

# Government Spending on Education, Human Capital Accumulation, and Growth

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## Abstract

The positive externalities associated with human capital accumulation and the difference between social and private returns to education often provide the rationale for government intervention. In this paper, we assess the growth and welfare implications of alternative methods of financing public spending on education. We develop a multi-sector endogenous growth model with both human and physical capital accumulation to assess the implications of increasing government spending on education in a small-open economy. We consider several fiscal instruments to finance the increase in government spending: government transfers to households, output tax, capital tax and labor tax. We find a significant difference in the quantitative growth impacts of the different financing methods. The non-distortionary financing method (government transfers) provides the highest output increase through its strong effect on physical and human capital stocks. The other distortionary financing methods have lower impacts on the long-run economic growth, with labour tax being the most performing, followed by, respectively, output tax and capital tax. Our simulation results also suggest that even if the different methods of financing have a positive impact on the long-run economic growth rate, their transitional impacts do differ. For example, financing the increase in public spending through higher labour tax rates crowds-in private investment in the short run

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and has only a transitory crowding-out effect on consumption in the short and medium runs. In contrast, the use of capital tax results in a crowding out of private capital in a proportion that is not sufficient to reduce long-run growth rate of the economy.

# 1 Introduction

This paper assesses the growth and welfare implications of alternative methods of financing public spending on education. The role of human capital in improving material well-being and in spurring economic growth can be hardly overstated. As a primary source of human capital, education makes labor force more productive, improves welfare and fosters growth. The positive externalities associated with human capital accumulation and the difference between social and private returns to education often provide the rationale for government intervention. In most countries, primary and secondary education is mainly funded by the public sector, while tertiary education is often subsidized by means of scholarships and student loans. Several studies have suggested that government spending on education improves general welfare, reduces poverty and boosts growth. Fan, Hazell and Thorat (2001) Fan, Nyange and Rao (2005), Sequiera and Martins (2008), Fan, Bingxin and Somchai (2008) and Fan and Zhang (2008) are some examples among several others.

While direct benefits of public spending on education are widely agreed upon, there is no consensus on the fiscal instruments that must be used to finance these spending. The reason for this is that tax-financed increases in government spending on education not only individual's consumption-saving decisions, but also impact the decisions about how much time is devoted to accumulation of human capital. For example, tax levied on labor income may give disincentive to accumulate human capital, because such tax effectively reduces after-tax future earnings. In view of these distortions, several studies have compared methods of financing public education and their macroeconomic impacts in dynamic general equilibrium (DGE) setting.

Annabi et al. (2007), Blankeneau and Simpson (2004) Verbič et al. (2009), and Voyvoda and Yeldan (2000), and several other studies have developed models that explicitly recognize two opposing effects of education-related government intervention. In Blankeneau and Simpson (2004) the relationship between public education spending and growth is highly conditional on tax structures that governments choose. The authors consider non-distortionary taxes, consumption taxes, capital and labor income taxes. In their specification education is more likely to boost growth if it is financed with consumption taxes, while the growth effects of income and capital taxes are ambiguous.

Verbič et al. (2009) compare similar fiscal policies in a DGE model of a small open economy. In their model, households invest their time and income in human capital. Firms are more willing to invest into human capital the more skill-intensive is their production technology. Government supports human capital accumulation by means of various taxes and subsidies to firms and households. In this setting, growth is most efficiently achieved with the decrease in personal income tax, allowing households to invest into human capital themselves. Meanwhile, corporate tax credit to firms that invest into human capital is a least effective policy instrument in terms of eventual growth.

Fiscal policy alternatives are also the subject of the study by Voyvoda and Yeldan (2000). The public education system endows labor market entrants with human capital in addition to human capital received (privately) from previous generation. Meanwhile, government repays its debt, levies proportional tax either on consumption or on wage income and funds public education. Instead of increased taxation, the government may choose to allocate smaller share of its expenditures to education in order to better service its debt obligations. Such policy leads to the most detrimental welfare losses and much slower long-run growth. As a policy alternative, 5% increase in income tax invigorates long-run growth, but generation entering labor force at the time of policy implementation suffers disproportionately. Finally, with 5% increase in consumption tax the burden of taxation is more equally shared across generations and economy achieves the highest long-run growth rate.

Another study by Annabi et al. (2007) compares fiscal policies in the context of Canadian economy with ageing population. The authors analyze the short-run and long-run implications of a 1% permanent increase in public education spending. This increase in spending can be financed by three alternative fiscal policies: lump-sum tax, personal income tax and re-composition of public spending. They find that the latter policy produces best welfare outcomes. In addition, re-composition of public spending towards education results in more egalitarian gains for households with differing levels of human capital endowments. Moreover, significant crowding-out effect is identified - higher taxes reduce disposable income and lower savings under the first two policies. In each policy scenario increased public education spending triggers temporary withdrawal of labor, particularly that of high-skilled workers.

The insights derived from these studies suggest that there are diverging recommendations on the most efficient fiscal instrument to increase growth and welfare through an increase

public spending in education. While Verbič et al. (2009) propose a decrease in personal income tax, Voyoda and Yeldan (2000) and Blankenau et al. (2004) advocate an increase in consumption tax, and Annabi et al. (2007) suggest a reallocation of public spending without altering the tax structure. It follows that the optimal method of financing public education spending is still an open question. This paper contributes to this debate by further inquiring on the growth and welfare implications of alternative methods of financing increases in public spending on education in a developing country. We do so by extending previous work in a multisector dynamic general equilibrium model of an open economy with human capital accumulation. In our model, human capital increases labor efficiency and its accumulation over time is affected by actions taken by households and government spending on education. [Continue with the summary of the key feature of the model and the extensions that we consider (in contrast to other studies) ...]

The model is calibrated to the economy of Benin, which a small developing country in West Africa that . . . .

The rest of paper is organized as follows. The next section provides a quick overview of the education system in Benin and of its economy, and section three presents the main characteristics of the model. We discuss the data and the model calibration in the fourth section analyzes the results, and we conclude in the last section.

## 2 The Education System in Benin

Over the past two decades, a wide range of concerted steps both at the national and international levels have been taken to improve the performance of the education sector in Benin. Quantitative education data on Benin over this time span and especially starting in 2000 shows considerable progress at all levels of the education system. In particular, access to primary education in Benin is today more or less universal. World Bank data show a primary gross enrollment rate of 125.85% in 2010 compared to 61% in 1991, including a threefold increase in the primary school enrollment rate of girls since the early 1990s. At the same time, more children are completing the full cycle of primary school, with World Bank data indicating a gross primary completion rate of 63% in 2009 compared to 22% in 1991. As of 2010, only 6% of Beninese children of primary school age are out of school. To put this figure

into perspective, 39% of children are out of school in Burkina Faso. In Nigeria and Ghana these figures are 38% and 23% respectively.

However, the education system in Benin still faces a number of significant challenges. Secondary and tertiary enrollment rate remains below other low-income countries as does adult literacy which stood at 41.6% in 2009. The quality of education is relatively poor partly due to the persistence of high student-teacher ratios, especially at the primary school level.

As a result, the limited supply of skilled labor poses a significant constraint to large firms operating in Benin. As cited by a World Bank (2009a) report, “expanding enrollment and quality of post-primary education is critical if Benin is to scale up its small scale processing, manufacturing and service sectors, and improve productivity.” In addition, despite notable improvements in decreasing dropout rates, the issue still remains a concern in the reform of Benin’s education sector. One important reason for low retention rates is the poor perception of schools by families as well as opportunity costs relates to child labor (World Bank, 2009b).

Addressing these issues has largely involved the development of IMF-supported poverty reduction strategy papers as well as the investment of additional resources by both international donors and the government of Benin. That education is an important developmental priority for Benin is evidenced by the volume of current public expenditure on education which has more than doubled since 1997 (World Bank, 2009b). In addition, the launch of the Education For All-Fast Track Initiative Program in 2007 funded primarily by the World Bank has yielded up to 100 million USD for the education sector in Benin since 2008 (Hagnonnou, 2011). Moreover, education spending is further expected to increase with the implementation of Benin’s latest growth and poverty reduction strategy (GSPR) for the 2011-2015 period which emphasizes the development and strengthening of human capital as a key pillar in boosting medium- and long-term economic growth.

## 3 The model

### 3.1 Households

We consider an infinitely-lived household who has preferences over an aggregate consumption good and leisure; hence his labor supply is endogenous. Referring to previous papers like Heckman (1976), the specification of leisure in the utility function takes into account both the quality and the quantity of time devoted to it. Human capital  $h_t$  augments the enjoyment of leisure time and hence reflects its quality. The efficiency of the household's labor supply depends on the level of human capital, which increases over time through schooling. In each period the representative household has one unit of time that can be devoted to schooling,  $x_t$ , or to work  $l_t$ . Time devoted to schooling makes it possible to increase human capital in the next period. The expression of leisure that enters the utility function is thus  $h_t(1 - x_t - l_t)$ .

Human capital evolves over time through the following accumulation equation that describes the technology of human capital

$$h_{t+1} = h_t(1 - \delta_h) + h_t\phi(x_t, G_t^e) \quad (3.1)$$

where  $\delta_h$  is the depreciation rate of human capital,  $\phi$  is the function of investment in human capital that depends on, among other variables, the time spent on education,  $x_t$ , current human capital,  $h$ , and on government expenditures on education,  $G_t^e$ .

Referring to Blankeneau and Simpson (2004), we define the function  $\phi$  as:

$$\phi(x_t h_t, G_t^e) = x_t^\gamma (G_t^e)^\mu$$

where  $\gamma \in (0, 1)$  reflects diminishing marginal productivity of time spent studying. This parameter restriction is consistent with empirical observation of diminishing marginal returns to education (Mincer, 1958). Evidence suggests that annual returns from completion of primary education are greater than those of higher-level education and that returns tend to diminish with additional year of schooling (Blundell, 1999). Furthermore, inclusion of public

investment as an argument of human capital technology with  $\mu \in (0, 1)$  is common in the literature. The specification of diminishing marginal returns to productive public investment is also motivated by empirical observations (Need citation here). The inclusion of previous period's human capital implicitly reflects the fact that parents tend to pass their knowledge to their children, albeit imperfectly. Since transfer of human capital from one period to the next is not perfect, we include human capital depreciation,  $\delta_h$ .

When the representative household works in period  $t$ , he gets  $w_t l_t h_t (1 - x_t)$  as labor income. He is the owner of the domestic capital stock,  $K_t$ , which is rented to domestic firms; he receives the rental rate  $R_t$ , and whose value is  $V_t$ . The representative household is responsible for the country's foreign liability,  $B_t^F$ , on which he pays an interest rate  $r_t$ . Hence, his portfolio,  $A_t$ , consists of domestic assets and foreign assets (liabilities), with a return rate,  $r_t$ . Assuming appropriate arbitrage conditions (discussed later) that requires both assets to generate the same return rate, the household net asset holdings has thus the following expression:

$$A_t = V_t - B_t^F \quad (3.2)$$

Households pay labor income taxes to the government at a fixed rate  $\tau_L$ , and receive lump-sum transfers,  $Tr_t^G$ ,  $Tr_t^F$  from, respectively, the government and the rest of the world. The household's period budget constraints are as follows:

$$A_{t+1} = (1 + r_t)A_t + (1 - \tau_L)w_t l_t h_t + Tr_t^G + Tr_t^F - P_t^c C_t \quad (3.3)$$

$$h_{t+1} = h_t(1 - \delta_h) + \phi(x_t h_t, G_t^e) \quad (3.4)$$

where  $C_t$  is aggregate consumption,  $P_t^c$ , its price, and  $w_t$  is the wage rate paid per unit of efficient labor.



The household intertemporal utility function is :

$$U_0 = \sum_{t=0} \beta^t [u(C_t) + \psi v[h_t(1 - x_t - l_t)]] \quad (3.5)$$

where  $\beta$  ( $0 < \beta < 1$ ) is the discount factor,  $u$  and  $v$  are time invariant instantaneous concave utility functions with regular properties, i.e., they are strictly increasing and concave, twice-continuously differentiable, and satisfy the Inada condition, and  $\psi$  is the leisure parameter in the utility function. The representative household maximizes the intertemporal utility function subject the period budget constraints, non-negativity constraints, and appropriate transversality conditions. He chooses the appropriate levels for aggregate consumption,  $C_t$  time spent on schooling,  $x_t$ , labor supply,  $l_t$ , and asset holdings in the next period,  $A_{t+1}$ , while taking the sequence of current and future prices, as well as the transfers, as given.

The optimality conditions related to the choices of aggregate consumption and leisure are given by, respectively:

$$\lambda_t P_t^c = \beta^t u'(C_t) \quad (3.6)$$

$$\lambda_t = \lambda_{t+1}(1 + r_{t+1}) \quad (3.7)$$

where  $\lambda_t$  is the Lagrange multiplier related to the consumption budget constraint. These two equations can be combined to give the traditional consumption Euler equation:

$$\frac{u'(C_t)}{P_t^c} = \beta(1 + r_{t+1}) \frac{u'(C_{t+1})}{P_{t+1}^c} \quad (3.8)$$

The optimal condition related to the choice of labor supply is:

$$\frac{\psi v'(h_t(1 - x_t - l_t))}{u'(c_t)} = \frac{(1 - \tau_L)w_t}{P_t^c} \quad (3.9)$$

That equation is the traditional arbitrage condition between leisure and consumption, where the marginal rate of substitution between leisure and consumption must be equal to the real wage rate

The next equation pertains to the optimality choice of time spent on education.

$$\beta^t \psi v' (h_t(1 - x_t - l_t)) = \lambda_{t+1}(1 - \tau_L)w_{t+1}l_{t+1}\phi'(x_t) \quad (3.10)$$

Taking into consideration (3.9), (3.6) and (3.8), the optimality condition in (3.10) can be written as:

$$w_t = \frac{1}{(1 + r_{t+1})} [w_{t+1}l_{t+1}\phi'(x_t)] \quad (3.11)$$

Equation (3.11) suggests that at the margin the household invests in schooling such that, between two consecutive periods, the opportunity cost of spending one unit of time in education must be equal to the marginal gain stemming from the increased efficient labor supply (from the additional human capital,  $\phi'(x_t)$ ), which is paid at the next period's wage rate. Naturally, the next period gain is discounted by the interest rate.

To analyze this expression a little further, total differentiation and rearrangement of equation (6) yields:

$$dx_t = \frac{1}{\phi''} [dw_t - \frac{1}{1 + r_{t+1}} d(w_{t+1}l_{t+1})] \quad (3.12)$$

where  $\phi'' < 0$ . It becomes evident that, at the optimum, an increase in time devoted to schooling will depend on the intertemporal wage differential  $d(w_t/w_{t+1})$ . Other things being equal, and increase in the wage tomorrow induces households to increase time spent to education today,  $x_t$ .

Finally, the condition related to the choice of the Lagrange multiplier,  $\lambda_t$ , is the period budget constraint:

$$A_{t+1} = (1 + r_t)A_t + (1 - \tau_L)w_t l_t h_t + Tr_t^G + Tr_t^F - P_t^c C_t$$

The arbitrage condition for asset holdings by the representative household, which describes the relationship that must hold between the rental rate of capital,  $R_t$ , and the interest rate,  $r_t$ , on foreign assets, can be derived as follows. First, note that, in reality, the aggregate capital stock,  $K_t$  and foreign liabilities,  $B_t^F$ , evolve according to the following motion

equations:

$$K_{t+1} = (1 - \delta)K_t + Inv_t \quad (3.13)$$

$$B_{t+1}^F = B_t^F(1 + r_t) + S_t^F ER_t \quad (3.14)$$

where  $Inv_t$  is aggregate investment,  $S_t^F$  is current account deficit or foreign saving in foreign currency,  $\delta$  the depreciation rate of physical capital, and  $ER_t$  is the currency conversion factor (also wrongly termed as nominal exchange rate). Assuming that the price of the aggregate invest good is  $P_t^I$ , the firm value in period  $t$  is  $V_t = P_{t-1}^I K_t$ . For the representative household to hold domestic assets that pay a rental rate  $R_t$ , while he is paying an interest rate,  $r_t$  on foreign liabilities, the following arbitrage condition must hold between the rental rate of capital and the interest rate:

$$R_t = (1 + r_t)P_{t-1}^I - (1 - \delta)P_t^I \quad (3.15)$$

At the margin, one unit of capital good bought and invested in period  $t - 1$  must generate in period  $t$  the same return,  $r_t$ , as an investment in foreign assets minus the residual value of the investment good at the end of period  $t$ .

The aggregate consumption good,  $C_t$ , consumed by the representative household is a unitary-elasticity composite of individual commodities,  $c_{it}$ , which are sold in the market at prices  $P_{it}^c$ . By minimizing the expenditure on individual commodities subject to the sub-utility function, the index price,  $P_t^c$ , associated to the composite and the demand for individual commodity can be written as follows:

$$P_t^c = \prod_i \left( \frac{P_{it}^c}{\eta_i} \right)^{\eta_i} \quad (3.16)$$

$$C_{it} = \frac{\eta_i P_t^c C_t}{P_{it}^c} \quad (3.17)$$

where  $\eta_i$  is the share of each commodity in the household consumption basket.

We assume that the aggregate investment,  $Inv_t$ , is a Cobb-Douglas composite of individual

investment goods,  $Dinv_{it}$  that are also sold at the same prices,  $P_{it}^c$ , as the consumer goods. However the composition of the aggregate investment good is not identical to that of the consumption good. Using the same minimization principle as in the household case, the index price of the investment good,  $P_t^I$ , and the demand for each investment can be specified as below:

$$P_t^I = \prod_i \left( \frac{P_{it}^c}{\varepsilon_i} \right)^{\varepsilon_i} \quad (3.18)$$

$$Dinv_{it} = \frac{\varepsilon_i P_t^I Inv_t}{P_{it}^c} \quad (3.19)$$

where  $\varepsilon_i$  is the share of each commodity in the aggregate investment good.

## 3.2 Firms

The representative firm in each sector produces a composite output by combining effective labor, physical capital, and intermediate inputs. Physical capital and effective labor are mobile across industries. Firms behave competitively in both factor and product markets and have access to linear homogeneous technology. They determine the optimal levels of inputs in order to maximize profits. Since the aggregate capital stock is provided by households, there is no need for firms to maximize an intertemporal objective function. Hence, they have a standard static optimization problem, from which the optimal level of input is determined so as to equalize its marginal product to its cost. Because of firm technology constant-returns-to-scale properties, the optimal level of firm,s output is determined by the position of the demand curve. The firm just sets its price to the marginal cost. We assume that the production function is weakly separable and we represent it by a series of nested production functions. At the top nest, gross output,  $Y_{jt}$  is a Cobb Douglas function of value added,  $VA_{jt}$ , and of the index of of intermediate goods,  $Int_{jt}$ . The latter is obtained by combining in a fixed proportion individual intermediate inputs,  $V_{ijt}$ . Value added is produced through the combination of effective labor  $LD_{jt}$  and physical capital,  $KD_{jt}$  using a Cobb-Douglas production function. Solution to the firm's profit maximization problem gives the following

expressions of price variables, i.e., the marginal cost (gross output price),  $P_{jt}^y$ ,

$$P_{jt}^y = \frac{1}{A_j^p} \left( \frac{P_{jt}^{int}}{1 - \alpha_j^p} \right)^{1 - \alpha_j^p} \left( \frac{P_{jt}^v}{\alpha_j^p} \right)^{\alpha_j^p} \quad (3.20)$$

where  $A_j^p$  and  $\alpha_j^p$  are respectively shift and share parameters in the Cobb-Douglas function of gross output at the top-level nest.

The index prices of value added,  $P_{jt}^v$ , and of intermediate inputs, could be written as follows.

$$P_{jt}^v = \frac{1}{A_j^v} \left( \frac{w_t}{1 - \alpha_j^v} \right)^{1 - \alpha_j^v} \left( \frac{R_t}{\alpha_j^v} \right)^{\alpha_j^v} \quad (3.21)$$

$$P_{jt}^{int} = \sum_i a_{ij} P_{it}^c \quad (3.22)$$

$A_j^v$ ,  $\alpha_j^{vp}$  are respectively shift and share parameters in the Cobb-Douglas function of value added at the second-level nest, and  $a_{ij}$  are the fixed proportion parameters in the index of intermediate inputs function.

The demand for composite inputs, i.e., value added, and index of intermediate inputs can be respectively written as in Equations (3.23) and (3.24).

$$VA_{jt} = \frac{\alpha_j^p P_{jt}^y Y_{jt}}{P_{jt}^v} \quad (3.23)$$

$$Int_{jt} = \frac{(1 - \alpha_j^p) P_{jt}^y Y_{jt}}{P_{jt}^{int}} \quad (3.24)$$

Finally, the demand for effective labor and demand for physical capital are specified in (3.25) and (3.26).

$$KD_{jt} = \frac{\alpha_j^v P_{jt}^v VA_{jt}}{R_t} \quad (3.25)$$

$$LD_{jt} = \frac{(1 - \alpha_j^v) P_{jt}^v VA_{jt}}{w_t} \quad (3.26)$$

### 3.3 The government

The government collects income taxes on primary factor incomes, on domestic and international transactions. It spends on its own consumption goods and on investment goods that could enhance the productivity of time spent on education. Its real aggregate consumption of goods  $G_t$  is fixed in real terms and the latter is a Leontief index of the consumption of individual goods  $G_{it}$ :  $G_t = \text{Min} \left[ \frac{G_{it}}{a_i^g} \right]$ , where the parameters  $a_i^g$  are the fixed proportion parameters. The aggregate index, the price index,  $P_t^g$ , associated to it, and the demand for individual government consumption goods,  $G_{it}$ , have the following expressions:

$$G_{it} = a_i^g G_t \quad (3.27)$$

$$P_t^g = \sum_i a_i^g P_{it}^c \quad (3.28)$$

where  $P_{it}^c$  are the user prices of individual commodities that are also bought by households and investors.

In addition to spending on consumption goods, the government also invests in education. As discussed earlier, government investment in education has an impact on the technology of human accumulation. We assume that government real aggregate investment in education is a policy variable whose level is decided by the government. Hence, government aggregate in education,  $Inv_t^v$ , is exogenous. Moreover, we assume that  $Inv_t^g$ , is a fixed-proportion composite of individual investment goods in education,  $G_{inv_{it}}$ :  $Inv_t^g = \text{Min} \left[ \frac{G_{inv_{it}}}{\xi_i^g} \right]$ , where  $\xi_i^g$  are fixed-proportion parameters in the government investment aggregate function.

The expressions of government investment demand for education and the index price associated,  $P_t^{gv}$  to it are as follows:

$$Ginv_{it} = \xi_i^v Inv_t^v \quad (3.29)$$

$$P_t^{gv} = \xi_i^v P_{it}^c \quad (3.30)$$

$\xi_i^v$  are the proportion parameters in the government investment aggregate function. The expression of government revenue  $Y_t^G$  can be written as:

$$Y_t^G = \tau^L wh_t l_t + \tau^K R_t K_t + \sum_i \tau_i^c P_{it} (C_{it} + Dinv_{it} + G_{it}) + \sum_i \tau_i^m P_{it}^{wm} M_{it} \quad (3.31)$$

where  $P_{it}$  is the before-tax value of the user price of commodity  $i$ ,  $\tau_i^m$ ,  $P_{it}^{wm}$  and  $M_{it}$  are respectively, the tax rate, the world price (in foreign currency) and the volume of the imported commodity  $i$ .

Finally, we assume that government saving,  $S_t^G$ , is exogenous in each period; it balances its account transfers to households. When the government increases its spending of education, it can introduce new tax instruments to pay for the increase in its outlays. We will discuss that possibility further in the paper. The government saving has the following expression:

$$S_t^G = Y_t^G - (P_t^g G_t + P_t^{gv} Inv_t^g + Tr_t^G) \quad (3.32)$$

### 3.4 Trade and relations with the rest of the world

Following the tradition in the CGE literature, we introduce commodity differentiation by origin in the model, both on the supply and demand sides. On the supply side, we assume that the gross output of each representative firm,  $Y_{jt}$ , is composite of exports,  $Ex_{it}$ , and domestic sales,  $XD_{it}^S$ , which are sold at, respectively,  $P_{it}^{ex}$  and  $P_{it}^d$ . We use a constant elasticity of transformation (CET) function to transform gross output into its two components. Using a revenue-maximizing principle, it is possible to determine the expression for the dual price of gross output as a function of the prices of exports and domestic sales and the expressions of the output supply in each market (domestic and foreign). These expressions can be written

as follows.

$$P_{it}^y = \frac{1}{A_i^x} \left[ \omega_i^{-\sigma_i^x} (P_{it}^{ex})^{1+\sigma_i^x} + (1 - \omega_i)^{-\sigma_i^x} (P_{it}^d)^{1+\sigma_i^x} \right]^{\frac{1}{1+\sigma_i^x}} \quad (3.33)$$

$$Ex_{it} = \frac{1}{(A_i^x)^{1+\sigma_i^x}} \left[ \frac{\omega_i P_{it}^{ex} Y_{it}}{P_{it}^y} \right]^{\sigma_i^x} \quad (3.34)$$

$$XD_{it}^S = \frac{1}{(A_i^x)^{1+\sigma_i^x}} \left[ \frac{(1 - \omega_i) P_{it}^d Y_{it}}{P_{it}^y} \right]^{\sigma_i^x} \quad (3.35)$$

$A_i^x$ ,  $\omega_i$ , and  $\sigma_i^x$ , are respectively, the shift and the share parameters, and the elasticity of substitution of the CET transformation function.

On the demand side, let total demand for each commodity by all domestic users (households, firms and government),  $XT_{it}$  be defined as:

$$XT_{it} = C_{it} + D_{inv_{it}} + G_{it} + G_{inv_{it}} + \sum_j V_{ijt} \quad (3.36)$$

We assume that  $XT_{it}$  is a composite of imports,  $M_{it}$ , and of the domestically produced good  $XD_{it}^D$ . Its price (before user tax),  $P_{it}$ , is hence an index of the import price and of the domestic good price,  $P_{it}^d$ . Using a cost-minimization principle, we can find the expressions of the  $P_{it}$ , and the demand for each commodity  $i$  by origin.

$$P_{it} = \frac{1}{A_i^m} \left[ \eta_i^{-\sigma_i^m} (P_{it}^m)^{1+\sigma_i^m} + (1 - \eta_i)^{-\sigma_i^m} (P_{it}^d)^{1+\sigma_i^m} \right]^{\frac{1}{1+\sigma_i^m}} \quad (3.37)$$

$$M_{it} = \frac{1}{(A_i^m)^{1+\sigma_i^m}} \left[ \frac{\eta_i P_{it} XT_{it}}{P_{it}^m} \right]^{\sigma_i^m} \quad (3.38)$$

$$XD_{it}^D = \frac{1}{(A_i^m)^{1+\sigma_i^m}} \left[ \frac{(1 - \eta_i) P_{it} XT_{it}}{P_{it}^d} \right]^{\sigma_i^m} \quad (3.39)$$

The prices of export and import goods in the domestic currency have the following expression:



$$P_{it}^m = ER_t P_{it}^{wm} (1 + \tau_{it}^m) \quad (3.40)$$

$$P_{it}^{ex} = ER_t P_{it}^{wx} \quad (3.41)$$

where  $P_{it}^{wx}$  is the world price of the exported good  $i$  in foreign currency.

Finally, the current account deficit,  $SF_t$ , discussed earlier has the following expression:

$$SF_t = \sum_i \tau_i^m P_{it}^{wm} M_{it} - \sum_i P_{it}^{wx} Ex_{it} - Tr_t^F \quad (3.42)$$

### 3.5 Dynamics and market clearing conditions

The dynamics of the economy can be represented by the motion equations of the state and control variables as specified in Equations (3.3, 3.4, 3.8, 3.11, 3.13, 3.14, 3.15). A competitive equilibrium for this economy is characterized by a sequence of allocations of quantity variables and a sequence of price variables, such that households and firms respect their optimal conditions, the government respects its budget constraint and satisfies the conditions in (3.27, 3.28, 3.29, and 3.30), the markets for domestically produced goods, labor and physical capital clear in each period, as in (3.43-3.45) and a transversality condition is imposed for household wealth and human capital accumulation. Referring to the definition of household wealth as in (3.2), imposing a transversality condition to his wealth, amounts to imposing the same condition to his domestic assets),  $V_t$ , and to foreign liabilities,  $B_t^F$ . The market clearing conditions are the following:

$$XD_{it}^S = XD_{it}^D \quad (3.43)$$

$$h_t l_t = \sum_j LD_{jt} \quad (3.44)$$

$$K_t = \sum_j KD_{jt} \quad (3.45)$$

We assume that there is no restriction to capital mobility and the country has access to the world; the world interest rate is exogenous and fixed at  $r^*$ . The model *numéraire* is the currency conversion factor,  $ER_t$ . Because of the high non-linearity of the model we cannot find a closed-form solution to the model equilibrium path. Therefore, we rely on numerical methods to find the optimal path of endogenous variables in the model. To do so, we assume that the household instantaneous utility function is of constant relative risk aversion (CRRA) type, i.e.,  $u(C_t) = \frac{1}{1-\sigma}C_t^{1-\sigma}$ , where  $\sigma$  is the inverse of intertemporal elasticity of substitution.

### 3.6 Data and calibration

Some of the model behavioral and policy parameters are calibrated using other extraneous parameters so as to reproduce the benchmark equilibrium. In that equilibrium, the economy is supposed to grow at an endogenous constant rate, which is the rate of accumulation of human capital. For the sake of simplicity, we abstract from the exogenous population growth rate and exogenous total factor productivity growth rate. The main engine of the long run growth of the economy is the growth rate of human capital. We assume that in the benchmark situation this growth rate is 2%. That value is well within the range of those used in similar studies on endogenous growth with human capital. Our literature search suggests that this rate ranges from 0.44% in Hamid and Pichler (2011), 0.79% in Arnold et al (2007) and 0.90% in Denison (1962) to 1.80% in Bouzazah et al. (2007), 2% in Lucas (1993) and 2.50% in Jung and Thorbecke (2003).

In the initial steady state, all quantity variables expressed per effective labour (i.e., labour including human capital) are constant, as well as prices and different shares. Normalizing the size of the population to one in each period, we set out to use the representation of the economy of Benin as shown in the social accounting matrix (SAM) of 2006 to characterize the steady state values of the per-effective-labour level of the quantity variables in the model. Table (xx) presents the main characteristics of the Sam of Benin in 2006. In addition to growth rate of human capital we borrow other parameters from the literature as presented in Table xx. The depreciation rates of physical and human capital have been set to, respectively, 0.08 and 0.1. The inverse of the intertemporal elasticity of substitution has been set to 0.5, and is in the range of values used in other studies. The substitution elasticities in the

Armington and CET function have been set to 2 as most studies. Following xx (xx) we use 0.1 as the input elasticity of government spending in the human accumulation technology function and 0.75 for the input elasticity of time spent at school by households in the same function. Setting most prices to unity in the benchmark, the values of most quantity variables can be calibrated as well as those of the fiscal policy instruments in the benchmark situation.

As in common in the computable general equilibrium literature, the other remaining behavioral parameters have been recovered using the first-order and steady state conditions of the economy as described in the previous section. The main requirement in the calibration process is the ability of the model to reproduce the observe equilibrium in which all quantity variables grow at the constant same rate as human capital, and in which all prices and shares are constant. An infinite horizon model like the present one can be solved numerically only by truncating the model horizon. Taking advantage of the fact that the economy will eventually reach a steady state, the model is solved using a finite time horizon sufficient long so as to let the economy reach a new steady. While several solution strategies are available to solve forward-looking dynamic models, we elect to use the one suggest in Fair Taylor 91983) where we sole the model as a two-boundary-value problem when the values of the state variables are fixed in the first period and steady-state conditions are fixed for co-state variables. See xx (xx) for a good summary on the various existing strategies to solved forward-looking dynamic models.

## 4 Simulations

We apply the model described above to study the growth and sectoral effects of several different forms of financing public spending on education. We choose four alternative instruments of financing a permanent 10% increase in government spending on education in comparison to the initial base-run level. In doing so, we consider a non-distortionary financing approach based on cuts in government transfer payments to households and a distortionary financing approach based on three alternative tax rules. These include: a rise in the labour income tax rate; a rise in the capital income tax rate; and, a uniform absolute increase in the production tax rate. Each fiscal policy, whether it is a tax or reduction in transfers, is such that public budget is kept balanced in each simulation period. Thus, under distortionary policies tax

rates do not remain constant throughout the simulation horizon. In what follows, we focus on highlighting several key mechanisms and channels involved in driving some significant quantitative and qualitative differences among the four different financing mechanisms considered. Table [ ] summarizes the economy-wide effects of using distortionary taxes for financing public spending on education compared to using a non-distortionary approach. Tables [ ] to [ ] present sectoral results for each of the four financing mechanisms. It is important to note here that the long-run growth rate of all quantity variables in the economy is endogenously determined by the growth rate of human capital. We assume that in the baseline scenario this growth rate is 2%. In the endogenous growth literature the assumption of this rate ranges from 0.44% in Hamid & Pichler (2011), 0.79% in Arnold et al (2007) and 0.90% in Denison (1962) to 1.80% in Bouzahzah et al. (2007), 2% in Lucas (1993) and 2.50% in Jung and Thorbecke (2003). Therefore, our figure of 2% is well within the range accepted by a number of similar studies. In contrast, all price variables remain constant in the long-run. This also applies to the share variables in the model represented by time spent on schooling, work, and leisure. For each fiscal instrument considered, we run the model for 100 periods and use the first 30 for our results analysis. This is because the economy reaches the steady state around the 30th period in which all quantity variables grow at a constant rate, namely the rate of human capital accumulation, and all price and share variables are constant. Thus, we report in the tables the aggregate and sectoral results for three different periods in time: first period (1st year), medium-run (10th year), and long-run (30th year).

## 4.1 Aggregate Effects: Non-distortionary financing

### 4.1.1 Government transfers to households

The main driver of the changes in the model is the increase in government spending on education, which enters as a direct input into the human capital production function. An increase in government spending on education induces households to increase their time spent on schooling, and hence, the growth rate of their human capital stock.

In the case of non-distortionary financing, public spending on education leads to a relatively high increase in the human capital growth rate, which rises immediately to 2.16% as compared to 2% in the reference case. This is because public spending on education has

an immediate positive effect on the productivity of time spent on schooling. Households are thereby induced to devote more time to schooling, which rises by almost 6% in the first period. Overall, higher public spending on education leads to a rise in human capital investment on the part of the households.

As government transfers to households decrease in order to finance the additional spending on education, the results in Table (xx) suggest that households immediately reduce their leisure time (-0.25%) and increase their time spent at work (0.47%). The increase in the time spent at work, coupled with the increase in human capital, increases effective labour supply by 0.47% in the first period. The increase in effective labour supply drives down the wage rate by 0.10% compared to the baseline scenario. However, this decline in the wage rate is not sufficient to reduce total labour income that increases by 0.36% in the first period. In addition, as the wage per efficient labour remains constantly lower by the same percentage deviation during the entire transitional period despite the increasing supply of educated labour, households are further encouraged to slightly increase their demand for schooling over the medium- and the long-run periods.

At the same time, as the stock of human capital grows and thus effective labour supply rises, the marginal product of capital increases leading to a higher rental rate of capital. Ultimately, capital income rises as well. Although the increases in labour and capital incomes are somewhat dampened by the reduction in government transfers to households, household disposable income increases, nonetheless. The immediate increase in the rental rate of capital (0.43%) provides incentives to households to increase their investment in physical capital. The rise in the rental rate of capital immediately boosts investment in physical capital by 2.8%. Indeed, public spending on education, when financed by non-distortionary means, has a strong positive crowding-in effect on private investment and thus on capital accumulation throughout the entire transition period to the long-run. This, in turn, also encourages households to give up some of their leisure time for working as their work effort increases over the medium-run to the long-run period.

Over time, the higher accumulation of the capital stock lowers the rental rate of capital, which starts to decrease in year 9. However, the decrease in the marginal product of capital over the medium- to long-run period is not significant enough to curb private investment or decrease household capital income. In the long-run, private investment and the economy's

capital stock increase by 6.85% and 5.22% respectively relative to the baseline scenario.

In the early years following higher public spending on education, disposable income does not rise sufficiently enough to make it possible for households to increase both investment in physical capital and consumption. Household consumption drops in the initial period by 0.61% in comparison to the reference case in order to take advantage of the higher return on physical capital. Despite the negative effect on short-run consumption, the simulation shows that the crowding-out effect quickly dissipates by year 3 and turns into a positive shock thanks to the increases in the stocks of physical and human capital. In the long-run, household consumption rises substantially by 4.38% relative to the baseline scenario.

As output increases, exports increase; the same is also true for imports when income increases. Since the increase in exports is more important than that of imports, the current account balances improves, and the ratio of foreign debt to GDP decreases in the long run. Ultimately, all quantity variables increase at a growth rate of 2.16% which is higher than the initial growth rate of human capital of 2%.

## **4.2 Aggregate Effects: Distortionary financing**

When government education spending is financed by distortionary means, the long-run output gains are considerably attenuated due to the adverse effects coming from the distortion of tax policy. In general, distortionary taxes make leisure more attractive than work and schooling, which, in turn, adversely affects the incentives for growth-promoting activity. However, the extent of these adverse effects varies among the three distortionary financing mechanisms. In particular, all three counterfactual tax simulations suggest that the labour tax has the greatest potential to increase output as well as physical and human capital stocks, and that these impacts will strengthen faster over time than those in the capital tax or the output tax funding scenarios. Nonetheless, the results show that, in the long-run, government education expenditures do affect positively the productivity of the economy as a whole regardless of the distortions that a tax used to finance them may create.

### 4.2.1 Capital tax

Capital tax emerges as the least favourable option of funding public spending on education. The simulation suggests that the very long-run gains from improved human capital accumulation may be appreciable (4.4% higher relative to the baseline scenario in the 100th year), but that there are significant distortions created elsewhere in the economy that persist for a considerable amount of time.

In the first period that the capital tax rises, households immediately increase leisure (0.08%) and decrease their time spent on work (-0.24%). The decreased work effort leads to an initial reduction in the supply of effective labour (-0.24%). This, in turn, drives down the rental rate of capital (-1.93%), inducing households to reduce their investment in physical capital for higher investment in human capital. Households, therefore, immediately increase their time spent on schooling (2.58%) and reduce their investment in physical capital by 5.48% compared to the baseline scenario. The latter effect combined with the reduction in the effective labour supply decrease output initially by -0.28% relative to the baseline case. In fact, under capital tax financing output further drops in the medium-run following the initial decrease. The medium-run output loss of 0.84% is the maximum GDP loss that occurs among all distortionary tax financing simulations.

In addition, the initial consumption boom experienced under capital tax financing is more than offset in the medium-run (-0.77%) owing primarily to a steep decrease in the disposable income received by households and the greater substitution toward leisure. As the capital tax rate needed to finance the public outlay grows over time, households allocate less time to schooling and work, and instead increase their leisure time. It follows that the new aggregate growth of the stock of human capital drops over time (from 2.09% to 2.06%). (See the graph of the growth rate of human capital accumulation.) The shortfall in disposable income of households is largely driven by the enactment of the capital tax which effectively acts as a tax on capital income and thereby lowers the after-tax return earned by households.

Furthermore, the sharp decline in household savings discourages households from investing in physical capital for quite some time<sup>1</sup> despite a rising rate of return to capital accumulation brought about by the reduced capital stock of the economy. Moreover, the rise in the marginal

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<sup>1</sup>Private investment start to increase in the 51st period.

product of capital is not sufficient to offset the downfall in capital income over time.

Indeed, the long-run output gain under capital tax financing is small (0.10% relative to the baseline case) in comparison to those realized under the labour tax or the output tax funding scenarios. The small positive effect on output in the capital tax funding scenario is primarily driven by increased human capital as the supply of effective labour rises by 1.3% in the long-run. Combined with worsened export performance, the diminished long-run output gain under capital tax financing is attributable to the persistence of the negative crowding-out effect on private investment in the long-run and, hence, reduced capital accumulation as well as reduced time devoted to human capital formation.

#### 4.2.2 Output tax

Similar changes are observed in the output tax funding scenario. In particular, the percentage increase in the time allocated to the accumulation of human capital during the first-period is cut in more than half from 5.87% in the scenario using transfers to 2.38% in the output tax scenario (recall that under capital tax schooling initially goes up by 2.58%). It seems that output tax financing has the lowest effect on increasing household schooling time in the first period and hence on the growth rate of human capital. Thus, the supply of effective labour in the initial period falls more strongly than in the capital tax funding option generating initial output losses of a similar magnitude as those realized under capital tax financing. As in the capital tax funding scenario, the subsequent decline in time devoted to labour and human capital accumulation induces increased leisure over the entire simulation period. The long-run effects on labour, schooling, leisure, effective labour supply, and the growth rate of human capital are qualitatively similar to those in the capital tax scenario.

Yet, the transitional adverse effects of increasing distortionary output taxes are less accentuated than in the capital tax funding scenario. The main reason for that is that the crowding-out of the private sector in the output tax funding scenario is present only in the first period and in the medium-run. Most importantly, these transitory crowding-out effects on private investment are not nearly as strong as in the capital tax scenario. The long-run crowding out effect on private investment is circumvented as the output tax, in contrast to the capital tax, does not work directly against the increase in the rate of return on physical capital



coming from the presence of higher government spending on education. Moreover, household disposable income is not as negatively affected as in the capital tax funding scenario allowing households to invest more in physical capital. Consequently, households sacrifice some of their consumption in the first-period and in the medium-run. However, consumption eventually reaches a level higher than in the capital tax funding scenario (0.60%) owing primarily to the increased stocks of physical and human capital. In the long-run, output tax financing makes it possible for the economy to achieve a larger output rise than under capital tax financing.

### 4.2.3 Labour tax

Of the three distortionary tax funding options, labour tax is the most favourable option. This is because any adverse effects arising from the distortion of income tax policy are largely constrained to the first period. In contrast to both capital and output tax funding options, output falls only in the immediate period following higher spending on education (-0.21) and thereafter rises by about 2% in the long-run.

The most significant adverse effect experienced under labour tax financing is reflected in the first-period values for household consumption. Of all the financing mechanisms considered, labour taxes exert the strongest immediate negative effect on private consumption, which falls by -0.74% compared to -0.61% in the case where government transfers financed the additional spending on education. This occurs despite a lower decrease in disposable income (-0.426%) than in the capital tax and the output tax funding scenarios. Moreover, although labour taxes directly reduce household post-tax income, the decline in labour income over the entire simulation period is lower than that experienced under both capital tax and output tax financing.

Reduced consumption, nonetheless, is offset by an immediate rise in physical capital investment leading to higher capital accumulation throughout the transitional period to the long-run. Hence, identical to the case in which government transfers financed public education, the labour tax funding option is characterized by an absence of a negative crowding-out effect on private investment. Public spending on education financed by higher labour taxes allows private investment to steadily increase during the transition path to the long-run.

As in the capital tax and the output tax financing scenarios, the first-period increase in time spent on schooling is associated with a withdrawal of labour from the market in the first period, which decreases by a similar magnitude as in the output tax financing option. However, in contrast to the capital tax and the output tax financing scenarios, schooling effort over time is less discouraged in the labour tax scenario. Schooling remains much more attractive in the labour tax scenario as the return on human capital (wage per efficient labour) rises immediately as the fall in effective labour supply is more important than the demand for labour. As a result, participation in the labour market (leisure) over the medium-run and the long-run periods is higher (lower) under the labour tax funding option than in the capital tax and output tax financing options. Thereafter, as GDP increases, effective labour demand by firms outweighs the increase in effective labour supply. Consequently, wages received by educated labour rise throughout the entire transition period, and are some 0.25% higher than in the baseline scenario in the long-run. In addition, the increase in the wage rate per efficient labour outweighs the increase in the rental rate of physical capital.

As a result, participation in the labour market (leisure) over the medium-run and the long-run periods is higher (lower) under the labour tax funding option than in the capital tax and output tax financing options. Indeed, although labour tax financing discourages to some extent work effort and investment in human capital, the increase in leisure over the medium-run to the long-run period is negligible compared to the capital tax and the output tax funding options. Hence, despite the distorting tax rate on income, the positive long-run effect on the effective labour supply is more pronounced in the labour tax funding scenario than in the capital or the output tax funding scenarios.

While the capital tax and the output tax funding option did not allow the economy to restore its long-run export performance, the labour tax funding option allows for a considerable increase in both exports and imports, which increase by a similar magnitude of 1.9% in the long-run. However, the larger increase in imports, compared to the capital tax and the output tax scenarios, is attributed to higher income achieved under labour tax financing. The considerable rise in imports translates into lower foreign saving and increased ratio of debt to GDP in the long-run. Overall, by removing the disincentives to save, work, and invest in human capital, non-distortionary financing of public spending on education has the most significant impact on macroeconomic aggregates both in the long-run and in the transitional

period. A non-distortionary financing mechanism allows the economy to achieve the largest increase in consumption, exports, physical and human capital stocks and therefore in output compared to the other distortionary tax funding options. The very long-run output gains realized under non-distortionary financing are substantial (17.5% compared to the baseline scenario in the 100th year). These gains are reduced by more than half under labour tax financing (7.8% relative to the baseline scenario in the 100th year), and are further diminished when higher spending on education is paid by increased output taxes (5.4%) or capital taxes (4.4%). As mentioned before, this result is not surprising since a non-distorting way of financing government spending on education is employed in this scenario.

### 4.3 Sectoral Effects of distortionary financing and non-distortionary financing

Our simulation exercise allows monitoring sector-specific impact of each fiscal policy. The sectoral results for Benin show some interesting patterns. In the very long run, human capital investment tends to improve industrial output, but the magnitude of the impact is quite sensitive to the financing scheme used. More specifically, non-distortionary and labour tax financing of additional public spending on education both have a fairly balanced, positive effect on output in the very-long across all 12 industries. In contrast, when capital tax or output tax is used to finance higher public spending on education, the output gains in the very long are rather unbalanced across industries, with service sectors<sup>2</sup> emerging as the biggest beneficiaries of higher investment in human capital.

While only 6 of the 12 sectors saw their output contract in the first period under non-distortionary financing, all sectors, except *Other Business Services*, experience initial output losses under the labour tax financing method of higher spending on education. This effect is also observed under output tax financing where the same 11 of the 12 sectors see a contraction in their initial output. However, the immediate negative effect of higher spending on education is spread out more evenly across sectors when labour taxes are used to finance human capital investment. In contrast, under output tax financing, certain highly labour-intensive sectors, such as *Cotton*, *Cash Crops* and *Other Handicrafts Industry* as well as a

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<sup>2</sup>Namely, Transportation-Communications, Banks Services and Other Business Services

capital-intensive-sector of *Other Modern Industries* record considerably stronger initial output losses than the other sectors. Meanwhile, presumably the skill-intensive *Bank Service* industry, suffers disproportionately less from the initial policy shock. Generally speaking, since each fiscal policy is an inducement to accumulate skill, unsurprisingly under each scenario relatively skill-intensive industries (*Banking and Other Business Services*) either suffer disproportionately less in the first period and/or exhibit a stronger rise in output in the long-run

Furthermore, capital tax financing leads to output contraction in the first period in only 4 of the 12 sectors. This is largely because capital-tax financing leads to an initial boost in consumption demand and hence in total domestic demand in the remaining 8 sectors of the economy. However, as sectoral consumption demand declines, all sectors see a fall in their output over the medium-run period, where the labour-intensive sectors of *Cotton* and *Cash Crops* suffer the strongest negative output losses of -3.5% and -2.6%, respectively.

In line with the aggregate results, non-distortionary financing of public spending on education has the strongest positive impact on sectoral output in the long-run. In particular, the labour-intensive sectors of Benin's economy (*Cotton, Other Handicrafts Industry, Other Business Services* and *Cash Crops*), experience substantial output expansion from public investment in human capital ranging from 5.72% to 6.25% in the long-run.

Although the positive output gains in the long-run under labour tax financing are considerably smaller than those realized under non-distortionary financing, the distribution of these positive gains across industries is relatively balanced, ranging from at least 1.18% in the *Textiles Industry* to at most 2.6% in *Other Business Services*. On the other hand, output tax financing and capital tax financing generate a much more varied effect on long-run sectoral output. In the case of capital tax financing, the small positive long-run effect of higher spending on education on aggregate GDP derives mainly from increased output of the service sectors of the economy (such as, *Other Business Services, Bank Services, and Transportation-Communications*). These sectors also benefit the most under output tax financing, where the adverse effects of higher spending on education on sectoral output persist for only 4 sectors in the long-run period, with *Cotton* and *Cash Crops* sectors being the most adversely affected. However, these adverse effects are substantially lower in magnitude than those experienced under capital tax financing. In this case, *Cotton* and *Cash Crops* industries bear the largest

long-run output losses of -2.75% and -1.78%, respectively.

## 4.4 Discussions

Since the various methods of financing the increase in government spending on education mentioned above work by increasing human capital accumulation, their qualitative effects on key macroeconomic variables, namely GDP, consumption, private investment, private and human capital stocks are rather similar in the very long-run. The use of a non-distortionary financing instrument, such as a reduction of government transfers in our model, achieves the highest output increase through its strong effect on physical and human capital stocks.

However, if the public spending on education is financed by distortionary taxes, our model implies that labour tax enables the economy to generate a higher output gain than the other distorting fiscal instruments. Thus, despite some qualitative similarities, the extent of the positive effects exerted by higher public spending on education varies markedly under different financing mechanisms. Our results are somewhat in tandem to simulation outcomes by Annabi et al. (2007), where non-distortionary financing method dominates tax policies. While Annabi et al. (2007) only consider changing the composition of public expenditures, lump-sum tax and personal income tax, their policy comparison does not involve growth as a merit criterion. Moreover, unlike our simulation results, two of their policy scenarios do now show long-term recovery in aggregate consumption. In addition, our simulation model demonstrates less significant transitory crowding-out effect due to slightly differing modelling structure.

Nonetheless, our model shows that public spending on education even when financed by distortionary means can improve the long-run macroeconomic and sectoral performance irrespective of the distortions that the tax may introduce in the transitional period. Our study finds that the transitional effects of using different fiscal instruments to fund public spending on education can vary, although the long-run impact on growth and sectoral performance is positive. More specifically, in contrast to the theoretical findings of Blankenau and Simpson (2004), we find no crowding out effect on private investment when non-distortionary means are used to finance higher public education spending. It is important to note that the analytical results in Blankenau and Simpson (2004) are also heavily premised on parameter

restrictions and, in contrast to the present study they assume varying level of public education expenditure. Additionally, our model shows that non-distortionary financing of higher spending on education crowds-in private human capital investment, in contrast to the other distortionary tax instruments. Furthermore, the crowding-out effect on private consumption is very short-lived and dissipates after the 3rd year. In fact, capital income taxation is the only fiscal instrument that leads to increased consumption in the very short-term period.

However, Blankenau and Simpson (2004) find that income taxes crowd in capital when labour taxes are sufficiently large. Our model shows that public spending on education financed by labour taxes crowds-in private investment immediately and leads to only transitory crowding-out effects on consumption over the initial to the medium-run period. On the other hand, capital income taxation has a drawn-out effect on private capital accumulation, which, although not strong enough to reduce long-run GDP growth owing to a positive effect on efficient labour supply, does weigh down the performance of the economy for a long period of time. Hence, similar to findings of Domenech and Garcia (2002) we find that public spending on education when financed by capital taxes crowds-out private investment in physical capital. However, when looked at from a dynamic perspective, this effect is present in the first 50 periods, which is half of the total simulation horizon. Output taxation, on the other hand, leads to a less pronounced crowding out effect on private investment both in terms of its duration and magnitude than capital income taxation.

In addition, important qualitative differences between distortionary and non-distortionary means of financing public education emerge over the very long-run. In particular, our model shows that when the education outlay is financed by a non-distortionary government policy instrument, leisure, the rental rate of capital, and wage per efficient labour attain lower steady-state levels than in the baseline scenario. Under distortionary financing, however, labour supply (work effort), labour income and capital income decline below their initial steady-state levels. In contrast to the long-run results of using capital tax, output tax, and reduced transfers financing, labour taxation is the only instrument that leads to a rise in the wage per efficient labour over time.

In contrast to similar models, we conduct explicit sector-specific impact of each policy scenario. Under non-distortionary financing and in labour tax scenario, output in each industry rises by roughly equal magnitudes vis-à-vis the base-run scenario. In the other two scenarios

(capital and output taxes) some sectors experience net output loss in the long run, with skill-intensive sectors suffering disproportionately less or gaining disproportionately more. Such sector-specific distributional consequences of increase in public education is reminiscent of Jung and Thorbecke (2003), whose multisector CGE model simulations suggest that, if not better targeted to the poor, more skilled population and more skill-intensive industries will gain more from education expenditure increase. Disproportional gains stemming from differences in skill-intensity are also found in Gallipoli et al. (2006), in Voyvoda and Yeldan (2000) and Verbic et al. (2009)

## 5 Concluding remarks

We have developed an endogenous growth model with both human and physical capital accumulation in a multisector setting to assess the implications of increasing government spending on education, with an application to the economy of Benin. We have considered several fiscal instruments to finance the increase in government spending so as to keep its balance (deficit or surplus) fixed at its base-run level. Our simulation results suggest that the increase in government spending on education has a positive effect in the long run on human capital accumulation that is the engine of growth. The main reason of the increase in the long-run growth rate of human capital accumulation has to do with the impact of the increase of government spending not only on the productivity of human accumulation technology, but also on the amount of time spent by households on schooling.

Still, our results also suggest that there is a significant difference in the quantitative growth impacts of the different financing methods. The use financing of the reduction in government transfers to households provides the highest output increase through its strong effect on physical and human capital stocks. The other distortionary financing methods have lower impacts on the long-run economic growth, with labour tax being the most performing, followed by, respectively, output tax and capital tax. Our results are in line with previous findings as those in Annabi et al. (2007), who use a different setting by considering a rearrangement of public expenditures.

Finally, even though our simulation results suggest that the different methods of financing have a positive impact on the long-run economic growth rate, their transitional impacts do dif-

fer. We find for example that financing the increase in public spending through higher labour tax rates crowds-in private investment immediately and has only a transitory crowding-out effect on consumption in the short and medium runs. In contrast, when capital tax is used to fund the rise in government spending on education, our results suggest that private capital is crowded out, in a proportion that is not sufficient to reduce long-run growth rate of the economy.

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**Table 1: Aggregate effects of public spending on education**

	Capital Taxes			Labour Taxes			Output Taxes			Government Transfers		
	First Period	Medium-run	Long-run	First Period	Medium-run	Long-run	First Period	Medium-run	Long-run	First Period	Medium-run	Long-run
Labour	-0.24	-0.53	-0.60	-0.32	-0.38	-0.39	-0.31	-0.53	-0.58	0.47	0.48	0.49
Schooling	2.58	1.64	1.42	2.53	2.32	2.28	2.38	1.65	1.48	5.87	5.91	5.92
Leisure	0.08	0.21	0.25	0.12	0.14	0.15	0.11	0.22	0.24	-0.25	-0.26	-0.26
New growth rate of human capital (%)	2.09	2.07	2.06	2.09	2.08	2.08	2.08	2.07	2.06	2.16	2.16	2.16
Effective labour supply	-0.24	0.13	1.30	-0.32	0.36	1.95	-0.31	0.12	1.32	0.47	1.92	5.20
Wage rate per efficient labour	-0.43	-0.50	-0.51	0.22	0.24	0.25	-0.40	-0.46	-0.47	-0.10	-0.10	-0.10
Rental rate of capital	-1.93	0.18	0.69	-0.10	0.15	0.19	-0.74	0.26	0.49	0.43	-0.03	-0.08
Price of aggregate consumption	-0.42	0.33	0.51	0.07	0.15	0.16	-0.11	0.23	0.31	0.07	-0.05	-0.07
Price of aggregate investment	-0.50	0.47	0.70	0.07	0.17	0.19	-0.06	0.39	0.49	0.10	-0.06	-0.08
Private Investment	-5.48	-2.94	-1.27	0.24	1.18	2.82	-1.81	-0.44	0.98	2.79	3.64	6.85
Total capital stock	0.00	-2.35	-1.82	0.00	0.47	2.02	0.00	-0.59	0.38	0.00	1.89	5.22
Capital income	-1.93	-2.84	-3.05	-0.10	-0.12	-0.13	-0.74	-0.99	-1.04	0.43	0.43	0.43
Labour income	-0.68	-1.03	-1.11	-0.10	-0.14	-0.14	-0.71	-0.99	-1.05	0.36	0.38	0.38
Disposable Income	-1.050	-0.899	0.217	-0.426	0.258	1.853	-0.664	-0.263	0.937	0.136	1.608	4.887
Real GDP	-0.28	-0.84	0.10	-0.21	0.40	1.98	-0.26	-0.18	0.95	0.29	1.89	5.18
Consumption	0.06	-0.77	0.11	-0.74	-0.16	1.42	-0.48	-0.51	0.60	-0.61	1.08	4.38
Total exports	0.51	-2.06	-1.59	-0.02	0.37	1.92	-0.03	-0.92	-0.01	0.81	2.71	6.04
Total imports	-1.30	-0.64	0.59	-0.39	0.35	1.95	-0.82	-0.22	1.03	0.17	1.56	4.83
Foreign saving	-6.60	0.89	3.74	-1.61	-0.15	1.58	-3.42	0.29	2.25	-1.00	-0.76	2.38
Ratio of debt to GDP	-0.66	-0.68	-0.68	-0.66	-0.66	-0.66	-0.66	-0.66	-0.67	-0.65	-0.65	-0.65
Value of firms	0.00	0.66	1.90	0.00	0.74	2.34	0.00	0.65	1.90	0	1.44	4.71
Total wealth	0.00	0.66	1.90	0.00	0.74	2.34	0.00	0.65	1.90	0	1.44	4.71
Government revenue	0.78	2.32	3.77	1.35	2.18	3.80	1.09	2.12	3.46	0.32	1.73	5.00
Tax rate on capital	1.29	2.02	2.20									
Tax rate on labour				0.57	0.61	0.61						
Tax rate on production							0.22	0.29	0.30			
Transfers to households										-5.33	-4.72	-4.66

*\*Percentage deviations of per capita variables from their base run values (except for leisure, labour and schooling)*



**Table 3: Sectoral Effects of public spending on education financed by government transfers**

	Food Agric.	Cash Crops	Agro-Industries	Cotton	Handicrafts Industry	Other Handicrafts Industry	Other Modern Industries	Utilities	Textile Industry	Transport-Comm.	Bank Services	Other Business Services
<b>Gross output</b>												
First Period	-0.57	0.80	-0.64	1.32	-0.50	1.29	0.35	1.29	-0.77	-0.02	0.08	0.91
Medium run	1.15	2.43	1.18	2.95	1.20	2.55	2.04	4.59	1.19	1.60	1.69	2.46
Long run	4.46	5.72	4.50	6.25	4.50	5.81	5.34	-0.41	4.52	4.89	4.98	5.74
<b>Investment by sector of destination</b>												
First Period	2.80	2.81	2.86	2.69		2.77	2.87		2.85			2.78
Medium run	3.64	3.64	3.60	3.69		3.64	3.59		3.60			3.66
Long run	6.85	6.85	6.80	6.92		6.85	6.78		6.80			6.87
<b>Exports</b>												
First Period	-0.77	0.63	-0.81	1.12	-0.77		0.13		-1.07	-0.09		0.72
Medium run	1.30	2.56	1.31	3.07	1.32		2.16		1.35	1.75		2.60
Long run	4.64	5.88	4.66	6.41	4.67		5.50		4.73	5.07		5.92
<b>Imports</b>												
First Period	-0.38	0.97	-0.47				0.57	-0.34	-0.46	0.04		1.19
Medium run	1.01	2.30	1.05				1.91	1.15	1.03	1.44		2.26
Long run	4.28	5.56	4.33				5.18	4.43	4.32	4.71		5.49
<b>Total domestic demand</b>												
First Period	-0.57	0.80	-0.64	1.51	-0.50	1.29	0.35	-0.41	-0.77	-0.02	0.08	0.95
Medium run	1.15	2.43	1.18	2.84	1.20	2.55	2.04	1.29	1.19	1.59	1.69	2.43
Long run	4.46	5.72	4.49	6.11	4.50	5.81	5.34	4.59	4.52	4.89	4.98	5.71
<b>Consumption demand</b>												
First Period	-0.63	-0.62	-0.56		-0.67	-0.65	-0.56	-0.57	-0.58	-0.57	-0.57	-0.65
Medium run	1.09	1.09	1.05		1.09	1.09	1.04	1.08	1.05	1.10	1.11	1.11
Long run	4.40	4.39	4.34		4.40	4.40	4.33	4.38	4.34	4.40	4.41	4.42
<b>Value Added</b>												
First Period	-0.57	0.79	-0.64	1.21	-0.62	1.23	0.28	-0.38	-0.79	0.03	0.10	0.90
Medium run	1.16	2.44	1.19	2.95	1.19	2.55	2.04	1.30	1.18	1.61	1.69	2.46
Long run	4.46	5.74	4.51	6.26	4.51	5.82	5.35	4.60	4.51	4.90	4.98	5.75

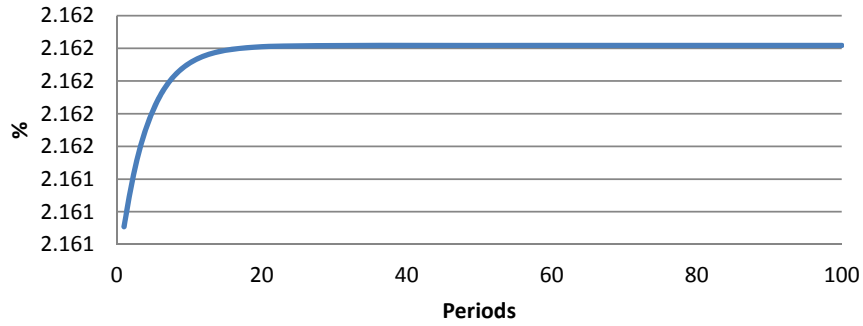
**Table 4: Sectoral Effects of public spending on education financed by labour taxes**

	Food Agric.	Cash Crops	Agro- Industries	Cotton	Handicrafts Industry	Other Handicrafts Industry	Other Modern Industries	Utilities	Textile Industry	Transport- Comm.	Bank Services	Other Business Services
<b>Gross output</b>												
First Period	-0.73	-0.40	-0.80	-0.29	-0.62	-0.15	-0.45	-0.70	-0.79	-0.39	-0.31	0.37
Medium run	-0.17	0.15	-0.31	0.23	-0.04	0.61	0.09	-0.14	-0.37	0.22	0.30	1.01
Long run	1.40	1.72	1.25	1.80	1.53	2.22	1.66	1.43	1.18	1.80	1.88	2.59
<b>Investment by sector of destination</b>												
First Period	0.23	0.23	0.28	0.17		0.24	0.30		0.29			0.20
Medium run	1.17	1.18	1.29	1.03		1.18	1.32		1.30			1.13
Long run	2.81	2.82	2.95	2.65		2.81	2.97		2.95			2.76
<b>Exports</b>												
First Period	-0.91	-0.56	-0.98	-0.43	-0.74		-0.59		-0.96	-0.64		0.18
Medium run	-0.57	-0.20	-0.67	-0.10	-0.40		-0.25		-0.81	-0.19		0.61
Long run	0.97	1.34	0.86	1.43	1.14		1.28		0.69	1.36		2.16
<b>Imports</b>												
First Period	-0.54	-0.23	-0.63				-0.31	-0.48		-0.13		0.63
Medium run	0.22	0.50	0.06				0.44	0.23		0.63		1.56
Long run	1.83	2.11	1.65				2.04	1.83		2.24		3.20
<b>Total domestic demand</b>												
First Period	-0.73	-0.40	-0.80	-0.15	-0.61	-0.15	-0.45	-0.70	-0.79	-0.39	-0.31	0.40
Medium run	-0.17	0.15	-0.31	0.55	-0.04	0.61	0.09	-0.14	-0.37	0.22	0.30	1.09
Long run	1.40	1.72	1.26	2.14	1.53	2.22	1.66	1.43	1.18	1.80	1.88	2.68
<b>Consumption demand</b>												
First Period	-0.75	-0.75	-0.70		-0.73	-0.74	-0.68	-0.76	-0.69	-0.79	-0.80	-0.77
Medium run	-0.19	-0.18	-0.07		-0.19	-0.19	-0.04	-0.16	-0.07	-0.21	-0.23	-0.24
Long run	1.38	1.39	1.51		1.38	1.39	1.54	1.42	1.52	1.37	1.35	1.33
<b>Value Added</b>												
First Period	-0.73	-0.41	-0.82	-0.25	-0.56	-0.13	-0.43	-0.74	-0.75	-0.43	-0.32	0.37
Medium run	-0.18	0.12	-0.34	0.22	-0.04	0.60	0.07	-0.18	-0.34	0.20	0.30	1.00
Long run	1.39	1.69	1.23	1.78	1.53	2.20	1.64	1.40	1.21	1.78	1.88	2.59

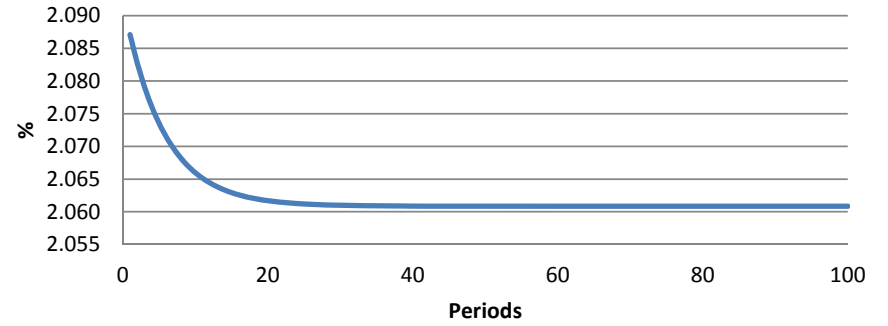
**Table 5: Sectoral Effects of public spending on education financed by output taxes**

	Food Agric.	Cash Crops	Agro- Industries	Cotton	Handicrafts Industry	Other Handicrafts Industry	Other Modern Industries	Utilities	Textile Industry	Transport- Comm.	Bank Services	Other Business Services
<b>Gross output</b>												
First Period	-0.42	-1.21	-0.48	-1.43	-0.53	-1.28	-1.11	-0.65	-0.46	-0.40	-0.33	0.16
Medium run	-0.56	-1.55	-0.90	-1.93	-0.63	-0.67	-1.51	-0.81	-1.25	-0.36	-0.26	0.34
Long run	0.52	-0.51	0.11	-0.94	0.46	0.57	-0.49	0.26	-0.32	0.76	0.86	1.49
<b>Investment by sector of destination</b>												
First Period	-1.65	-1.68	-1.85	-1.83			-1.89		-1.85			-1.64
Medium run	-0.22	-0.23	-0.17	-0.87			-0.17		-0.21			-0.32
Long run	1.22	1.21	1.32	0.46			1.33		1.28			1.09
<b>Exports</b>												
First Period	0.08	-0.83	-0.34	-1.39	-0.43		-1.25		-0.33	-0.24		0.56
Medium run	-0.90	-1.88	-1.58	-2.76	-1.60		-2.63		-2.36	-0.83		-0.11
Long run	-0.01	-1.01	-0.75	-1.96	-0.76		-1.84		-1.71	0.14		0.84
<b>Imports</b>												
First Period	-0.92	-1.60	-0.63				-0.97	-0.66	-0.60	-0.57		-0.41
Medium run	-0.21	-1.20	-0.21				-0.36	-0.17	-0.11	0.12		0.97
Long run	1.06	0.00	0.99				0.89	1.05	1.11	1.39		2.39
<b>Total domestic demand</b>												
First Period	-0.42	-1.22	-0.49	-1.48	-0.53	-1.28	-1.11	-0.65	-0.47	-0.40	-0.33	0.08
Medium run	-0.56	-1.54	-0.90	-1.16	-0.62	-0.67	-1.50	-0.81	-1.25	-0.36	-0.26	0.43
Long run	0.52	-0.51	0.12	0.02	0.46	0.57	-0.48	0.26	-0.31	0.76	0.86	1.62
<b>Consumption demand</b>												
First Period	-0.36	-0.40	-0.57		-0.54	-0.56	-0.60	-0.58	-0.57	-0.51	-0.40	-0.36
Medium run	-0.44	-0.45	-0.39		-0.77	-0.76	-0.39	-0.54	-0.43	-0.51	-0.41	-0.54
Long run	0.66	0.65	0.75		0.29	0.31	0.76	0.58	0.71	0.59	0.70	0.53
<b>Value Added</b>												
First Period	-0.36	-1.10	-0.26	-1.08	-0.17	-0.95	-0.69	-0.42	-0.18	-0.26	-0.27	0.26
Medium run	-0.49	-1.47	-0.65	-1.77	-0.46	-0.41	-1.14	-0.47	-0.90	-0.08	-0.15	0.44
Long run	0.59	-0.45	0.37	-0.81	0.59	0.82	-0.14	0.62	0.05	1.07	0.99	1.59

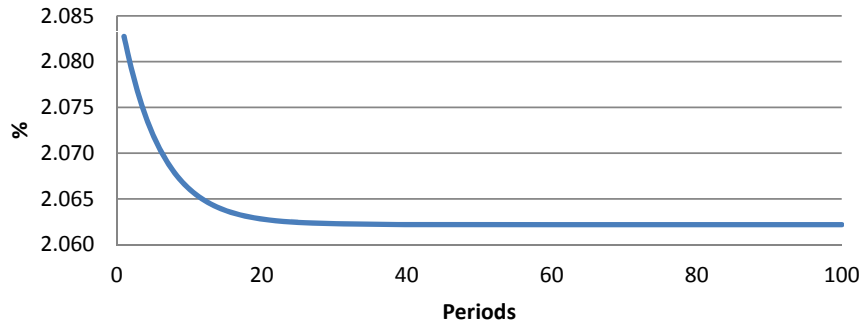
**Human capital growth rate  
Capital Gov. Transfers**



**Human capital growth rate  
Capital tax financing**



**Human capital growth rate  
Output tax financing**



**Human capital growth rate - Capital tax  
financing**

