predict the impact of price changes on households according to characteristics such as the number of children.

Once the parameters of the demand equations have been estimated, it becomes possible to predict the changes in real income following any change in prices or nominal income resulting from fiscal and social policies such as those proposed in this study. This is done using the following equation (which results from the system of preferences described by the AIDS equations):

$$\ln e_{c,h} = b(\mathbf{p}_r)\left[\frac{\ln x_{c,h} - \ln z(\mathbf{p}_c)}{b(\mathbf{p}_c)}\right] + \ln z(\mathbf{p}_r)$$

where

$z(\mathbf{p}_c)$ is the subsistence cost of living (see Deaton and Muellbauer, 1980), defined as

$$\ln z(\mathbf{p}_c) = a_{0c} + \sum_{k=1}^{K} a_k \ln p_{c,k} + \frac{1}{2}\sum_{j=1}^{K}\sum_{k=1}^{K} b_{j,k} \ln p_{c,j} \ln p_{c,k}$$

and may be approximated by the poverty line in strata c

and $b(\mathbf{p})$ is equal to

$$b(p) = \prod_j p_j^{c_j}$$

Then, the own-price, cross and income elasticities are calculated as:

- Own-price elasticity of good j ($\varepsilon_{j,j}$) is:

  $$\varepsilon_{j,j} = \frac{b_{j,j}}{\overline{w_j}} - c_j - 1$$

  with $\overline{w_j}$ as the average budget share allocated to good j

- Cross-price elasticity of good j ($\varepsilon_{j,j}$) with respect to changes in the price of good k ($\varepsilon_{j,k}$) is:

  $$\varepsilon_{j,k} = \frac{b_{j,k}}{\overline{w_j}} - \frac{c_j}{\overline{w_j}}\overline{w_k}$$

- Elasticity of good j with respect to income (η_j) is:

$$\eta_j = \frac{c_j}{w_j} + 1$$

4.3.4. Caloric poverty

The caloric poverty indicator is the caloric adequacy ratio, where we assume that all household members have the same ratio (i.e., that all calories are equitably distributed among household members in proportion to the needs of each member).

$$CAR_{i,t} = \frac{CI_{i,t}}{CR^*}$$

where $CAR_{i,t}$ is the caloric adequacy ratio of individual *i* in time *t,* $CI_{i,t}$ are the calories consumed per day by individual *i* and CR^* is the caloric requirements of the reference male adult (2450 kcal per day). The poverty line is therefore equal to 1. $CI_{i,t}$ is defined as:

$$CI_{i,t} = \sum_j Q_{i,j,t} K_k$$

where $Q_{i,j,t}$ is the quantity consumed (adjusted by the caloric requirement of individual *i*) of good *j* by individual *i* in time *t* and K_j are the kcal of good *j* consumed.

With the estimates of the coefficients of the demand system, it is then possible to estimate the new consumption vectors (which follow the changes in prices and nominal income).

4.3.5. Child mortality

In this section we estimate the under-5 child mortality rate (U5MR) and the elasticities to supply to the macro model. The models presented in this section are estimated using the sample of children under the age of 5.

An initial and more detailed estimation was carried out with a Cox survival model using micro data from the 2003 Burkina Faso Demographic and Health Survey (DHS). This model specifies instantaneous risk of death (i.e. risk) as a function of time *t* they are exposed to the risk, as well as other explanatory variables, to estimate the proportional risk (represented by $exp(\beta_v)$ in the following expression). We estimate the function

$$\theta_i(t_i, X_i) = \theta_0(t) \exp\left(\sum_{v=1}^{V} \beta_v X_i\right)$$

where θ_i is the instantaneous risk of death of child *i* at instant *t* that the child faced (i.e., his/her exposure to risk) up to *t*. $\theta_0(t)$ is the base risk, which is the same for all children. The *V* explanatory variables *X* identified in this specification are: the sex of the child, urban/rural residence and region of residence, whether the mother obtained a primary diploma or higher, whether the child is a twin, the average number of women in each geographical cluster receiving prenatal checkups during pregnancy (a variable which identifies the availability and accessibility of medical services for pregnant women), whether he/she lives in housing with access to an improved source of water, whether he/she lives in housing with access to electricity.

Since the DHS does not provide information on household consumption/income, in order to estimate the income elasticity of the probability of death among children under the age of 3 years, we produce a more parsimonious model which uses explanatory variables that are

included in both the DHS survey (which provides the information needed to calculate mortality) and the EICVM survey (which includes data on household consumption). Compared to the preceding model, we exclude the twin and prenatal care variables. The coefficients of this model are estimated using a logit model as we cannot use a Cox model because the information needed to determine the period of exposure to risk is not available in the EICVM data. Once the coefficients of the logit model have been estimated (using the DHS survey), we use them to estimate the probability of death among children under the age of 5 (using EICVM data). We then estimate the OLS coefficient of real per capita consumption on the probability of death and, finally, the elasticity of the probability of death with respect to per capita consumption.

5. Simulation scenarios

5.1. Reference scenario

The reference scenario is constructed using IMF forecasts (see http://www.imf.org/external/french/pubs/ft/scr/2011/cr11226f.pdf). Between 2009 (the reference year in the model) and 2033 (the last year simulated in the model), we produce a scenario which accounts for IMF forecasts for specific indicators: increases in foreign demand for cotton and minerals, a reduced deficit-to-GDP ratio, an increase in direct taxes on households and firms, and constant public spending as a share of GDP. Introducing the forecast increase in exports and the targeted income from direct and indirect taxes allows our model to produce an evolution of GDP similar to the forecast in the IMF document.

The IMF forecasts only cover up to 2015, so the reference scenario anticipates that the policies implemented by 2015 will be maintained in following periods. Also, the demand for various export products matches the population growth rate as of 2015, implying that the foreign demand will continue to grow but at a slower pace compared to the 2010-2015 period. All of these assumptions are maintained throughout the simulations and the results are then compared to the reference scenario.

Finally, we used demographic forecasts produced by the United Nations.[15] These anticipate a gradual decline in the rate of population growth from 3.0% in 2009 to 2.6% in 2033.

5.2. Comparison of spending

Three types of public spending are analyzed:

- An increase in current education spending (*Spending*, in the tables and figures);
- A school fees subsidy (*Subsidy*); and
- A cash transfer to households with children aged 0-5 years (*Transfer*).

The same total amount of money is injected into the economy in each of these three cases, making it easier to compare the three scenarios. It must be noted that the policy is temporary (10 years) in every case, and by 2020 the public policies return to their levels in the reference scenario. Table 1 below establishes the connection between these additional amounts and the variables in question.

[15] UNDESA, 2010.

Table 2: Simulated interventions

	Spending (in % of education spending)	*Subsidy* (CFA per student)	*Transfer* (CFA per child 0-5 years)
2010	25%	24 501	17 823
2011	23%	23 982	17 463
2012	21%	23 380	17 135
2013	16%	18 954	14 026
2014	15%	18 414	13 790
2015	14%	17 867	13 568
2016	11%	13 820	10 668
2017	11%	13 340	10 498
2018	5%	6 436	5 166
2019	5%	6 208	5 085

5.3. Comparison of financing mechanisms

We compare three financing mechanisms for each of the spending scenarios:

- **Reduced subsidies** (*PSUB* in the tables and figures). The products and sectors benefitting from a subsidy in the reference situation[16] see their subsidy rates fall in order to cover the shortfall in the budget associated with the new policies. Under this financing mechanism, the deficit-to-GDP ratio remains at its reference level. In other words, this ratio declines by half between 2009 and 2015.
- **Higher collection rate** of indirect taxes (*COLL*). In this case, increased government spending is financed by increasing the collection of various indirect taxes and, as in the preceding financing scenarios, the deficit-to-GDP ratio follows the expected trend relative to the reference scenario.
- **Extending the public deficit reduction** over ten years rather than five (*DEFICIT*). In this case, the government interventions are not offset by any fiscal measures. The deficit thus grows relative to the reference scenario, and the government achieves its goal of reducing the deficit-to-GDP ratio by half over ten years, rather than the anticipated five years.

6. Analysis of results

6.1. Increase in public education spending

We begin here with a discussion of the effects of this simulation on education, the economy and poverty without consideration of the financing mechanism. Qualitatively, the results essentially go in the same direction and can be explained by the same transmission channels. We close the analysis of this scenario by comparing financing mechanisms.

6.1.1. Impact on education

While the additional amount injected by the government is the same in each of the three scenarios, the transmission channel affecting school participation rates is different. For example,

[16] Manufactured products, including: oil; electricity, gas and water; transportation; and telecommunications.

in the *Spending* scenario, the government improves the education quality index, i.e., the volume of services supplied per student at each level of study. An increase in education spending leads to an increase in the supply of education services: with a constant number of students, the education quality index would improve (Figure 1).[17] In our model, the education quality index is one of the factors influencing school participation rates. An increase in this indicator thus leads to an increase in the primary school entry rate (Figure 2) and a reduction in the dropout rate (Figure 3).

Figure 2: Education quality index, first level of study (2009 = 100)

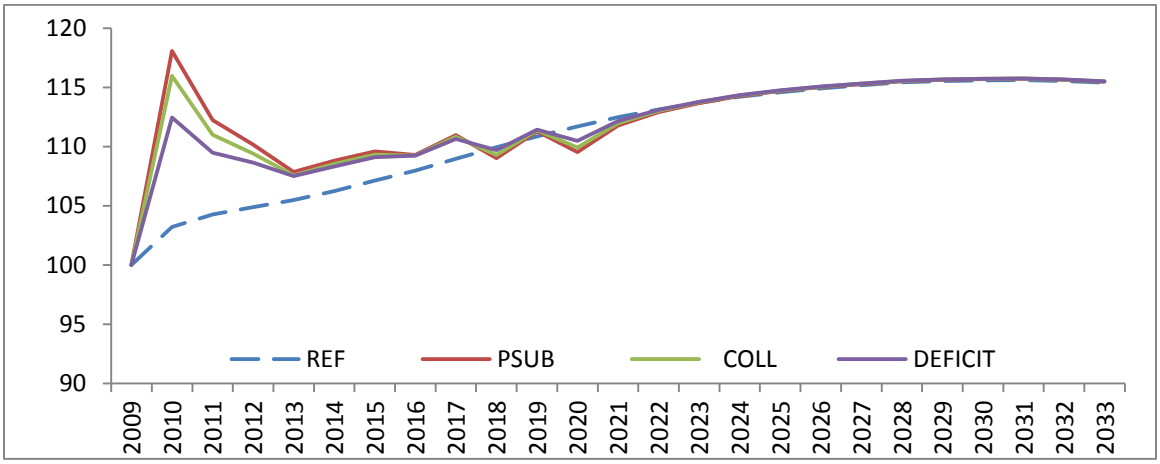
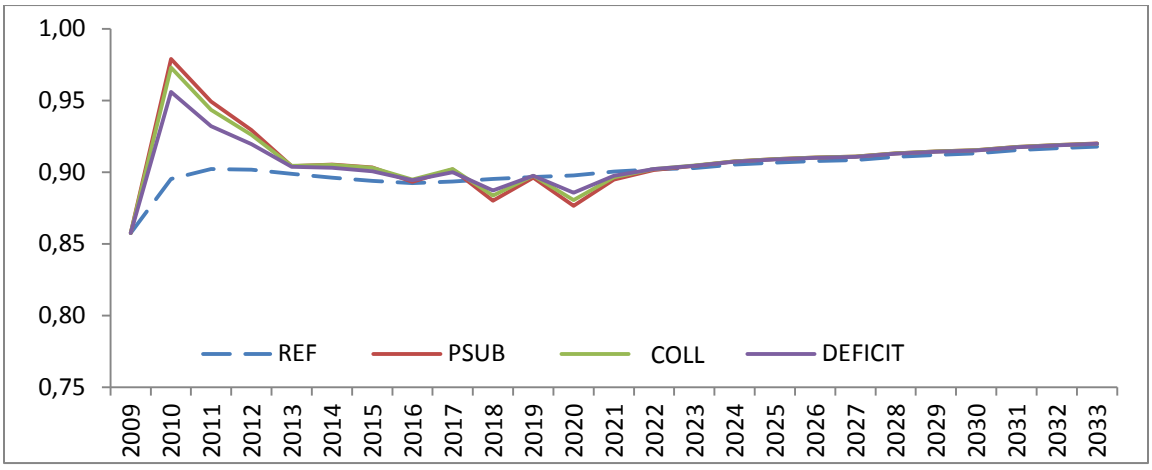
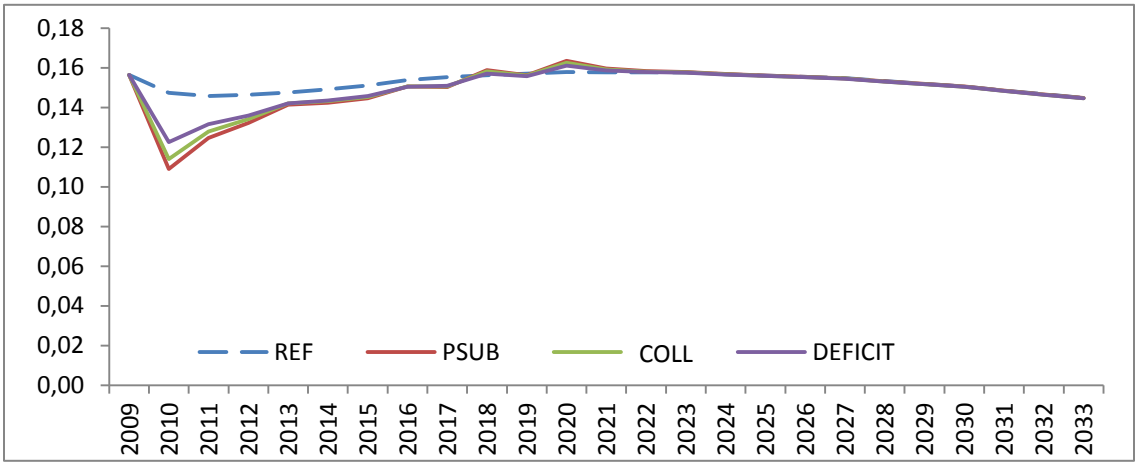


Figure 3: Entry rate, primary school



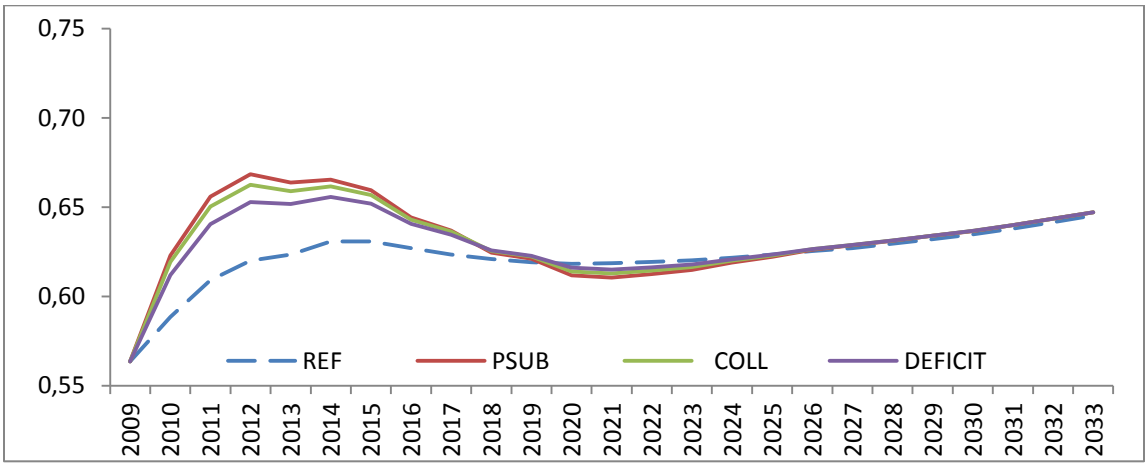
[17] Recall that the education quality indicator is measured as the ratio of the *volume* of services and the number of students.

Figure 4: Dropout rate, first level of study



The combined effects of higher entry and lower dropout rates effectively increase the number of students going to school and thus improve the primary school net enrolment ratio[18] (Figure 4). This improvement was in the range of nearly 5 percent during the period of increased spending.

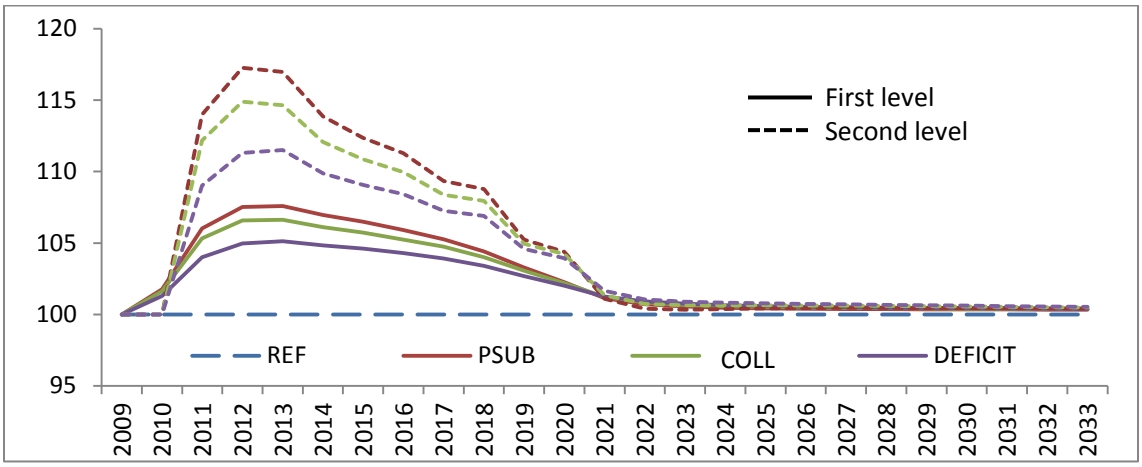
Figure 5: Primary school net enrolment ratio



Similar impacts are observed at the second level of study. The improvement in the education quality index also encourages students who graduate from the first level of study to continue their studies at the next level. The number of students thus increases in each of these levels of education, but this increase is even stronger in the second level, where the number of students substantially exceeds that observed in the reference scenario (Figure 5).

[18] Here, this includes children aged 6-11 years who attend school.

Figure 6: Indicator of number of students per level (reference = 100)

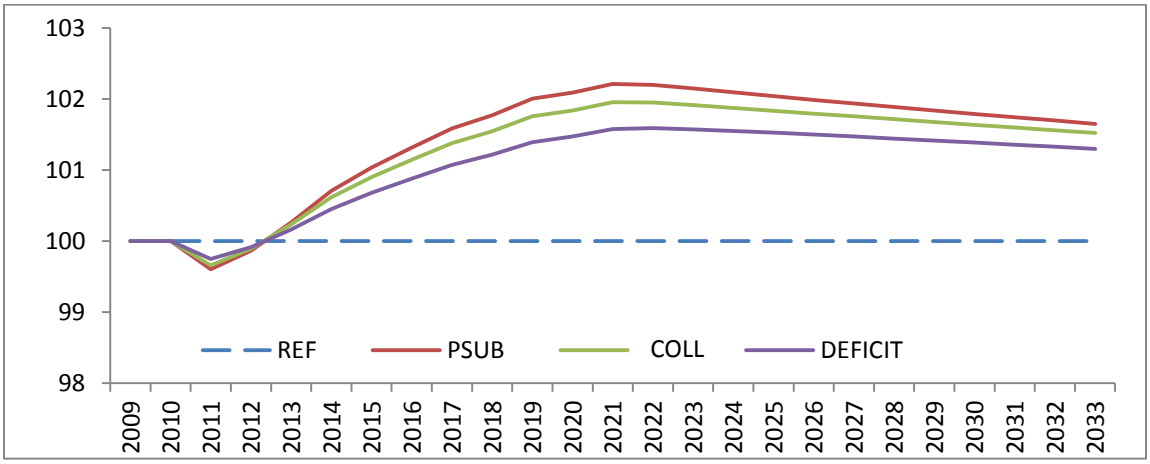


6.1.2. Macroeconomic impact

Employment

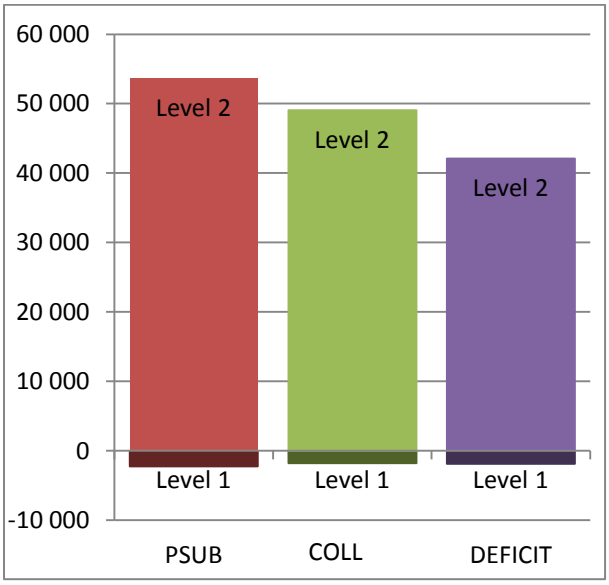
The increase in the school participation rate has a positive impact on the supply of skilled workers. Recall that a worker is considered as skilled if he/she has successfully completed the first level of secondary school. The promising results presented above thus indicate growth in the supply of skilled workers, as shown in Figure 6. The increase is more than 2% higher than in the reference scenario. The small decline observed during the first two years can be attributed to an increase in the number of students continuing school beyond the first level of secondary. After this, and even by the end of the simulation period, the number of skilled workers remains higher than in the reference period.

Figure 7: Supply of skilled workers indicator (reference = 100)



In absolute terms, there would be nearly 50 000 new skilled workers. It is interesting to highlight that, since the number of students pursuing their studies in level 2 increases, the composition of skilled workers would include more workers who studied at the secondary level and somewhat fewer workers with only the first level diploma (Figure 7). The total supply of skilled workers thus increases, as does the level of education.

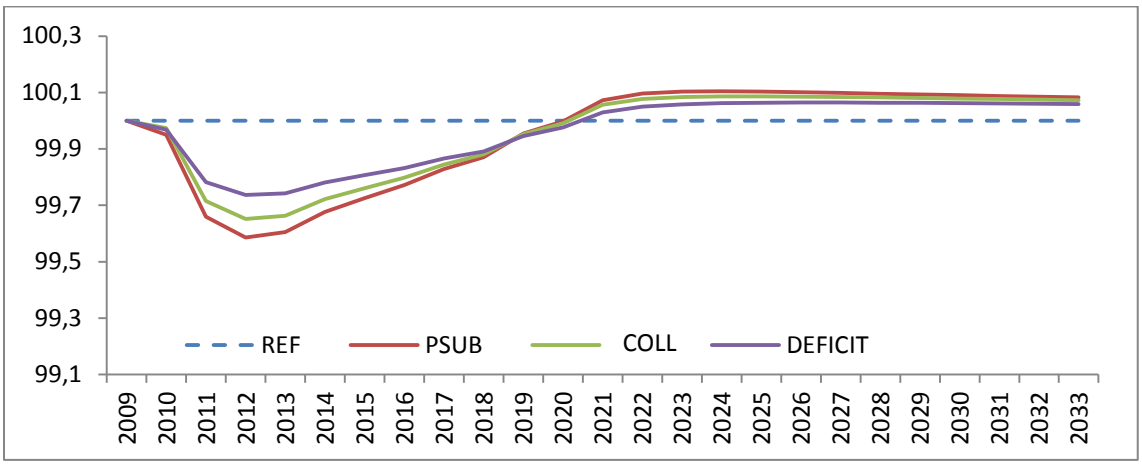
Figure 8: Number of new skilled workers by education level



Growth

The impacts of an increase in education spending on GDP and economic growth are limited. On the one hand, it is useful to recall that the reference scenario forecasts a marked increase in exports, which significantly stimulates economic activity. On the other hand, these results are not surprising given that it is assumed that responsibility for the financing mechanisms is taken on by the economy of Burkina Faso. In other words, there is reallocation within the economy; financing via foreign aid would have been shown to generate important impacts on growth.[19]

Figure 9: Real GDP index (reference = 100)



The impact on real GDP varies over the course of the period of analysis. For example, we observe a slight reduction in real GDP during the period of increased spending, due to the fact that students pursue their studies for longer and thus join the labour market less quickly.

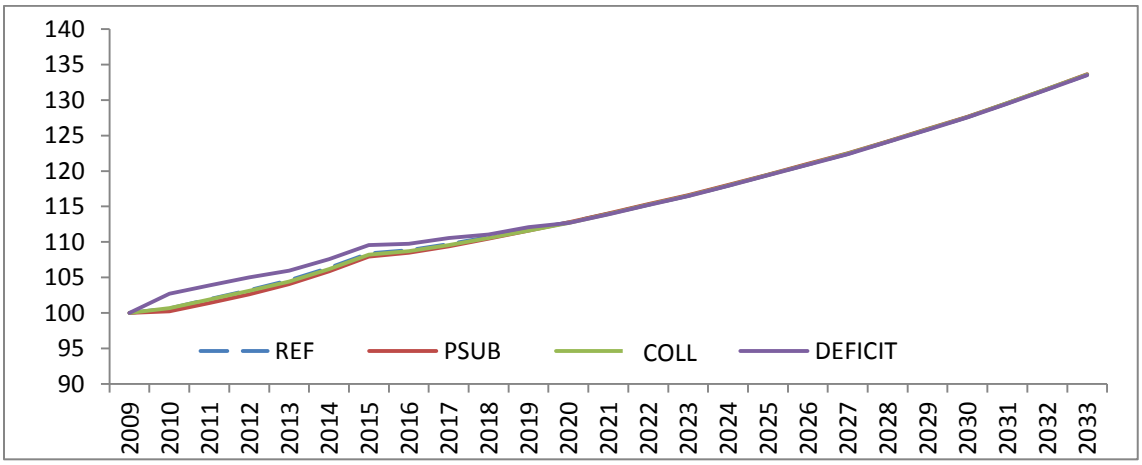
[19] This is notably the case in the study of Gottschalk et al (2009).

However, once their studies are completed, these new workers will be able to contribute to growth in national production (Figure 8).

Consumption

The reference scenario, as we presented above, forecasts economic growth to be higher than population growth. It is therefore unsurprising to observe an increase in real per capita consumption throughout the period of analysis. An increase in public education spending has little effect on real per capita consumption (Figure 9).[20] In fact, only the scenario with increased public spending via a deficit shows an improvement for the years when the shock is introduced. The other financing mechanisms (reduced subsidies and improved tax collection) inevitably lead to an increase in consumption prices with the result that individual purchasing power basically remains the same. We discuss the financing mechanisms in greater detail in section 6.1.4.

Figure 10: Real per capita consumption index (2009 = 100)



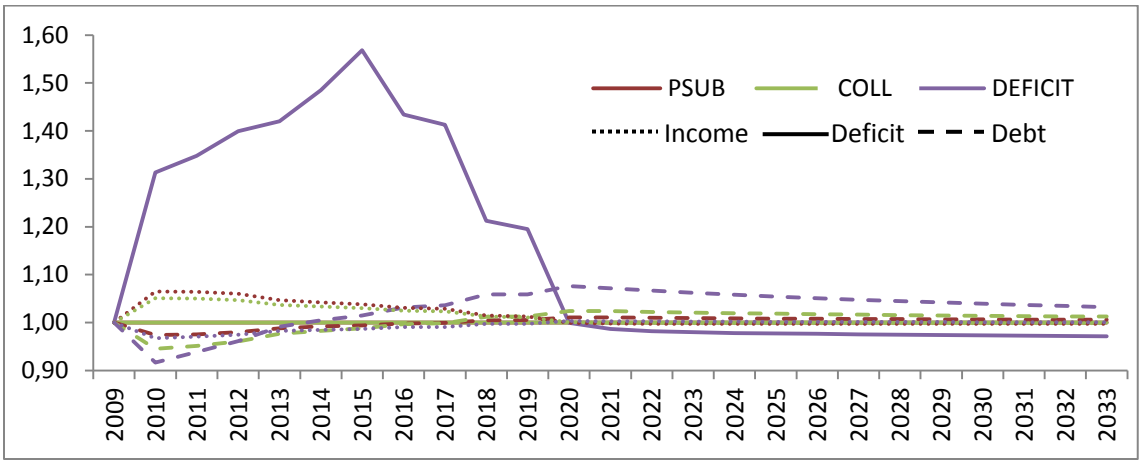
Taxation

Figure 10 presents the evolution of the government's income-, deficit- and debt-to-GDP ratios relative to the reference scenario. From a fiscal perspective, financing the increased spending does not impact the deficit-to-GDP ratio if this spending is financed by reducing subsidies or by improving tax collection These lines are superimposed in this figure. An increase in income compensates for new spending (dotted line). Debt thus does not change significantly as a share of GDP if one or the other of these mechanisms is used to finance the increased spending.

However, if the spending is financed by a temporary increase in the deficit, the debt-to-GDP ratio increases to nearly 1.6 times its level in the reference scenario. In the longer term, it is thus unsurprising that debt as a share of GDP is slightly higher than it would have been.

[20] Note that real per capita income progresses similarly.

Figure 11: Fiscal ratios (reference = 1)

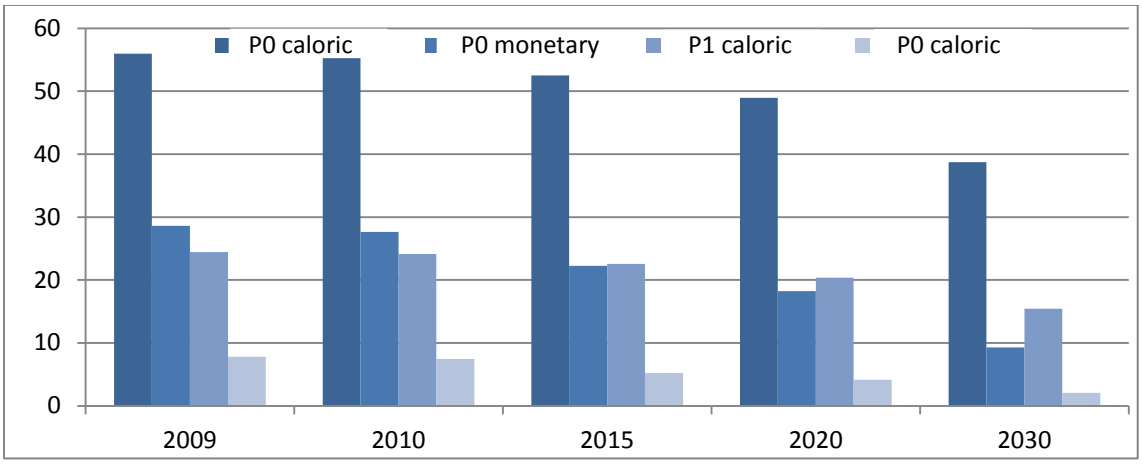


6.1.3. Impact on poverty

The simulation results from the computable general equilibrium model – particularly those related to wage rates, employment of skilled and unskilled workers, production and consumption prices, and sectoral value added – are introduced in a microsimulation model of household and individual behaviour to forecast the impacts on child monetary and caloric poverty. It is important to highlight that the equivalence scales used in this study (adult equivalent according to caloric needs) differ from those used in the official estimates. This having been said, the estimates presented below are not comparable with the official number. The caloric and monetary poverty lines were determined in terms of the needs of children aged 0-17. This explains why the child poverty rates are lower than poverty when using the lines set for the population as a whole.

Given the reference scenario discussed above, and more specifically the evolution of real per capita consumption (Figure 9), it is not surprising that the incidence and depth of poverty (respectively P0 and P1) decline for both caloric and monetary poverty throughout the period of analysis (Figure 11).

Figure 12: Evolution of poverty indicators in the reference scenario



In the long run, the incidence of child monetary poverty declines by nearly two-thirds, from 28.6% in 2009 to 9.3% in 2030 (Figure 11); the poverty gap declines from 7.8 to 2.1% over this same timeframe.

The poverty indicators expressed in caloric terms also improve, but by less: whereas nearly one in ten children can be expected to suffer from monetary poverty in 2030, nearly one in four will still suffer from caloric poverty. This can be explained by the differing impacts on the prices of food commodities, which increase by more than prices of other consumer products.

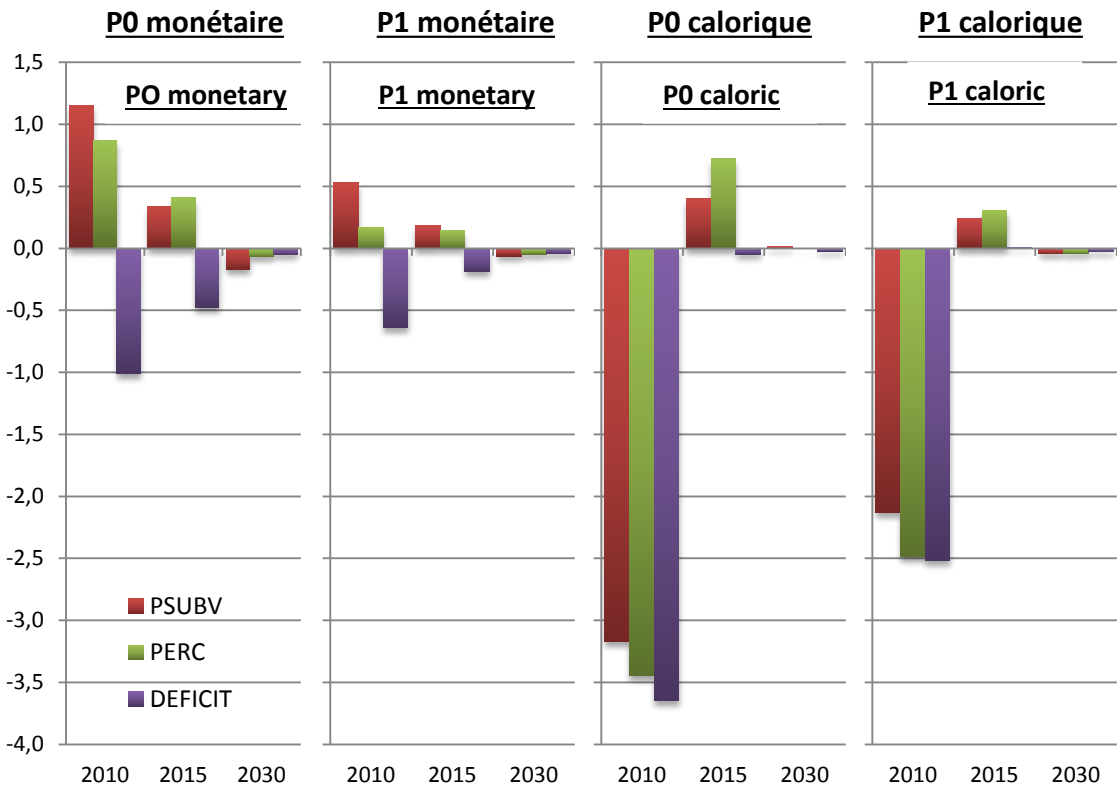
Similarly, the poverty gap declines by less when considering caloric rather than monetary poverty. In 2009, an average increase in the equivalent caloric intake of nearly one-quarter of the caloric poverty line would have eliminated caloric poverty (P1). The required increase is one-third lower in 2030.

The increase in public education spending has little impact on these long term trends. In effect, in 2030 the indicators are fairly close to what they would have been in the absence of any government intervention, particularly when expressed in caloric terms (Figure 12).

However, during the intervention period (i.e. over 2010-2015), monetary poverty indicators deteriorate when increased public spending is financed by a reduction in subsidies or improved tax collection. In fact, these two measures have the effect of increasing consumption prices, which explains why the incidence and gap of poverty are higher than their level in the reference scenario.

Since taxes and subsidies are less oriented toward food products, these become relatively less expensive than other consumption goods. Households thus substitute away from non-food goods, which become more expensive relative to other goods. The situation with respect to caloric poverty thus improves in the first year of the simulation (2010) regardless of the financing mechanism. Recall that spending particularly grows in the early years of the simulation, and that this increase gradually diminishes in time (Table 1). The impact on caloric poverty is thus more pronounced in this first year and is lower thereafter.

Figure 13: Variation (in percentage points) of poverty indicators with respect to reference scenario



6.1.4. Comparison of financing mechanisms

The impact of an increase in public education spending is qualitatively similar, regardless of the financing mechanism. Compared to the reference scenario, the school participation and pass rates improve, the supply of skilled labour increases and economic activity is stimulated.

Financing this new spending by reducing existing subsidies, however, leads to slightly higher levels of each of these indicators; the effect is similar, although smaller, when improved tax collection finances the spending. As discussed above, both of these financing mechanisms raise the overall price level. Since the price of education is not affected by these two mechanisms, neither reduced subsidies nor increased tax collection have a direct impact on education: the impact is thus felt through a relative change in prices, where the real price of education in the consumer's deflated basket declines, thus promoting school participation and pass rates, along with the ensuing macroeconomic effects.

The opposite is observed in terms of the impacts on poverty. Only financing the additional spending through an increase in the deficit reduces poverty rates significantly in the medium term. In the longer term, monetary poverty falls regardless of the financing mechanisms used, and the reduction is greater in both cases other than the increased deficit. These differences are barely perceptible for caloric poverty.

These results were observed for all intervention types. In the following analysis, we solely focus on comparison of the three intervention types under one single financing mechanism, namely the deficit. The reader should nevertheless keep in mind the slightly differentiated impacted of the other financing mechanisms.

6.2. Comparison of intervention types

6.2.1. Impact on education

The simulated interventions, while equivalent in terms of public spending, act differently on the factors influencing school participation and pass rates, as shown in the following three figures. Here, we see an increase in education spending improving the education quality index (Figure 13), a school fees subsidy reducing the relative price of education (Table 14), while the transfer to households essentially promotes real per capita consumption (Table 15). Each of these elements has differing impacts on student behaviour, as reflected by different elasticities.

Figure 14 : Education quality index, first level of study (2009 = 100)

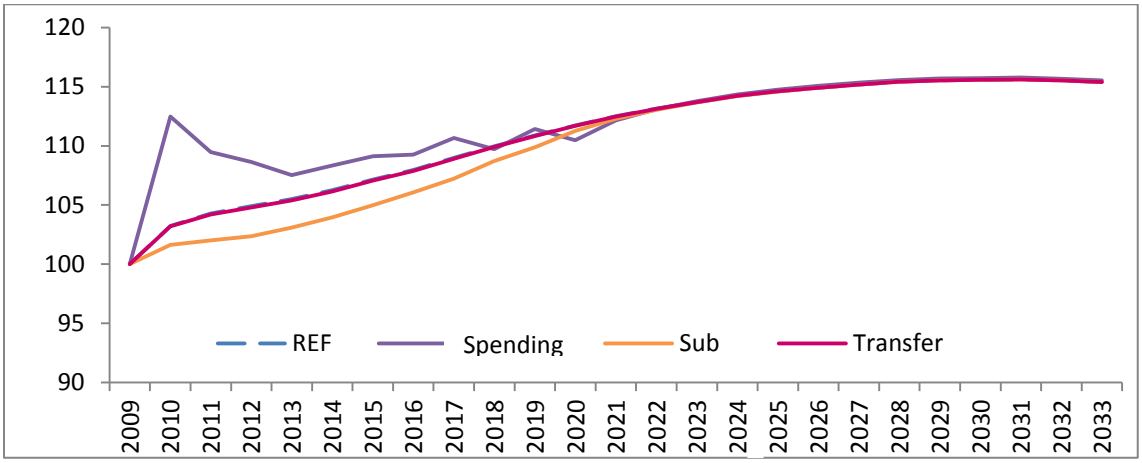


Figure 15: Relative price of education index (2009 = 1)

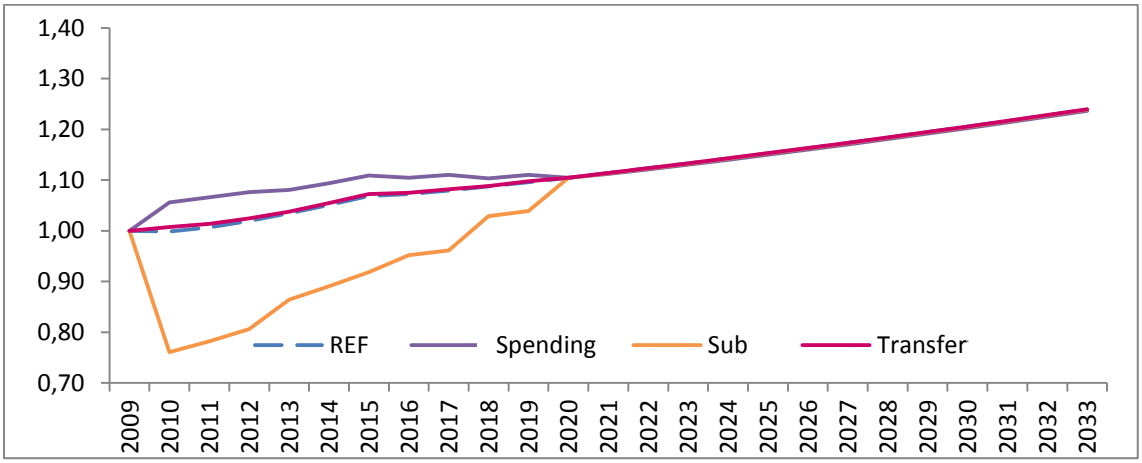
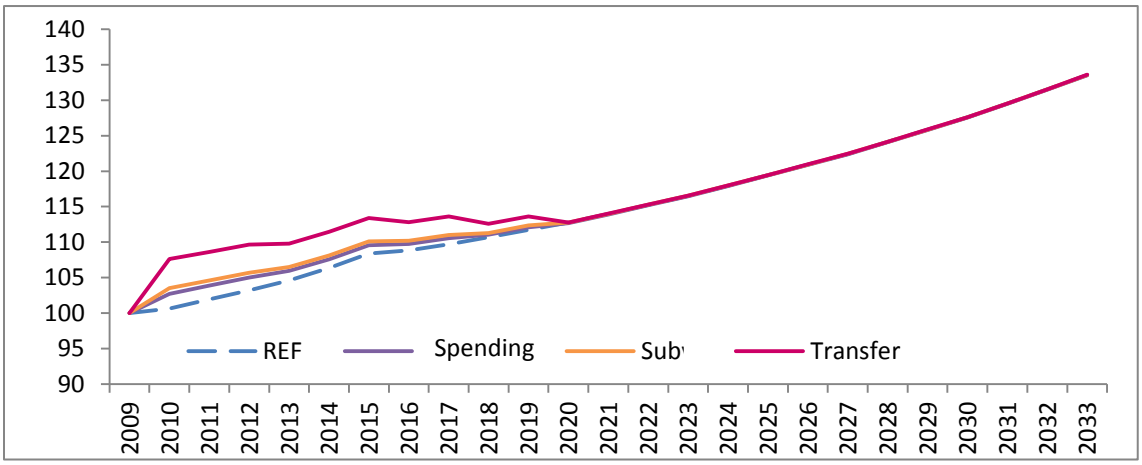


Figure 16: Real per capita consumption index (2009 = 100)



A reduction in school fees is shown to improve the primary school entry rate, but has less of an impact on the dropout rate, the transition rate and the graduation rate. So, subsidizing school fees causes more six-year-old children to join the education system. Since public spending on education is constant in this scenario, the higher number of students has the effect of reducing the quantity of education services received by each student (Table 13). The education quality index has the largest impact on pass rates, so the dropout rate is higher in this scenario (Table 17). The primary school net enrolment ratio is thus somewhat lower than in the spending scenario, and this improvement is essentially due to an increase in the number of students entering primary school (Table 18). Moreover, the transition rate between the two levels of education is mainly affected by the education quality index. A higher dropout rate and a lower transition rate have the effect of reducing the number of students in the second level (Table 19).

By increasing household purchasing power, transfers to households promote growth in real per capita consumption. While this is a determinant explaining educational behaviour, this factor has a smaller impact on education decisions, as reflected by a lower elasticity. The different indicators are thus essentially the same as in the reference scenario.

Figure 17: Entry rate, primary school

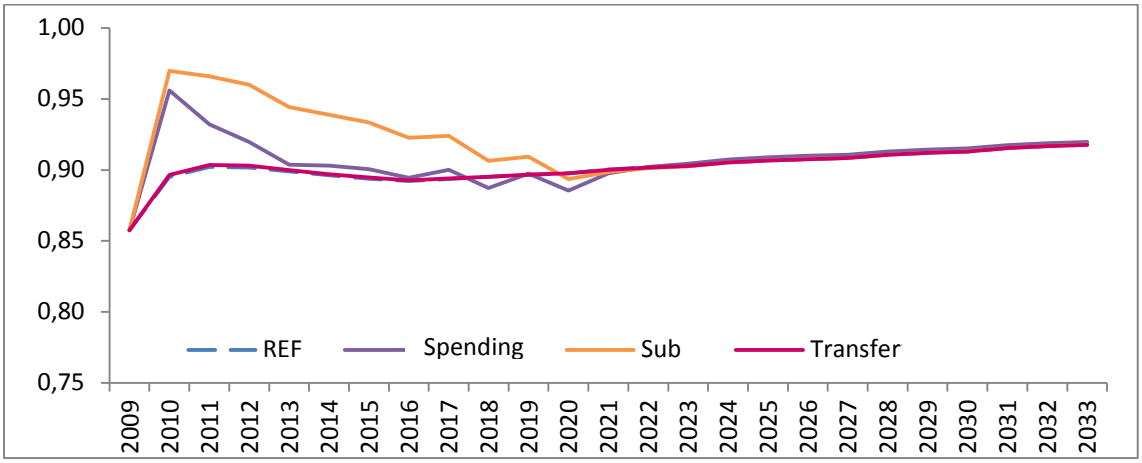


Figure 18: Dropout rate, first level of study

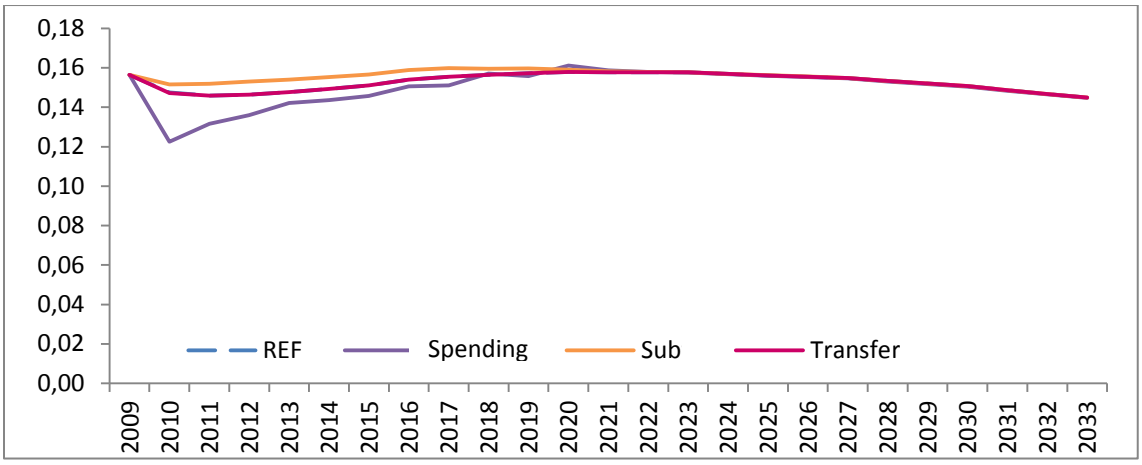


Figure 19: Primary school net enrolment ratio

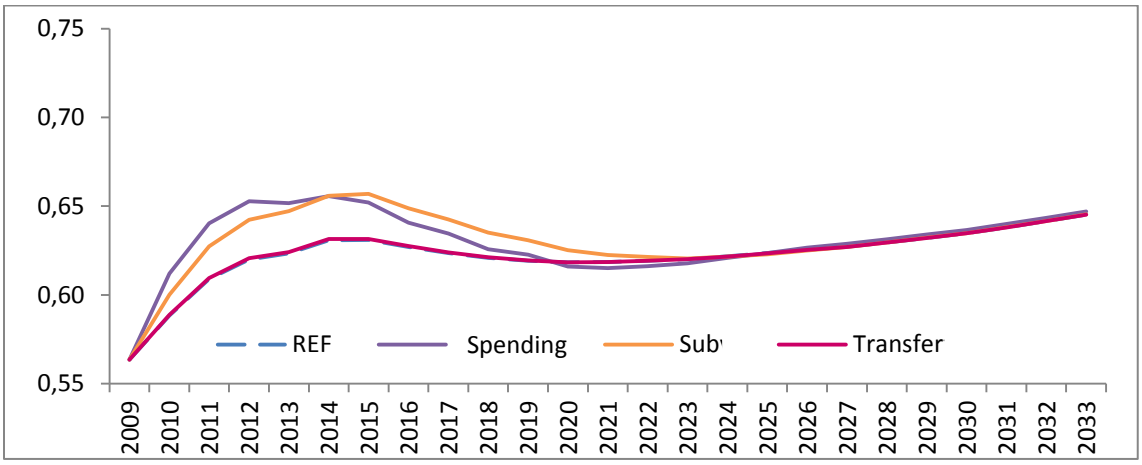
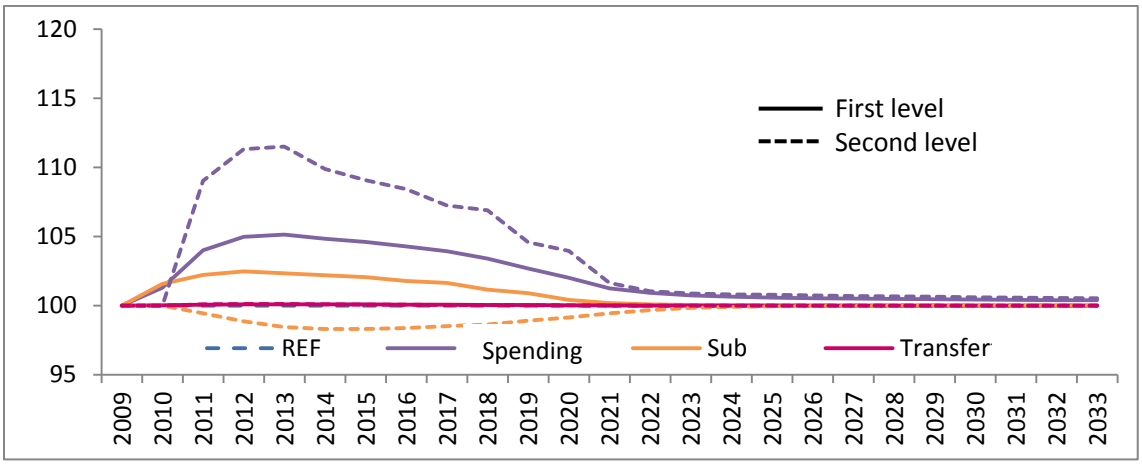


Figure 20: Number of students per cycle index (reference = 100)



6.2.2. Impact on labour market and growth

Given the impacts on educational behaviours, it is not surprising to find that the supply of skilled workers is less stimulated in the subsidy and cash transfer scenarios than in the spending scenario. In fact, a school fees subsidy increases the number of skilled workers by just 3 000, and workers would be less educated because fewer of them pursue studies beyond the first level. A cash transfer to households, for its part, has a negligible impact on the number of skilled workers (less than 400 new workers) and has little impact on their level of education. As a result, the impacts on growth are barely perceptible.

Figure 21: Supply of qualified workers index (reference = 100)

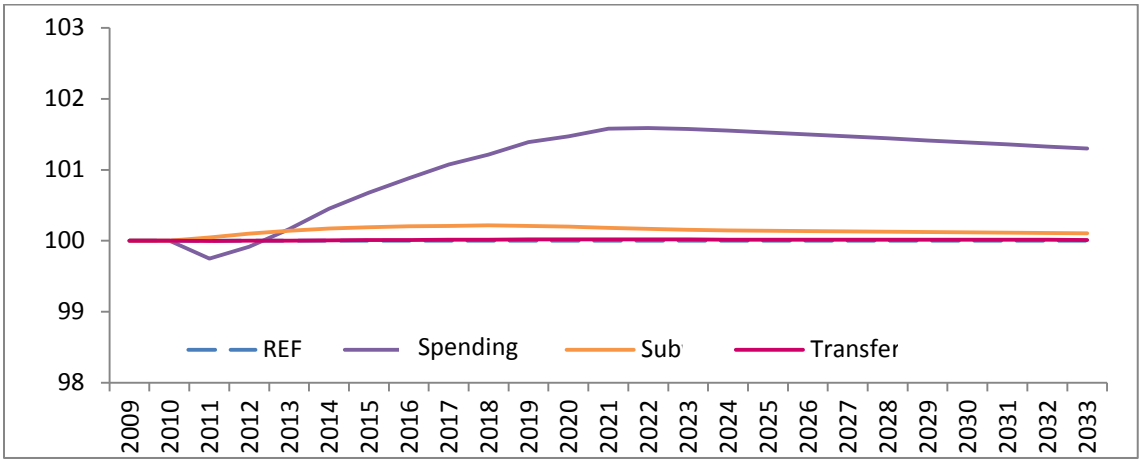


Figure 22: Number of skilled workers by education level

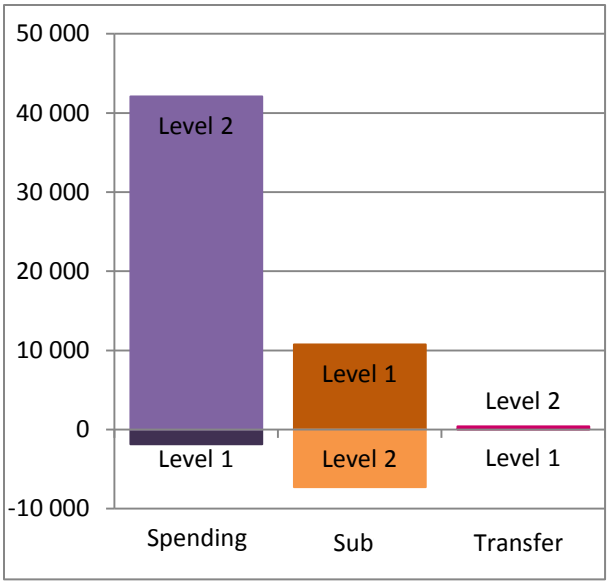
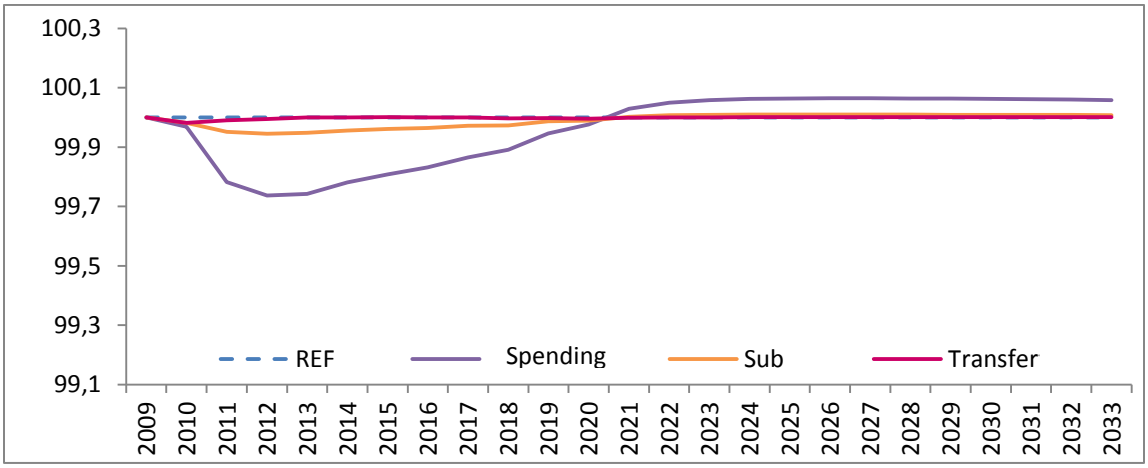
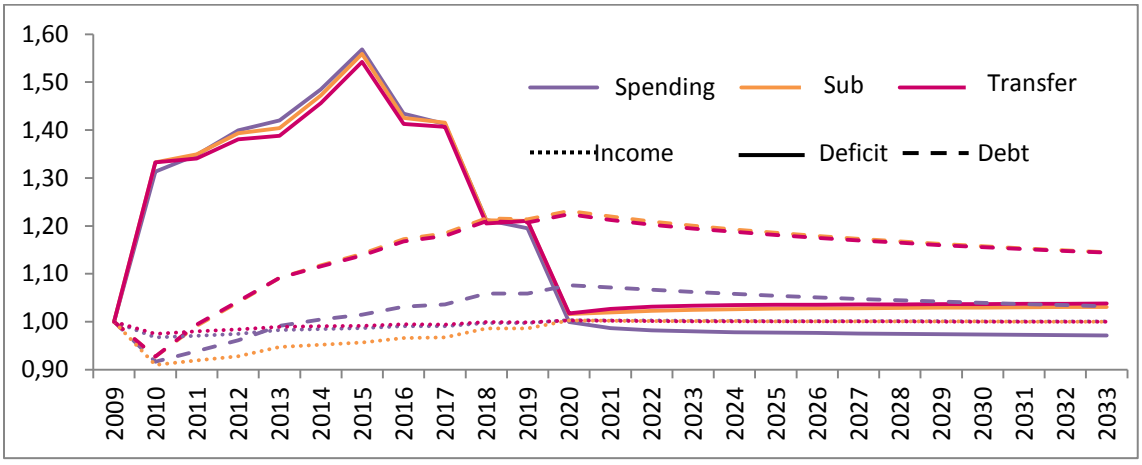


Figure 23: Real GDP index (reference = 100)



All of the scenarios have a similar impact on the deficit-to-GDP ratio; it increases during the period of increased spending and then returns to near its reference values. The deficit-to-GDP ratio is slightly higher than it would have been in the reference scenario after the period of increased spending, while the opposite is observed in the other interventions. Incidentally, the school fees subsidy and transfers to households both have greater impacts on the debt-to-GDP ratio in the long term. This result can also be explained by increased economic activity in the long term in the education spending scenario (Figure 22), which increases the denominator of the debt-to-GDP ratio. In other words, in the subsidy and cash transfer scenarios, the numerator (debt) is higher and the denominator (GDP) is lower than those in the spending scenario.

Figure 24: Evolution of fiscal ratios (reference = 1)



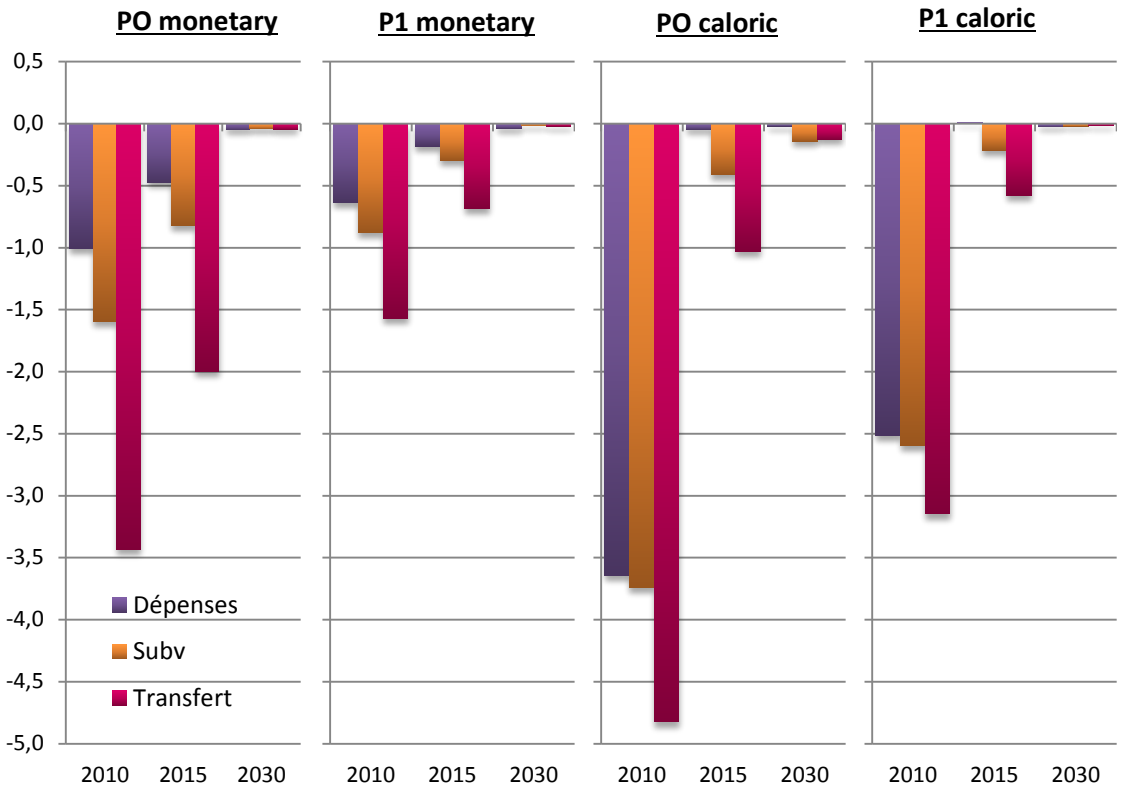
6.2.3. Impact on poverty

While the cash transfer scenario has little macroeconomic impact, its effects on poverty are incontrovertible (Figure 24). All of the poverty indicators, expressed in both monetary and caloric forms, improve markedly as of the first year: the incidence of monetary poverty in 2010 would be three percentage points lower than in the reference scenario and the incidence of caloric poverty would be nearly five percentage points lower. In other words, there would be

three fewer children in a hundred living under the poverty line and five fewer children in a hundred suffering from caloric poverty. These values decline with the level of the transfer, and are almost negligible in the long term. The poverty gap progresses similarly: there is a large reduction in the poverty gap during the period of cash transfers with a gradual return to the reference values in the long run.

All of these results can be explained by higher income among households with children, which clearly increases their purchasing power. Given that poor households have on average more children, this type of policy would tend to benefit them more than the other two policies. The other intervention types have a smaller and more indirect impact on household consumption, as shown in Figure 15. Compared to the spending scenario, the school fees subsidy opens up a share of the household consumption budget for the purchase of other products, which explains why the results concerning poverty are better. However, cash transfers still have the greatest impact on poverty.

Figure 25: Variation (in percentage points) of poverty indicators with respect to reference scenario



7. Conclusion

Despite high growth rates in recent years, Burkina Faso remains a poor country. The government recognizes the need for a stronger commitment to achieve the millennium development goals, particularly to reduce poverty.

At the same time, the Burkinabe budget deficit has risen in recent years, in response to the various crises which have hit the country. There are strong pressures to rapidly reduce this budget deficit, but there are active concerns about how this will be achieved.

It is in this challenging budgetary context that policymakers are struggling to find economic policies that would ensure improved living conditions for its inhabitants, most especially for its children.

We modelled three public spending policies: (i) an increase in education spending, (ii) a school fees subsidy and (iii) a cash transfer to households with children under the age of five. The amount injected into the economy is the same in each of these three cases, making it easy to compare the three scenarios. We identified the three most realistic financing mechanisms: (i) an increase in Spending (ii) an increase in the indirect tax collection rate and (iii) an extension of the time to red e the public deficit to ten years rather than five.

We used a dynam computable general equilibrium model together with a microeconomic model to evaluate the impacts of these three policies under three different financing mechanisms. Relative to the reference scenario, the results indicate that higher public education spending increases school participation and pass rates, leading to an increased supply and education level of skilled workers, all in turn leading to a lower incidence and depth of both monetary and caloric poverty.

The school fees subsidies have more differentiated impacts on education, with a larger beneficial impact on primary school entry and a smaller impact on continuation of their studies. Finally, the supply of skilled workers increases slightly, but the education level of these workers is lower than in the reference scenario. This type of intervention thus also has a positive impact on poverty, and the impacts in this case are more pronounced than in the case of public education spending.

As for the cash transfers, they have a minimal impact on educational behaviours, and thus on the supply of skilled workers, but they significantly reduce the incidence and severity of poverty.

These results are qualitatively similar regardless of the financing approach. Moreover, the financing mechanism does not appear to have a significant impact on macroeconomic and fiscal indicators in the long term, particularly in the case of public education spending. For the other intervention types, the debt-to-GDP ratio would be higher than in the reference scenario. This having been said, financing the state interventions through a reduction in subsidies or improved tax collection would have negative impacts on poverty, because these measures increase the price level.

In summary, if the objective is to achieve improved educational and economic performance, it seems as though the best approach to the intervention would be to increase public education spending. However, cash transfers to families would be more suitable if reducing child poverty is instead prioritized. Regardless of the intervention(s) ultimately adopted, the most suitable

financing mechanism appears to be a temporary increase in the public deficit since this generates smaller negative impacts on the quality of life of the most destitute.

Annex A: Equations, sets, variables and parameters

A1. Equations

A1.1 Production

1. $VA_{j,t} = v_j XST_{j,t}$
2. $CI_{j,t} = io_j XST_{j,t}$
3. $VA_{j,t} = \left(\frac{KD_t^{INF}}{KD^{INFO} / pop_t} \right)^{\sigma_j^{INF}} B_j^{VA} \left[\beta_j^{VA} LDC_{j,t}^{-\rho_j^{VA}} + \left(1 - \beta_j^{VA}\right) KD_{j,t}^{-\rho_j^{VA}} \right]^{-\frac{1}{\rho_j^{VA}}}$
4. $LDC_{j,t} = \left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}} \frac{RTI_{j,t}}{WC_{j,t}} \right]^{\sigma_j^{VA}} KD_{j,t}$
5. $LDC_{j,t} = B_j^{LD} \left[\sum_l \beta_{l,j}^{LD} \; LD_{l,j,t}^{-\rho_j^{LD}} \right]^{-\frac{1}{\rho_j^{LD}}}$
6. $LD_{l,j,t} = \left[\frac{\beta_{l,j}^{LD} \; WC_{j,t}}{WTI_{l,j,t}} \right]^{\sigma_j^{LD}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_{j,t}$
7. $DI_{i,j,t} = aij_{i,j} CI_{j,t}$

A1.2 Income and savings

A1.2.1 Households

8. $YH_t = YHL_t + YHK_t + YHTR_t + INT_t^{DOM}$
9. $YHL_t = \sum_{l,j} \left(W_{l,t} \; LD_{l,j,t} \right)$
10. $YHK_t = \lambda_{hh'}^{RK} \left(\sum_j R_{j,t} KD_{j,t} \right)$
11. $YHTR_t = \sum_{ag} TR_{hh',ag,t}$
12. $YDH_t = YH_t - TDH_t - TR_{gvt','hh',t}$
13. $CTH_t = YDH_t - SH_t - \sum_{agng} TR_{agng,'hh',t}$
14. $SH_t = PIXCON_t^{\eta} sh0_t + sh1 YDH_t$

A1.2.2 Firms

15. $YF_t = YFK_t + YFTR_t$
16. $YFK_t = \lambda_{'firm'}^{RK} \left(\sum_j R_{j,t} KD_{j,t} \right)$
17. $YFTR_t = \sum_{ag} TR_{'firm',ag,t}$

18. $YDF_t = YF_t - TDF_t$

19. $SF_t = YDF_t - \sum_{ag} TR_{ag,'firm',t}$

A1.2.3 Government

20. $YG_t = YGK_t + TDHT_t + TDFT_t + TPRODN_t + TPRCTS_t + YGTR_t$

21. $YGK_t = \lambda^{RK}_{gvt'} \left(\sum_j R_{j,t} KD_{j,t} \right)$

22. $TPRODN_t = TIWT_t + TIKT_t + TIPT_t$

23. $TIWT_t = \sum_{l,j} TIW_{l,j,t}$

24. $TIKT_t = \sum_j TIK_{j,t}$

25. $TIPT_t = \sum_j TIP_{j,t}$

26. $SIPT_t = \sum_j SIP_{j,t}$

27. $TPRCTS_t = TICT_t + TIMT_t + TIXT_t$

28. $TICT_t = \sum_i TIC_{i,t}$

29. $TIMT_t = \sum_m TIM_{m,t}$

30. $TIXT_t = \sum_x TIX_{x,t}$

31. $YGTR_t = \sum_{agng} TR_{gvt,agng,t}$

32. $TDH_t = PIXCON_t^{\eta}\ ttdh0_t + \left[ttdh1_t + NTD_t \right] YHL_t$

33. $TDF_t = PIXCON_t^{\eta}\ ttdf0_t + \left[ttdf1_t + NTD_t \right] YFK_t$

34. $TIW_{l,j,t} = ttiw_{l,j,t} W_{l,t} LD_{l,j,t}$

35. $TIK_{j,t} = ttik_{j,t} R_{j,t} KD_{j,t}$

36. $TIP_{j,t} = ttip_{j,t} PP_{j,t} XST_{j,t}$

37. $SIP_{j,t} = ajsub_t\ tsip_{j,t} PP_{j,t} XST_{j,t}$

38. $TIC_{nm,t} = \left[ajti_t\ ttic_{nm,t} + NTI_t \right] \cdot \left(PL_{nm,t} + \sum_i tmrg_{i,nm} PC_{i,t} \right) DD_{nm,t}$

39. $TIC_{m,t} = \left[ajti_t\ ttic_{m,t} + NTI_t \right] \cdot \left\{ \begin{array}{l} \left(PL_{m,t} + \sum_i tmrg_{i,m} PC_{i,t} \right) DD_{m,t} + \\ \left(1 + ttim_{m,t} PWM_{m,t}\ e_t + \sum_i tmrg_{i,m} PC_{i,t} \right) IM_{m,t} \end{array} \right\}$

40. $TIM_{m,t} = ttim_{m,t} PWM_{m,t}\ e_t\ IM_{m,t}$

41. $TIX_{x,t} = ttix_{x,t}\ PE_{x,t}\ EXD_{x,t}$

42. $SG_t = YG_t - \sum_{agng} TR_{agng,gvt,t} - G_t - INT_t^{DOM} - INT_t^{ROW} - IT_t^{PUB}$

43. $DEBT_t^{ROW} = DEBT_t^{TOT} - DEBT_t^{DOM}$
44. $INT_t^{ROW} = ir_t^{ROW} DEBT_t^{ROW}$
45. $INT_t^{DOM} = ir_t^{DOM} DEBT_t^{DOM}$
46. $R_t^{TD} = \left[TDF_t + TDH_t\right] / GDP_t^{MP}$
47. $R_t^{TI} = TICT_t / GDP_t^{MP}$
48. $R_t^{SG} = SG_t / GDP_t^{MP}$

A1.2.4 Rest of the world

49. $YROW_t = e_t \sum_m PWM_{m,t} IM_{m,t} + \lambda_{row,k}^{RK} \left(\sum_j R_{j,t} KD_{j,t} \right) + \sum_{agd} TR_{row,agd,t} + INT_t^{ROW}$
50. $SROW_t = YROW_t - \sum_x PE_{x,t}^{FOB} EX_{x,t} - \sum_{agd} TR_{agd,row,t}$
51. $SROW_t = -CAB_t$

A1.2.5 Transfers

52. $TR_{agng,'hh',t} = \lambda_{agng,'hh'}^{TR} YDH_t$
53. $TR_{gvt,hh,t} = PIXCON_t^{\eta}\ tr0_t + tr1_t\ YH_t$
54. $TR_{ag,firm,t} = \lambda_{ag,firm}^{TR} YDF_t$
55. $TR_{agng,gvt,t} = PIXCON_t^{\eta}\ TR_{agng,gvt}^{0}\ pop_t$
56. $TR_{agd,row,t} = valtr_{agd,'rdm',t,ref}$

A1.3 Demand

57. $$\frac{C_{ia,t} PC_{ia,t}}{CTH_t} = \alpha_{ia}^{C} + \sum_{iaj} \gamma_{ia,iaj}^{C} \ln PC_{iaj,t} + \gamma_{ia,CNALIM}^{C} \ln PCNA_t + \beta_{ia}^{C} \ln\left[\frac{CTH_t}{pop_t\ PIXSTO_t}\right]$$
58. $$\frac{CNA_t PCNA_t}{CTH_t} = \alpha_{CNALIM}^{C} + \sum_{iaj} \gamma_{CNALIM,iaj}^{C} \ln PC_{iaj,t} + \gamma_{CNALIM,CNALIM}^{C} \ln PCNA_t + \beta_{CNALIM}^{C} \ln\left[\frac{CTH_t}{pop_t\ PIXSTO_t}\right]$$
59. $PC_{ina,t} C_{ina,t} = \gamma_{ina}^{CNA}\ CNA_t\ \ PCNA_t$
60. $GFCF_t = IT_t - \sum_i PC_{i,t}\ VSTK_{i,t}$
61. $PC_{i,t} INV_{i,t}^{PRI} = \gamma_i^{INVPRI} IT_t^{PRI}$
62. $PC_{i,t} INV_{i,t}^{PUB} = \gamma_i^{INVPUB} IT_t^{PUB}$
63. $INV_{i,t} = INV_{i,t}^{PRI} + INV_{i,t}^{PUB}$
64. $\sum_i PC_{i,t} CG_{i,t} = G_t$
65. $DIT_{i,t} = \sum_j DI_{i,j,t}$

66. $MRGN_{i,t} = \sum_{ij} tmrg_{i,ij} D_{ij,t} + \sum_{m} tmrg_{i,m} \quad IM_{m,t}$

A1.4 Supply of products from domestic producers and international trade

67. $XST_{j,t} = B_j^{XT} \left[\sum_i \beta_{j,i}^{XT} XS_{j,i,t}^{\rho_j^{XT}} \right]^{\frac{1}{\rho_j^{XT}}}$

68. $XS_{j,i,t} = \frac{XST_{j,t}}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}} \left[\frac{P_{j,i,t}}{\beta_{j,i}^{XT} PT_{j,t}} \right]^{\sigma_j^{XT}}$

69. $XS_{j,x,t} = B_{j,x}^{X} \left[\beta_{j,x}^{X} EX_{j,x,t}^{\rho_{j,x}^{X}} + \left(1-\beta_{j,x}^{X}\right) DS_{j,x,t}^{\rho_{j,x}^{X}} \right]^{\frac{1}{\rho_{j,x}^{X}}}$

70. $XS_{j,nx,t} = DS_{j,nx,t}$

71. $EX_{j,x,t} = \left[\frac{1-\beta_{j,x}^{X}}{\beta_{j,x}^{X}} \frac{PE_{x,t}}{PL_{x,t}} \right]^{\sigma_{j,x}^{X}} DS_{j,x,t}$

72. $EXD_{x,t} = EXD_{x,t}^{O} \left(\frac{e_t \ PWX_{x,t}}{PE_{x,t}^{FOB}} \right)^{\sigma_x^{XD}}$

73. $Q_{m,t} = B_m^{M} \left[\beta_m^{M} IM_{m,t}^{-\rho_m^{M}} + \left(1-\beta_m^{M}\right) DD_{m,t}^{-\rho_m^{M}} \right]^{\frac{-1}{\rho_m^{M}}}$

74. $Q_{nm,t} = DD_{nm,t}$

75. $IM_{m,t} = \left[\frac{\beta_m^{M}}{1-\beta_m^{M}} \frac{PD_{m,t}}{PM_{m,t}} \right]^{\sigma_m^{M}} DD_{m,t}$

A1.5 Prices

A1.5.1 Production

76. $PP_{j,t} XST_{j,t} = PVA_{j,t} VA_{j,t} + PCI_{j,t} CI_{j,t}$

77. $PT_{j,t} = \left(1 + ttip_{j,t} + ajsub_t \ tsip_{j,t}\right) PP_{j,t}$

78. $PCI_{j,t} CI_{j,t} = \sum_i PC_{i,t} DI_{i,j,t}$

79. $PVA_{j,t} VA_{j,t} = WC_{j,t} LDC_{j,t} + RTI_{j,t} KD_{j,t}$

80. $WTI_{l,j,t} = W_{l,t} \left(1 + ttiw_{l,j,t}\right)$

81. $RTI_{j,t} = R_{j,t} \left(1 + ttik_{j,t}\right)$

A1.5.2 International trade

82. $PT_{j,t} XST_{j,t} = \sum_i P_{j,i,t} \ XS_{j,i,t}$

83. $P_{j,x,t} XS_{j,x,t} = PE_{x,t} EX_{j,x,t} + PL_{x,t} DS_{j,x,t}$

84. $P_{nx,t} = PL_{nx,t}$

85. $PE_{x,t} \left(1 + ttix_{x,t}\right) = PE_{x,t}^{FOB}$

86. $PD_{i,t} = \left(1 + ajti_t\ ttic_{i,t} + NTI_t\right)\left(\sum_{ij} tmrg_{ij,i} PC_{ij,t} + PL_{i,t}\right)$

87. $PM_{m,t} = \left(1 + ajti_t\ ttic_{m,t} + NTI_t\right)\left(1 + \sum_i tmrg_{i,m}\right)\left(1 + ttim_{m,t}\right) e_t\ PWM_{m,t}$

88. $PC_{m,t} Q_{m,t} = PM_{m,t} IM_{m,t} + PD_{m,t} D_{m,t}$

89. $PC_{nm,t} = PD_{nm,t}$

90. $PCNA_t = \frac{1}{A^{CNA}} \prod_{ina} \left[\frac{PC_{ina,t}}{\gamma_{ina}^{CNA}}\right]^{\gamma_{ina}^{CNA}}$

91. $PIXGDP_t = PIXGDP_{t-1} \sqrt{\frac{\sum_j PVA_{j,t} VAO_j}{\sum_j PVA_j^0\ VA_j^O} \frac{\sum_j PVA_{j,t} VA_{j,t}}{\sum_j PVA_j^O\ VA_{j,t}}}$

92. $PIXCON_t = \frac{\sum_i PC_{i,t} CO_i}{\sum_i PCO_i\ CO_i}$

93. $PIXINV_t^{PRI} = \prod_i \left(\frac{PC_{i,t}}{PCO_i}\right)^{\gamma_i^{INVPRI}}$

94. $PIXINV_t^{PUB} = \prod_i \left(\frac{PC_{i,t}}{PCO_i}\right)^{\gamma_i^{INVPUB}}$

95. $PIXGVT_t = \prod_i \left(\frac{PC_{i,t}}{PCO_i}\right)^{\gamma_i^{GVT}}$

96. $\ln PIXSTO_t = \sum_{ia} \left\{\frac{PC_{ia,t} C_{ia,t}}{CTH_t} \ln PC_{ia,t}\right\} + \frac{PCNA_t\ CNA_t}{CTH_t} \ln PCNA_t$

A1.6 Equilibrium

97. $Q_{i,t} = C_{i,t} + CG_{i,t} + INV_{i,t} + DIT_{i,t} + MRGN_{i,t} + VSTK_{i,t}$

98. $\sum_j LD_{l,j,t} = LS_{l,t}$

99. $\sum_j KD_{k,j,t} = KS_{k,t}$

100. $IT_t = SH_t + SF_t + SG_t + SROW_t + IT_t^{PUB}$

101. $IT_t^{PRI} = IT_t - IT_t^{PUB} - \sum_i PC_{i,t}\ VSTK_{i,t}$

102. $\sum_j DS_{j,i,t} = DD_{i,t}$

103. $\sum_j EX_{j,x,t} = EXD_{x,t}$

A1.7 Gross domestic product

104. $GDP_t^{BP} = \sum_j PVA_{j,t} VA_{j,t} + TIPT_t + SIPT_t$

105. $GDP_t^{MP} = GDP_t^{BP} + TPRCTS_t$

106. $GDP_t^{IB} = \sum_{l,j} W_{l,t} LD_{l,j,t} + \sum_j R_{j,t} KD_{j,t} + TPRODN_t + TPRCTS_t$

107. $GDP_t^{FD} = \sum_i PC_{i,t}\left[C_{i,t} + CG_{i,t} + INV_{i,t} + VSTK_{i,t}\right] + \sum_x PE_{x,t}^{FOB} EX_{x,t} - \sum_m e_t * PWM_{m,t} IM_{m,t}$

A1.8 Dynamic equations

108. $IT_i^{PUB} = PK_t^{PUB}\left[\sum_{pub} IND_{pub,t} + IND_t^{INF}\right]$

109. $IT_i^{PRI} = PK_t^{PRI} \sum_{bus} IND_{bus,t}$

110. $PK_t^{PRI} = 1/A^{K\_PRI} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPRI}}\right]^{\gamma_i^{INVPRI}}$

111. $PK_t^{PUB} = 1/A^{K\_PUB} \prod_i \left[\frac{PC_{i,t}}{\gamma_i^{INVPUB}}\right]^{\gamma_i^{INVPUB}}$

112. $IND_{bus,t} = \phi_{bus}\left[\frac{R_{bus,t}}{U_{bus,t}}\right]^{\sigma_{k,pri}^{INV}} KD_{bus,t}$

113. $U_{bus,t} = PK_t^{PRI}\left(\delta_{bus} + IR_t\right)$

114. $U_{pub,t} = PK_t^{PUB}\left(\delta_{bpub} + IR_t\right)$

A1.9 Millennium Development Goals

115. $EDQ_{edjt} = \frac{XST_{edj,t}}{NST_{edj,t}}$

116. $CPC_t = \frac{\sum_i PCO_i C_{i,t}}{POP_t^H}$

117. $\frac{SHR_{edj,REUSSI\_GRD,t}}{SHR_{edj,GRD,t}} = \frac{SHR_{edj,REUSSI\_GRD}^0}{SHR_{edj,GRD}^0}$

118. $SHR_{edj,REUSSI\_CTN,t} = SHR_{edj,REUSSI,t} - SHR_{edj,REUSSI\_GRD,t}$

119. $SHR_{edj,GRD\_FIN,t} = 1 - SHR_{edj,GRD\_CSUP,t}$

120. $SHR_{edj,REDOUBLE,t} = \frac{SHR_{edj,REDOUBLE}^0}{\left(1 - SHR_{edj,REUSSI}^0\right)}\left(1 - SHR_{edj,REUSSI,t}\right)$

121. $SHR_{edj,ABANDON,t} = 1 - SHR_{edj,REUSSI,t} - SHR_{edj,REDOUBLE,t}$

122. $SHR_{edj,\lg,t} = ext_{edj,\lg} + \frac{\alpha_{edj,\lg}^{ED}}{1 + \exp\left\{\gamma_{edj,\lg}^{ED} + \beta_{edj,\lg}^{ED}\left(SHR_{edj,\lg,t}^I - SHR_{edj,\lg}^0\right)\right\}}$

123. $$SHR^{I}_{edj,\lg,t} = SHR^{0}_{edj,\lg}\left\{\begin{array}{l}\left[\frac{EDQ_{edj,t}}{EDQ^{0}_{edj}}\right]^{\sigma^{EDQ}_{\lg}}\left[\frac{KD_{edj,t}}{KD^{0}_{edj}}\right]^{\sigma^{KD}_{\lg}}\left[\frac{KD^{INF}_{t}}{KD^{INFO}}\right]^{\sigma^{KD}_{\lg}}\left[\frac{W_{'LSK',t}\,/\,W_{'LUSK',t}}{W^{0}_{'LSK'}\,/\,W^{0}_{'LUSK'}}\right]^{\sigma^{WP}_{\lg}} \\ \left[\frac{MDGVAL_{'MDG4',t}}{MDGVAL^{0}_{'MDG4'}}\right]^{\sigma^{MDG4}_{\lg}}\left[\frac{PT_{edj,t}\,/\,PIXCON_{t}}{PT^{0}_{edj}\,/\,PIXCON^{0}}\right]^{\sigma^{PT}_{\lg}}\left[\frac{CPC_{t}}{CPC^{0}}\right]^{\sigma^{CH}_{\lg}}\end{array}\right\}$$

124. $$NST_{edj,t} = NST^{O}_{edj,t} + NST^{N}_{edj,t}$$

125. $$NST^{N}_{EDUC1,t} = SHR_{EDUC1,ENTREE,t}\,POP^{H6}_{t}$$

126. $$MGDVAL_{mdgn2,t} = ext^{MDG}_{mdgn2} + \frac{\alpha^{MDG}_{mdgn2}}{1+\exp\left\{\gamma^{MDG}_{mdgn2} + \beta^{MDG}_{mdgn2}\left(MDGVAL^{I}_{mdgn2,t} - MDGVAL^{0}_{mdgn2}\right)\right\}}$$

127. $$MDGVAL^{I}_{mdgn2,t} = MDGVAL^{0}_{mdgn2}\left\{\begin{array}{l}\left[\frac{CG_{SANTE,t}\,/\,POP^{H}_{t}}{CG^{0}_{SANTE}\,/\,POP^{HO}}\right]^{\sigma^{HLT}_{mdgn2}}\left[\frac{LS_{LQ,t}}{pop_{t}\;LS^{0}}\right]^{\sigma^{EDU}_{mdgn2}} \\ \left[\frac{MDGVAL_{MDG7,t}}{MDGVAL^{0}_{MDG7}}\right]^{\sigma^{WAT}_{mdgn2}}\left[\frac{CPC_{t}}{CPC^{0}}\right]^{\sigma^{CH2}_{mdgn2}}\end{array}\right\}$$

A1.10 Others

128. $$\frac{CG_{i,t}PC_{i,t}}{GDP^{MP}_{t}} = \frac{CG^{0}_{i}PC^{0}_{i}}{GDP^{MP\_0}}$$

129. $$\frac{IND_{pub,t}PK^{PUB}_{pub,t}}{GDP^{MP}_{t}} = \frac{IND^{0}_{pub}PK^{PUB\_0}_{pub}}{GDP^{MP\_0}}$$

130. $$\frac{IND^{INF}_{t}PK^{PUB}_{pub,t}}{GDP^{MP}_{t}} = \frac{IND^{INF\_0}_{pub}PK^{PUB\_0}_{pub}}{GDP^{MP\_0}}$$

131. $$\frac{CAB_{t}}{GDP^{MP}_{t}} = \frac{CAB^{0}}{GDP^{MP\_0}}$$

132. $$\frac{VSTK_{i,t}PC_{i,t}}{GDP^{MP}_{t}} = \frac{VSTK^{0}_{i}PC^{0}_{i}}{GDP^{MP\_0}}$$

133. $$\frac{DEBT^{DOM}_{t}}{GDP^{MP}_{t}} = \frac{DEBT^{DOM\_0}}{GDP^{MP\_0}}$$

A1.10 Equations defined in the loop

The variables in this subsection are fixed in the first period.

134. $$DEBT^{TOT}_{t} = DEBT^{TOT}_{t-1} - SG_{t-1}$$

135. $$KD_{j,t} = KD_{j,t-1}\left(1-\delta_{j}\right) + IND_{j,t-1}$$

136. $$KD^{INF}_{j,t} = KD^{INF}_{j,t-1}\left(1-\delta^{INF}\right) + IND^{INF}_{j,t-1}$$

137. $$NST^{O}_{edj,t} = NST_{edj,t-1}\left(SHR_{edj,REUSSI\_CTN,t-1} + SHR_{edj,REDOUBLE,t-1}\right)$$

138. $$NST^{N}_{EDUC2,t} = NST_{EDUC1,t-1} \cdot SHR_{EDUC1,REUSSI\_GRD,t-1} \cdot SHR_{EDUC1,GRD\_CSUP,t-1}$$

139. $$LS_{LNQ,t} = \left(1 - ret_{LNQ}\right)LS_{LNQ,t-1} + NST_{EDUC1,t-1} \cdot SHR_{EDUC1,DROP,t-1} + \left(1 - SHR_{EDUC1,ENTREE,t-1}\right)POP^{H6}_{t-1}$$

140. $$LS_{LQ,t} = \left(1 - ret_{LQ}\right)LS_{LQ,t-1} + NST_{EDUC1,t-1} \cdot SHR_{EDUC1,REUSSI\_GRD,t-1} \cdot SHR_{EDUC1,GRD\_FIN,t-1} + NST_{EDUC2,t-1} \cdot SHR_{EDUC2,ABANDON,t-1} + NST_{EDUC2,t-1} \cdot SHR_{EDUC2,REUSSI\_GRD,t-1} \cdot SHR_{EDUC2,GRD\_FIN,t-1}$$

141. $$MDGVAL_{MDG2,t} = \frac{\left\{\begin{array}{l} POP^{H6}_{t} \cdot SHR_{EDUC1,ENTREE,t} + POP^{H6}_{t-1} \cdot SHR_{EDUC1,ENTREE,t-1} \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) \\ + POP^{H6}_{t-2} \cdot SHR_{EDUC1,ENTREE,t-2} \cdot \left(1 - SHR_{EDUC1,ABANDON,t-1}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) \\ + POP^{H6}_{t-3} \cdot SHR_{EDUC1,ENTREE,t-3} \cdot \left(1 - SHR_{EDUC1,ABANDON,t-2}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t-1}\right) \\ \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) + POP^{H6}_{t-4} \cdot SHR_{EDUC1,ENTREE,t-4} \cdot \left(1 - SHR_{EDUC1,ABANDON,t-3}\right) \\ \cdot \left(1 - SHR_{EDUC1,ABANDON,t-2}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t-1}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) \\ + POP^{H6}_{t-5} \cdot SHR_{EDUC1,ENTREE,t-5} \cdot \left(1 - SHR_{EDUC1,ABANDON,t-4}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t-3}\right) \\ \cdot \left(1 - SHR_{EDUC1,ABANDON,t-2}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t-1}\right) \cdot \left(1 - SHR_{EDUC1,ABANDON,t}\right) \end{array}\right\}}{\left\{POP^{H6}_{t} + POP^{H6}_{t-1} + POP^{H6}_{t-2} + POP^{H6}_{t-3} + POP^{H6}_{t-4} + POP^{H6}_{t-5}\right\}}$$

A2. Sets

A2.1 Sectors and products

All sectors:

$$j, jj \in J = \left\{\begin{array}{l} crops, livestock, syl, extr, bevtob, elg water, othman, constr, trade, transport, \\ telec,\ fin, othser, educ1, educ2, health,\ publserv \end{array}\right\}$$

Public sectors: $pub \in PUB \subset J = \{educ1, educ2, health,\ publserv\}$

Education sectors: $edj \in PUB \subset J = \{educ1, educ2\}$

Private sectors:

$$bus \in BUS \subset J = \left\{\begin{array}{l} crops, livestock, syl, extr, bevtob, elg water, \\ othman, constr, trade, transport, telec, \\ fin, othser \end{array}\right\}; BUS \cap PUB = \emptyset$$

All products plus an artificial one for non-food products:

$$itot, itotj \in ITOT = \left\{\begin{array}{l} maize, rice,\ fruveg, oils, condsalt, meats, bevtob, syl, extr \\ cot on, elg water,\ petrol, othman, constr, trade, transport, telec,\ fin, \\ othser, educ1, educ2, health,\ publserv, cna lim \end{array}\right\}$$

All products:

$$i, ij \in ITOT = \begin{Bmatrix} maize, rice, fruveg, oils, condsalt, meats, bevtob, syl, extr \\ \cot on, e\lg water, petrol, othman, constr, trade, transport, telec, fin, \\ othser, educ1, educ2, health, publserv, cna\lim \end{Bmatrix}$$

Products entering the household consumption function:

$$icm, icmj \in ITOT = \{maize, rice, milsorg, fruveg, oil, condsalt, meats, bevtob, cna\lim\}$$

Food products:

$$ia, iaj \in I = \{maize, rice, milsorg, fruveg, oils, condsalt, meats, bevtob\}$$

Non-food products:

$$ina, inaj \in I = \begin{Bmatrix} syl, extr, \cot on, e\lg water, petrol, othman, constr, trade, transport, telec, fin, \\ othser, educ1, educ2, health, publserv \end{Bmatrix}$$

Imported products:

$$m \in M \subset I = \begin{Bmatrix} maize, rice, milsorg, fruveg, oils, condsalt, meats, bevtob, syl, extr \\ \cot on, e\lg water, petrol, othman, constr, transport, telec, fin, othser \end{Bmatrix}$$

Non-imported products:

$$nm \in NM \subset I = \{trade, educ1, educ2, health, publserv\}; NM \cap M = \emptyset$$

Exported products: $x \in X \subset I = \begin{Bmatrix} milsorg, fruveg, oils, condsalt, meats, bevtob, extr \\ \cot on, othman, transport, telec, fin, othser, publserv \end{Bmatrix}$

Non-exported products:

$$nx \in NX \subset I = \begin{Bmatrix} maize, rice, syl, e\lg water, petrol, constr, trade, educ1, educ2 \\ health \end{Bmatrix}; NX \cap X = \emptyset$$

Education: $edi \in NM \subset I = \{educ1, educ2\}$

All products other than education:

$$nedi \subset I = \begin{Bmatrix} maize, rice, milsorg, fruveg, oils, condsalt, meats, bevtob, syl, extr \\ \cot on, e\lg water, petrol, othman, constr, trade, transport, telec, fin, \\ othser, health, publserv \end{Bmatrix}$$

A2.2 Production factors

Categories of workers: $l \in L = \{Lq, Lnq\}$

A2.3 Agents

All agents: $ag, agj \in AG = H \cup F \cup \{GVT, ROW\} = \{HH, firm, GVT, RDM\}$

Non-governmental agents: $agng \in AGNG \subset AG = H \cup F \cup \{ROW\} = \{HH, firm, RDM\}$

Domestic agents: $agd \in AGD \subset AG = H \cup F \cup \{GVT\} = \{HH,\ firm, gvt\}$

A2.4 Students' behaviours

Behaviour of students:

$$sb, sbj \in SB = \{entry, repeat, dropout, pass\_ctn, pass\_grad, grad\_higher\}$$

Behaviour of students characterized by a logistic function:

$$\lg, \lg j \in SB = \{entry, pass, grd\_nextlvl\}$$

A2.5 MDG

Millennium development goal indicators: $mdg, mdgj \in MDG = \{mdg2, mdg4, mdg5, mdg7\}$

Millennium development goals (logistic function): $mdgn2, mdgn2\, j \in MDG = \{mdg4, mdg5\}$

A2.6 Periods

Periods: $t \in T = \{2009 - 2033\}$

A3. Variables

A3.1 Variables in volumes

$C_{i,t}$:	Household consumption of product *i*
$CG_{i,t}$:	Public consumption of product *i*
$CI_{j,t}$:	Total intermediate consumption of sector *j*
CNA_t :	Household consumption of non-food products (aggregate)
$DD_{i,t}$:	Total domestic demand for product *i*
$DI_{i,j,t}$:	Intermediate consumption of product *i* by sector *j*
$DIT_{i,t}$:	Total intermediate demand for product *i*
$DS_{j,i}$:	Internal supply of product *i* by sector *j*
$EX_{j,x,t}$:	Quantity of product *x* exported by sector *j*
$EXD_{x,t}$:	World demand for exported product *x*
$EXD^0_{x,t}$:	Initial world demand for exported product *x*
$IM_{m,t}$:	Quantity of product *m* imported
$IND_{j,t}$:	Volume of new capital invested in sector *j*
IND^{INF}_t :	Volume of new capital invested in infrastructure
$INV_{i,t}$:	Final demand for product *i* for investment (GFCF)
$INV^{PRI}_{i,t}$:	Final demand for product *i* for investment (private)
$INV^{PUB}_{i,t}$:	Final demand for product *i* for investment (public)
$KD_{j,t}$:	Demand for capital by sector *j*
KD^{INF}_t :	Infrastructure stock
KS_t :	Total supply of capital
$LD_{l,j,t}$:	Sector *j* demand for worker type *l*

$LDC_{j,t}$: Sector *j* aggregate labour demand

$LS_{l,t}$: Total supply of type *l* workers

$MRGN_{i,t}$: Demand for product *i* (margins)

$NST_{edj,t}$: Total number of students in level *edj*

$NST^{N}_{edj,t}$: Number of new students in level *edj*

$NST^{O}_{edj,t}$: Number of previous students in level *edj*

POP^{H}_{t} : Population

POP^{H6}_{t} : Population of age to enter education system

$Q_{i,t}$: Quantity demanded of product *i*

$VA_{j,t}$: Value added of sector *j*

$VSTK_{i,t}$: Changes in stock of product *i*

$XS_{j,i,t}$: Production of product *i* by sector *j*

$XST_{j,t}$: Aggregate production of sector *j*

A3.2 Price variables

e_t : Nominal exchange rate

IR_t : Interest rate

$P_{j,i,t}$: Baseline production price of product *i* in sector *j*

$PC_{i,t}$: Consumer prices of product *i* (including taxes and margins)

$PCI_{j,t}$: Price index of intermediate consumption in sector *j*

$PCNA_t$: Price index of non-food products

$PD_{i,t}$: Price of product *i* sold on domestic market (including taxes and margins)

$PE_{x,t}$: Price received for export of product *x* (excluding export taxes)

$PE^{FOB}_{x,t}$: FOB price of exported product *x* (in local currency)

$PIXCON_t$: Price index of household consumption

$PIXGDP_t$: GDP deflator

$PIXGVT_t$: Price index of public consumption

$PIXINV^{PRI}_{t}$: Price index of private investment

$PIXINV^{PUB}_{t}$: Price index of public investment

$PIXSTO_t$: Stone price index

PK^{PRI}_{t} : Price of new private capital

PK^{PUB}_{t} : Price of new public capital

$PL_{i,t}$: Price of product *i* sold in domestic market (excluding taxes on products)

$PM_{m,t}$: Price of imported product *m* (including taxes and tariffs)

$PP_{j,t}$: Price of total production of sector *j*

$PT_{j,t}$: Base price of total production in sector *j*

$PVA_{j,t}$: Price of value added of sector *j*

$PWM_{m,t}$: World price of imported product *m* (in currency)

$PWX_{x,t}$: World price of exported product *x* (in currency)

$R_{j,t}$: Capital remuneration rate in sector *j*

$RTI_{j,t}$: Capital remuneration rate in sector *j* (including taxes)

$U_{j,t}$: Cost of using capital in sector *j*

$W_{l,t}$: Remuneration rate of worker type *l*

$WC_{j,t}$: Price index of aggregate labour

$WTI_{l,j,t}$: Remuneration rate of worker type *l* (including taxes)

A3.3 Nominal variables

CAB_t : Current account balance

CPC_t : Real per capita consumption

CTH_t : Household consumption budget

$DEBT_t^{DOM}$: Domestic public debt

$DEBT_t^{ROW}$: Foreign public debt

$DEBT_t^{TOT}$: Total public debt

G_t : Current public expenditures on goods and services

GDP_t^{BP} : GDP at base prices

GDP_t^{FD} : GDP at market prices (final demand)

GDP_t^{IB} : GDP at market prices (income)

GDP_t^{MP} : GDP at market prices

$GFCF_t$: Gross fixed capital formation

INT^{DOM} : Interest on domestic public debt

INT^{ROW} : Interest on foreign public debt

IT_t : Total investment

IT_t^{PRI} : Private investment

IT_t^{PUB} : Public investment

SF_t : Firm savings

SG_t : Government savings

SH_t : Household savings

$SROW_t$: Rest of world savings

$SIP_{j,t}$: Public production subsidy in sector *j*

$SIPT_t$: Total public production subsidies

TDF_t : Taxes on firm income

TDH_t : Taxes on household income

$TIC_{i,t}$: Public receipts from indirect taxes on product *i*

$TICT_t$: Total public receipts from indirect taxes

$TIK_{j,t}$: Public receipts from taxes on capital in sector *j*

$TIKT_t$: Total public receipts from taxes on capital

$TIM_{m,t}$: Public receipts from customs tariffs on product *m*

$TIMT_t$: Total public receipts from customs tariffs

$TIP_{j,t}$: Public receipts from production taxes in sector *j*

$TIPT_t$: Total public receipts from production taxes

$TIW_{l,j,t}$: Public receipts from payroll taxes of worker type *l* in sector *j*

$TIWT_t$: Total public receipts from payroll taxes

$TIX_{x,t}$: Public receipts from export taxes on product *x*

$TIXT_t$: Total public receipts from export taxes

$TPRCTS_t$: Public receipts from taxes on products

$TPRODN_t$: Public receipts from production taxes

$TR_{ag,agj,t}$: Transfer from *agj* to agent *ag*

YDF_t : Firm disposable income

YDH_t : Household disposable income

YF_t : Firm total income

YFK_t : Firm capital income

$YFTR_t$: Firm transfer income

YG_t : Total government income

YGK_t : Government capital income

$YGTR_t$: Government transfers income

YH_t : Total household income

YHK_t : Household capital income

YHL_t : Household labour income

$YHTR_t$: Household transfer income

$YROW_t$: Rest of world income

A4. Initial rates and intercepts

$ajsub_{,t}$: Adjustment variable via subsidies

$ajti_{,t}$: Adjustment variable via indirect taxes

EDQ_{edjt} : Education quality indicator at level *edj*

$MDGVAL_{mdg,t}$: Value of MDG indicator

$MDGVAL^{I}_{mdgn2,t}$: Intermediary value of MDG indicator

NTD_t : New direct tax rate to reach IMG objectives

NTI_t : New indirect tax rate to attain the IMF objectives

R_t^{SG} : Deficit-to-GDP ratio

R_t^{TD} : Direct tax-to-GDP ratio

R_t^{TI} : Indirect tax-to-GDP ratio

$sh0_{t,}$: Initial intercept (household savings)

$sh1$: Slope (household savings)

$SHR_{edj,sb,t}$: Share of students in level *edj* with behaviour *sb*

$SHR_{edj,sb,t}^{I}$: Intermediary share of students in level *edj* with behaviour *sb*

$tr0_t$: Initial intercept (transfers from households to government)

$tr1$: Marginal transfer rate from households to government

$ttdf0_t$: Initial intercept (taxes on firm income)

$ttdf1_t$: Marginal tax rate on firms

$ttdh0_t$: Initial intercept (taxes on household income)

$ttdh1_t$: Marginal tax rate on households

$ttic_{i,t}$: Tax rate on product *i*

$ttik_{j,t}$: Tax rate on capital in sector *j*

$ttim_{m,t}$: Customs tax rate on import of product *m*

$tsip_{j,t}$: Subsidy rate to production in sector *j*

$ttip_{j,t}$: Tax rate on production in sector *j*

$ttiw_{l,j,t}$: Tax rate on payroll of workers in sector *j*

$ttix_{x,t}$: Tax rate on exports of product *x*

A5. Parameters

$aij_{i,j}$: Input-output coefficient

α_{itot}^{C} : AIDS parameter

$\alpha_{edj,\lg}^{ED}$: Parameter (education logistic function)

α_{mdg}^{MDG} : Parameter (other MDG logistic function)

A^{CNA} : Scale parameter, Cobb-Douglas non-food products

A^{K_PRI} : Scale parameter (private investment function)

A^{K_PUB} : Scale parameter (public investment function)

B_j^{LD} : Scale parameter (CES – aggregate labour)

B_m^{M} : Scale parameter (CES – composite product)

B_j^{VA} : Scale parameter (CES – value added)

$B_{j,x}^{X}$: Scale parameter (CET – world and domestic market)

B_j^{XT} : Scale parameter (CET – total output)

β_{itot}^{C} : AIDS parameter

$\beta_{edj,\lg}^{ED}$: Parameter (education logistic function)

$\beta_{l,j}^{LD}$: Distributive parameter (CES – aggregate labour)

β_m^{M} : Distributive parameter (CES – composite product)

β_{mdg}^{MDG} : Parameter (other MDG logistic function)

β_j^{VA} : Distributive parameter (CES – value added)

$\beta_{j,x}^{X}$: Distributive parameter (CET – world and domestic market)

$\beta_{j,i}^{XT}$: Distributive parameter (CET – total output)

δ_j : Capital depreciation rate in sector *j*

δ^{INF} : Infrastructure depreciation rate

η : Price elasticity of transfers and indexed parameters

$ext_{edj,\lg}$: Extreme value (education logistic function)

ext_{mdg}^{MDG} : Extreme value (other MDG logistic function)

$\gamma_{itot,itotj}^{C}$: AIDS parameter

γ_{ina}^{CNA} : Share of non-food products

$\gamma_{edj,\lg}^{ED}$: Parameter (education logistic function)

γ_i^{GVT} : Share of product *i* in current public consumption

γ_i^{INVPRI} : Share of product *i* in total private investment

γ_i^{INVPUB} : Share of product *i* in total public investment

γ_{mdg}^{MDG} : Parameter (other MDG logistic function)

io_j : Coefficient (Leontief – intermediate consumption)

ir^{DOM} : Interest rate on domestic public debt

ir^{ROW} : Interest rate on foreign public debt

λ_{ag}^{RK} : Share of capital remuneration received by agent *ag*

$\lambda_{ag,agj}^{TR}$: Distributive parameter (function for transfers between agents)

$n1$: Population growth rate in the first period

ny_{edj} : Number of years in level *edj*

ϕ_j : Scale parameter (investment allocated per sector)

pop_t : Population index

ret_l : Retirement rate for type *l* workers

ρ_j^{LD} : Elasticity parameter (CES – aggregate labour)

ρ_m^{M} : Elasticity parameter (CES –composite product)

ρ_j^{VA} : Elasticity parameter (CES – value added)

$\rho_{j,x}^{X}$: Elasticity parameter (CET – world and domestic market)

ρ_j^{XT} : Elasticity parameter (CET – total output)

$\sigma_{\lg}^{CH}$: Elasticity – per capita consumption (education intermediary function)

σ_{mdg}^{CH2} : Elasticity – per capita consumption (other MDG intermediary function)

$\sigma_{\lg}^{EDQ}$: Elasticity – education indicator (education intermediary function)

σ_{mdg}^{EDU} : Elasticity – primary participation elasticity (other MDG intermediary function)

σ_{mdg}^{HLT} : Elasticity – health indicator (other MDG intermediary function)

$\sigma_{\lg}^{KD}$: Elasticity – infrastructure (education intermediary function)

σ_{j}^{INF} : Elasticity – productivity and infrastructure

σ_{j}^{INV} : Elasticity (investment demand)

σ_{j}^{LD} : Elasticity (CES – aggregate labour)

σ_{m}^{M} : Elasticity (CES – composite product)

$\sigma_{\lg}^{MDG4}$: Elasticity – MDG4 (education intermediary function)

$\sigma_{\lg}^{PT}$: Elasticity – school fees (education intermediary function)

σ_{j}^{VA} : Elasticity (CES – value added)

σ_{mdg}^{WAT} : Elasticity – access to water index (other MDG intermediary function)

$\sigma_{\lg}^{WP}$: Elasticity – skilled/unskilled wage ratio (education intermediary function)

$\sigma_{j,x}^{X}$: Elasticity (CET – world and domestic market)

σ_{x}^{XD} : Elasticity – price of world demand for product *x*

σ_{j}^{XT} : Elasticity (CET – total output)

$tmrg_{i,ij}$: Margin rate *i* applied to product *ij*

v_{j} : Coefficient (Leontief – value added)

8. References

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