Taxation, Human Capital Formation and Long-run Growth with Private Investment in Education

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Abstract

Privately financed education is introduced into the standard endogenous growth model along the lines of Lucas (1990) to examine the effects of tax reform on growth rate and human capital accumulation. Using parameters calibrated to match the features of the Indonesian economy, this study finds that tax reform affects the growth rate non-negligibly, which is different from the well-established evidence from the US data. Under plausible parameter values, eliminating capital income tax rate can an increase growth rate by 8 to 14 percentage change. While private spending on education changes considerably in response to changes in both tax rate and public spending on education, learning time remains relatively constant. Results also show that the growth effects of changes in public spending on education are stronger than those of taxation.

1 Introduction

It has been well established that in the endogenous growth model with investment in human capital as the driving force of growth, tax reform has a negligible effect on the US growth rate. A widely discussed starting point for the recent literature tracing the effect is Lucas (1990) who performed quantitative experiments using the US data and found an insignificant growth effect of tax reform. Stokey and Rebelo (1995), by assessing the endogenous model features and parameter values that are significantly important for determining the quantitative impacts of tax reform on growth, conclude that Lucas's conclusion is theoretically robust and consistent with the evidence.

One of the fundamental assumptions of the above model is that human capital is produced using existing human capital and learning time.[1] Glomm and Ravikumar (1998) relax this assumption by introducing public spending on education in the human capital technology and investigating the impact of tax reform on growth rate and human capital accumulation. The motivation is that government spending on education is distortionary; it can affect an individual's time profile of consumption over his lifetime as well as the individual's physical and human accumulation investment decisions. Despite the distortionary government spending, their findings on the US economy are also consistent with that of Lucas's (1990). The trivial impact is mainly due to the negligible change in the human capital in response to changes in capital income tax.

This study introduces another channel through which taxation can potentially affect human capital formation, namely private investment on education. In this case, in addition to facing the trade-off between consumption and investment in physical capital, an individual is also faced with the trade-off between consumption and investment in human capital in making decision about her income allocation. Consider when an individual must finance her own education. When her income decreases, we would expect her to spend less on her education.[2] For instance, Flug, et al. (1998) find that changes in capital income tax rate has a stronger correlation with investment in human capital than physical capital suggesting that an increase in capital income tax rate will discourage not only investment in physical capital, but also human capital.[3] Hence, in a model where human capital is the driving force of growth, the growth effects of tax reform, theoretically, would be larger

[1]Some studies have extended Lucas's model, especially on the human capital technology. King and Rebelo (1990) consider an open economy and physical capital as an input into the production of human capital. In one of their experiments, a 10% increase in the capital income tax reduces the growth rate by 8.6%. By combining the elements of both Lucas (1990) and King and Rebelo (1990), Jones, et al. (1993) find that tax reform can significantly affect growth. For more detail, see Stokey and Rebelo (1995).

[2]In a developing country such as Indonesia, where the majority of the population works in the agricultural sector, the above suggestion is most likely true. For instance, Cameron and Worswick (2001) find that the rural farmers in Indonesia tend to decrease their expenditures on education in response to crop losses.

[3]The study of the impact of earnings taxation on the formation of human capital was previously done by Boskin in the 1970s who noted that the current tax structure creates a disincentive to accumulate human capital. A few studies thereafter, such as those of Eaton and Rosen (1980), King and Rebelo (1990), Trostel (1993), and Lord and Rangazas (1998), suggest the impact to be anywhere from negligible effects to a significant reduction in the long run stock of human capital.

when privately financed investment is incorporated into the model.

Unlike the recent studies that focus on the US data, I also evaluate the model using the Indonesian data. With two distinct episodes of development during the 1970-1996 period, the country's economy offers an interesting background for this study. In the first episode, from 1975 to 1987, the country's fiscal policy was aggressive and its economy grew moderately with an average of 4.5% per year. In the second episode, from 1988 to 1996, fiscal policy was less aggressive and the economy grew relatively high with an average of 5.9% per year.[4] In addition, with 60% of the total education spending during the 1975-1996 period was privately financed, private spending on education played an important role in human-capital formation in Indonesia.

This study particularly asks the following questions. First, does the model with privately financed education deliver a non-negligible effect of tax reform on growth and human-capital formation? Second, is the model prediction on the effects of taxation and public-education spending on growth rate and human-capital formation also consistent with other economy? Third, using the parameters of public policy implemented during $1986 - 1996$ in Indonesia, where the capital-tax rate was relatively low and public spending on education was relatively high, can the model generate the growth rate as observed in the data?

I then calibrate the model using the data from the 1975-1987 period and quantify the effects of changes in the capital income tax rate and public-education spending on growth and human capital formation. Under plausible parameter values, changes in capital income tax rate result in non-negligible effects on growth rate. Eliminating the capital income tax rate can increase growth rate by 8 to 14 percentage points. The result under the model without private investment in education is relatively lower. Eliminating capital income tax increases growth rate by 5 percentage change. While private spending on education changes considerably in response to changes in both capital income tax rate and public spending on education, learning time does not change. Results also show that the growth effect of changes in public spending on education is stronger than that of taxation. Similar policy experiments using the US data produce almost the same results: a tax reform has non-negligible impact on growth rate which is different from the well-established evidence from the US data.

The rest of the paper is organized as follows. Section 2 briefly describes the Indonesian economy during the 1975-1996 period. Section 3 outlines the model. Sections 4 and 5 examine the effects of public policy on growth and human capital accumulation. Conclusions are drawn in Section 6.

2 Indonesian Economy: 1975-1996

The growth rate of output per capita in Indonesia during the 1975-1996 period is plotted in Graph 1, panel a. The plot indicates that the growth rate was higher and less fluctuated

[4] See the next section for more detail.

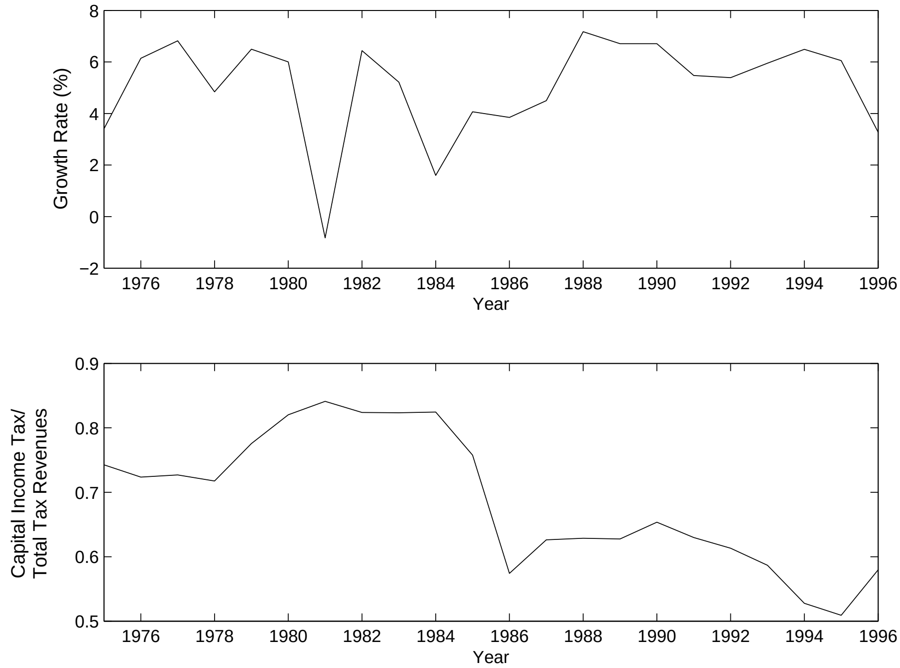

Figure 1: Growth Rate and the Ratio of Capital Income Tax to Total Tax Revenues in Indonesia, 1975-1996

after 1988.[5] The difference in the economic performances in the two periods has often been attributed to the difference in the macroeconomic management. The literature on the Indonesian economy generally labels the first period as an oil boom and adjustment period. The oil boom of the 1970s provided the government with very large gains in revenue, which was used to finance investment in infrastructure and other public expenditures. During this period, the annual government revenue grew by almost 15% and the income-tax rate was about 30%. Taxes on income, profits, and capital gains were a major component of government revenue and contributed to about 75% of total tax revenues (panel b).

The decline in oil prices, the high inflation rates, and the decrease in the GDP per capita growth rate in the early 1980s compelled the government to undertake changes in macroeconomic policy, including modernizing the tax system in 1983. Furthermore, the significant effect of the decrease in oil prices and the decline in Indonesia's overall terms of trade, which was equivalent to a reduction of about 10% in Gross National Income, have forced the government, starting in 1988, to respond by cutting its expenditures and widening the reforms of the tax and financial systems into a series of large-scale deregulations. While taxes on income, profits, and capital gains continued to be the major component of total tax revenues, they were no longer as significant as in the previous

[5]A simple two-sample t-test shows that the means of per capita growth rates in the two periods are statistically different from each other. The test for equal variances also shows that the variances of per capita income growth rates are statistically different from each other (at 5% significant level).

period. The average ratio of taxes on income, profits, and capital gains to total tax revenues decreased from 75% to 60%. This is the beginning of the second period, which is called the liberalization period, during which the average of annual government revenue grew by 7.0% and the income-tax rate decreased from 30% to about 25%.[6].

3 The Model

The economy is populated by a large number of identical and infinitely lived households, firms and a government. I assume that population growth is zero and population size is normalized to one. A single good is produced by competitive firms using physical and human capital input factors. Factors are rented from households in competitive markets. The government collects taxes on capital and labor incomes, and uses the revenues to finance its spending on education and lump-sum transfer payments. Households and firms take fiscal policies as given when making optimal decisions.

3.1 Households

Each household divides her time on working (n_t) or learning (v_t). There is no leisure. Preferences of the representative household are given by the CRRA utility function:

$$U = \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma}, \ \sigma > 0, \beta \in (0,1), \tag{1}$$

where c_t is consumption at time t, $1/\sigma$ is the inter-temporal elasticity of substitution and β is the household's rate of time preference.

In period 0, each household is endowed with h_0 units of human capital and k_0 units of physical capital. In each period, households rent physical capital to firms at the rental rate and supply effective labor $n_t h_t$ at the wage rate w_t. The government taxes households' capital at rate τ_K and labor income at rate τ_L . Households use their after tax income to purchase consumption goods, provide "quality" of education and accumulate physical capital. Each period, the households face a budget constraint:

$$c_t + i_t + e_t = (1 - \tau_L) w_t n_t h_t + (1 - \tau_K) k_t + \Delta_t \tag{2}$$

where i_t is the household's investment in period t, e_t is the household's investment in human capital, and Δ_t is the lump sum transfer from the government to the household. The household's physical capital evolves over time according to

$$k_{t+1} = (1 - \delta_k) k_t + i_t, \ 0 < \delta_k < 1, \tag{3}$$

[6]For more detail of these episodes, see Bhattacharya and Pangestu (1993)

where δ_k is the depreciation rate.

The human capital is produced using technology:

$$h_{t+1} = Bv_t^{\eta}\Big[\varphi G_t^{\rho} + (1-\varphi)e_t^{\rho}\Big]^{\frac{(1-\mu)}{\rho}} h_t^{\mu} + (1-\delta_h)h_t,\ B > 0, \mu, \eta, \varphi, \rho \in (0,1), \tag{4}$$

where v_t is time input from household, e_t and G_t are privately and publicly provided "quality" of education, δ_h is the depreciation rate of human capital, and ρ is the elasticity substitution between the publicly and privately provided "quality" of education.

An important feature of this specification is the inclusion of household's income invested in human capital, e_t. Previous studies typically consider the following inputs in human capital formation: time inputs (Lucas, 1988), physical capital (King and Rebelo, 1990), market goods (Trostel, 1993), genetically transmitted endowments (Becker and Tomes, 1979) and public spending on education (Glomm and Ravikumar, 1997, 1998). The formulation in (4), which includes publicly and privately provided "quality" of education, allows an investigation of the effect of capital income tax on individual's decision to accumulate human capital through his investment in the quality of education. The importance of quality education on human capital and growth has been stressed by Behrman and Nancy (1983) and Card and Krueger (1992), Hanushek and Kim (1995) and many others. Hanushek and Kim (1995) for instance, by considering international test scores in mathematics and science across country as a measure of labor force quality, find that the improved labor force quality proves to have a strong and robust influence on growth. Card and Krueger (1992), by using the pupil/teacher ratio, average term length, and the relative teacher pay as a measure of school quality, find that men educated in states with higher-quality schools have a higher return to additional years of schooling. Here, private investment in education is used as the determinant of education/school quality: increased spending on education leads to a better quality of schooling and to an increase in human capital.

The household's allocation of time between learning and working implies

$$n_t + v_t \leq 1. \tag{5}$$

Given initial endowment of physical capital, k_0 and human capital, h_0, a sequence of prices and public choice $\{p_t, w_t, r_t\}_{t=0}^{\infty}$, the household maximizes (1) subject to (2)$-$(5).

3.2 Firms

Final output is produced using private physical and human capital with constant returns to scale technology. Each firm produces output y_t at time t according to the technology:

$$y_t = Ak_t^{\alpha}(n_t h_t)^{1-\alpha}, A > 0, \alpha \in (0,1), t = 0, 1, 2, ... \tag{6}$$

where k_t is the amount of private capital rented by the firm, $n_t h_t$ is the amount of effective labor hired by the firm at time t. The representative firm's profit maximization problem yields $r_t = A\alpha z^{\alpha-1}$ and $w_t = A(1-\alpha)z^{\alpha}$, where $z = k_t/n_t h_t$.

3.3 Public Sector

In this model, the public sector collects taxes on labor (τ_L) and capital income (τ_K) to finance its spending on education (G_t) and lump-sum transfer to households (Δ_t). I assume that the government spending on education is a fraction of output, $G_t = \xi y_t$, and the rest of its revenue is transfer. The government maintains a balanced budget in all periods such that $\tau_L w_t n_t h_t + \tau_K r_t k_t = \Delta_t + G_t$.

3.4 Equilibrium

Given a fiscal policy $\{\Delta_t, G_t, \tau_K, \tau_L\}_{t=0}^{\infty}$, a competitive equilibrium is a set of allocations $\{c_t, v_t, n_t, e_t, h_{t+1}, k_{t+1}\}_{t=0}^{\infty}$ together with prices $\{p_t, w_t, r_t\}_{t=0}^{\infty}$ such that:
(i) $\{c_t, v_t, n_t, e_t, h_{t+1}, k_{t+1}\}_{t=0}^{\infty}$ solves the household's problem,
(ii) $\{n_t h_{t+1}, k_t\}_{t=0}^{\infty}$ solves the firm's problem,
(iii) the government's budget constraint is satisfied: $\tau_L w_t n_t h_t + \tau_K r_t k_t = \Delta_t + G_t$, and
(iv) $G_t = \xi y_t$.

3.5 Long-run Growth and Fiscal Policy

Along the balanced growth path,
$1 + \gamma = c_{t+1}/c_t = k_{t+1}/k_t = h_{t+1}/h_t$; $n_t = n, v_t = v, e_t = e, z_t = z$, for all t,
where γ is the growth rate. In this economy the steady state solutions to the model are characterized by a system of four nonlinear equations (7)−(10) with four unknowns $\gamma, v, \tilde{e}$, and z, where $\tilde{e} = e/y$.

$$(1+\gamma)^{\sigma} = \beta[(1-\delta_k) + (1-\tau_K)\alpha A z^{\alpha-1}], \tag{7}$$

$$\frac{(1+\gamma)^{\sigma}}{\gamma+\delta_h} = \beta\left[\frac{(1-v)\eta}{v} + \mu + \frac{1-\delta_h}{\gamma+\delta_h}\right], \tag{8}$$

$$1 = B(1-\varphi)(1-\mu)v^{\eta}[(1-v)Az^{\alpha}]^{-\mu}\left[\varphi\xi^{\rho} + (1-\varphi)\tilde{e}^{\rho}\right]^{(1-\mu-\rho)/\rho}, \tag{9}$$

$$\gamma + \delta_h = Bv^{\eta}[(1-v)Az^{\alpha}]^{1-\mu}\left[\varphi\xi^{\rho} + (1-\varphi)\tilde{e}^{\rho}\right]^{(1-\mu)/\rho}. \tag{10}$$

Equation 7 describes the tradeoff between consumption and physical capital investment. Equation 8 describes the tradeoff between learning and working. Allocating more time to learning reduces household's current income but increase its human capital which will increase the household's future income. Equation 9 describes the tradeoff between consumption and investment in human capital. Equation 10 follows from the learning technology.

When $e = 0, \varphi = \rho = 1$, equation (9) is disappeared and equations (7), (8) and (10) are exactly the same as those of (11)−(13) in Glomm and Ravikumar (1998).

4 Qualitative Evaluation

One of the objectives of this study is to investigate whether the growth effects of tax reform and public spending on education are different with or without privately financed education. The key parameters governing the effects are φ (the public share in total spending on education) and ρ (the elasticity of substitution between public and private spending on education). The following results summarize the theoretical effects of the two parameters on growth and human capital formation.

Proposition 1: *If elasticity of substitution between public and private spending on education, ρ is less than c_1 and steady state of learning time (v) is greater than c_2, the growth effect of tax reform is increasing in φ and the effect of tax reform on learning time is decreasing in φ. Moreover, if public spending on education is larger than the private one, the growth effect of tax reform is increasing in ρ and the effect of tax reform on learning time is decreasing in ρ.*

Proof (see the appendix).

Intuitively, with larger ρ (more of substitutability) a decrease in tax rate increases private investment by larger amount which then increases human capital stock and raises growth rate.

The above results also suggest that setting φ equal to 1 (or without private spending on education) would produce the highest effect on growth and human capital formation of a change in capital income tax. However, for a certain value of φ, this is not true which is summarized in the following proposition.

Proposition 2: *Suppose the steady state values of v and z are the same in the model with and without privately financed education, then for $\varphi > c_3$, the growth effects of taxation is higher in the model with privately financed education than the model without private investment in education.*

Proof (see the appendix).

As shown in the appendix, the value of c_3 is

$$\varphi < 1 + \frac{\gamma \frac{\eta}{v} \phi_2 - 1}{\gamma(1-\mu)^2} \tilde{e}(1-v)z^{\alpha}.$$

The proposition establishes a theoretical possiblity of having a greater growth effect of a tax reform in the model with privately financed education. To see this, let's suppose the parameter values in the above equation are as follows: $\alpha = 0.4, \gamma = 0.045, \eta = 0.8, v = 0.5, \beta = 0.9, \sigma = 1.5, \tilde{e} = 0.02, z = 0.1$, and $\delta_h = 0.06$. These values imply that $\varphi < 0.40$ which is theoretically possible.

Proposition 3: *If elasticity of substitution between public and private spending on education, ρ, less than c_1, and steady state of learning time (v) is greater than c_2, the growth rate is increasing and learning time is decreasing in public spending on education. Moreover, if public spending on education is larger than the private one, the growth effects of public spending on education is increasing in ρ and the effect of tax reform on human capital formation is lower for a larger ρ.*

Proof (see the appendix).

The intuition is, with larger ρ, more of substitutability, an increase in public spending on education lowers private investment in education by a larger amount, which in turn, increases human capital stock and raises growth rate.

5 Calibration

5.1 Baseline Parameterization

Except when specific values for the Indonesian economy are available, parameterization of the model follows Lucas (1990) and Glomm and Ravikumar (1998) to produce comparable results. I set the 1975-1987 period as the benchmark parameterization. The average growth rate during this period is 4.5%. The inter-temporal elasticity of substitution, $1/\sigma$, is set equal to 0.5 (or $\sigma = 2$). For technology parameters, Kim and Lau (1996) estimate that the share of physical capital in output, α, is around 0.67 for Indonesia; Harrison (1996) estimates the share to be about 0.4 for developing countries, while Collins and Bosworth (1996) suggest the share for developing countries to be between 0.3 and 0.4. As a baseline, I set α equal to 0.4. The depreciation rate of physical capital is set at 6%.

For the parameter values of human capital technology, the share of public spending on total education spending is about 0.4. This is calculated using the data of a households's final consumption as a percentage of GNP, which has an average of 60%, and the data of households's spending on education as percentage of final consumption, which has an average of 4.5% over the period of 1980-1987. This gives the average ratio of private spending on education to GNP to be about 2.55. With the average ratio of public education spending to GNP is 1.7, the share of public spending on total education spending is 0.4. The average return to investment in education is within the range of 10% to 15%.[7]

[7] There are various version of return to schooling in Indonesia. Payaman (1981) and Pscharopoulos (1982) in Behrman and Deolalikar (1991) estimate private rates of return to be in the range of 15% to 26% for various school levels. Behrman and Deolalikar (1991), by adjusting standard estimations of rates of return to schooling for repetition of grades and dropping out which are widespread phenomenon in most developing countries, find that the rates of return to schooling in Indonesia range from 5% to 11.7% for various school levels. McMahon and Boediono (1992) estimate social (adjusting for public sector costs) rates of return to be in the range of 9% to 25% for various school levels. World Bank (1990) reports estimates rates of return to schooling in Indonesia at 10%. The recent estimates by Duflo (2001) show that the rates of return to schooling range from 6.8% to 10.6%. For the rest of the paper, I focus the discussion on $\mu = 0.70$ which implies that rates of return to schooling are about 15%.

This implies that the marginal return to human capital or the elasticity of human capital, μ, is between 0.7 and 0.8.[8] Following Lucas (1990), I set the elasticity of time input, η, equal to 0.8. The remaining parameter values of the human capital technology that need to be determined are the elasticity of public and private spending on education, ρ, and the depreciation rate of human capital, δ_h.

For the value of ρ, there are few known facts concerning the degree of substitutability/complementary between public and private spending on education. However, it is reasonable to expect that public and private spending on education are either slightly complementary or substitutability. Hence, the value of ρ is likely to be between 0 and -1.[9] As for the depreciation rate, Stokey and Rebelo (1995) suggest a range of 3% to 8% for the US data to be reasonable, while Glomm and Ravikumar (1998), following Mincer (1974), set the depreciation rate equal to 1.2%. The condition of the Indonesian economy is considerably different from the US. Besides accounting for retirement rate as what Stokey and Rebelo (1995) did, it is reasonable to assume that any potential unmatched skills of labor force are likely to induce higher depreciation rate of human capital.[10] In this case, labor mismatched is likely to be higher in Indonesia than the US which suggests δ_h could be higher than 4%. The exact values of ρ and δ_h are set in such a way that the private spending on education equals 2.55% of income. This sets ρ and δ_h equal to -0.85 and 0.045, respectively.

Regarding the parameter values of public policy, the tax rates on capital income and labor income equal 30%. The share of public spending on education as percentage of GNP is 1.7%. Finally, given the parameter values in Table 1 and by normalizing coefficient A to 1, the value of β is obtained from (7); the learning time is determined by (8); and equations (9) and (10) are used to obtain the coefficient B as well as the fraction of income spent on education, $\hat{e}$, which equals 2.55%. I then use the system of the four non-linear equations in (7)-(10) to quantitatively evaluate the model predictions on growth rate and human capital for different parameter values of public policy.

5.2 Quantitative Evaluation

The first policy experiment consists of removing capital income tax. The results in Table 2 show that the growth rate decreases non-negligibly in tax rates. Eliminating capital income tax rate from the initial rate of 30% increases the growth rate by 8.5 percentage change. While the effect on learning time is negligible, private education spending decreases from 2.55% to 2.24% of income in response to the removal of capital income tax. The intuition for the non-negligible effect on private education spending is as follows: a

[8]For instance, with an average return of 15%, μ is given by: $\varphi(1-\mu)+(1-\varphi)(1-\mu)=2\times 0.15$, which equals 0.7.

[9]Recall the human capital technology in equation (4). When $\rho \to -1$, we have perfect substitute between public and private spending on education. When $\rho \to \infty$, we have perfect complementary, while $\rho < -1$ indicates complementary.

[10]For instance, an employee who has an engineering background but works in the fishery industry, which requires less of his educational training in engineering, would likely experience a higher depreciation rate of his human capital than if otherwise employed in the sector that utilizes his skills.

decrease in capital income tax rate, other things being constant, increases the net capital rental rate, and makes investment in physical capital relatively more attractive than human capital. Likewise, an increase in capital income tax rate reduces the net capital rental rate which makes investment in human capital relatively more attractive. Hence, for a lower return to education, change in private spending on education, in response to changes in capital income tax, is higher. When $\mu = 0.8$ (the return to education is 10%), eliminating capital income tax rate from 30% reduces private spending on education by 16 percentage change.

In Table 3, I conduct the same experiment under the model without private spending on education. All parameter values are set the same as in Table 1, except the elasticity of human capital is set at 0.85 so that the return to investment in education is approximately equal to 15%. Eliminating capital income tax increases growth rate by 5 percentage change, lower than the 8.5 percentage change in the model with private investment.

I also examine the model implication using the US data. The parameter values used are the same as in Lucas (1990) and Glomm and Ravikumar (1998) except for the additional parameter values of ρ and φ (share of public education spending on total spending on education).[11] Eliminating capital income tax increases growth rate by 10 percentage change which is higher than those of the studies (Table 4).

The second experiment is to investigate the impact of public spending on education. The results in Table 5 show that the growth effects of changes in public spending on education are higher than those of tax reform. This is because human capital formation is more responsive to changes in public spending on education as can be seen from the relatively large change in learning time. The positive relationship between learning time and public spending on education can be explained as follows: an increase in public spending on education increases human capital stock, which then decreases the marginal product of human capital and lowers wage rate. This, in turn, makes the allocation of time to learning is more attractive than to working. Unlike tax reform, the effect on private spending on education is small. In the model, an increase in public spending on education increases human capital stock which then raises the marginal product of physical capital or rental rate of capital. Holding the capital income tax rate constant, an increased rental rate of capital raises the household's income, which provides household with extra income to spend on education.

The third experiment is to investigate the model prediction on growth rate and human capital accumulation when tax rate and public spending on education are changed simultaneously. I use the parameter values of fiscal policy as the ones implemented in the 1988-1996 period where the capital income tax rate was 25% and the ratio of public spending on education to GNP was 2.1%. This experiment essentially asks the following

[11] The complete parameter values are as follows: Capital output ratio (2.4), growth rate of per capital income (0.015), capital income tax rate (0.36), labor income tax rate (0.4), share of public expenditure on education (0.0629), elasticity of time input (0.8), inter-temporal elasticity of substitution in consumption (0.5), elasticity of human capital (0.8), depreciation rate of physical capital (0.06), ratio of public spending on education to total education spending (70%), depreciation of human capital (0.04) and the elasticity of public and private spending on education (-0.95).

question: Given the tax rate and public spending on education in the 1988-1996 period, and assuming the remaining parameter values of the model were the same as in the 1975-1987 period, can the model generate a large change in the growth rate and human capital which are consistent with the data? Table 6 shows that for plausible rates of return to education, with a simultaneous change in the capital income tax rate and public spending on education, growth rate and private spending on education change by a small amount while learning time relatively constant. To a certain extent, the model can produce a relatively large growth rate, although the gap with the data is still relatively large. Under the baseline parameter values, the model generates a growth rate of 4.9%, lower than the 5.9% rate as observed in the data.

5.3 Alternative Parameterization

Do the results hold under different parameter values? Stokey and Rebelo (1995) show that, in the endogenous growth models, among the critical parameters determining the quantitative impact of taxation on growth are factor shares, α, and the inter-temporal elasticity of substitution $(1/\sigma)$. First, the growth effects of tax reform are larger for a smaller σ, higher factor share, and higher degree substitutability between public and private spending on education. A lower σ implies a lower discount factor, β, and a higher interest rate. With a higher interest rate, a representative household is more willing to forgo her current consumption for future consumption which raises her investments. By equation (3), this increases physical capital stock, raises the marginal product of human capital, and induces a higher growth rate. Intuitively, from equation (7), eliminating the capital income tax rate induces households to raise their physical capital investment. This can be seen from a large change in the ratio of physical capital to effective labor, z. Since learning time is relatively constant (which implies that working time is also relatively constant), the large increase in z is primarily due to an increase in the physical capital. As for α, when the value of α is large, a decrease in the capital income tax rate increases the after-tax rental rate of capital by a higher rate and makes investment in physical capital more attractive. With respect to public spending on education, the effects on growth are also larger for a lower σ, larger α, and when public and private spending on education are substitutability.

Using this sensitivity analysis, I choose a set of alternative parameter values of the model by setting α equal to 0.45 and σ equal to 1.5 (Table 7). Both numbers are still within plausible range for the Indonesian data. The results of the experiment are reported in Table 8. Under this new set of parameter values, eliminating the capital income tax rates results in an increase in growth rate by 13 percentage change, a decrease in private spending on education by 12 percentage change while learning time is relatively constant. The change in growth rate is almost twice that of the model without private investment in education. When tax rate and public education spending are changed simultaneously, growth rate increases by 10 percentage change, from 4.5% to 5.1%.

Why is the growth effect of taxation less than observed in the data? First, human capital in the model does not change substantially in response to tax reform. In the data, if the years of schooling are used as a proxy for human capital stock, human capital stock has increased significantly during the 1975-1996 period in Indonesia.[12] The averages of schooling years during the 1975-1987 and 1988-1996 periods were 3.71 and 4.97, respectively−an increase of 34%. If the school attainment of the labor force, which reflects the quality of the labor force, is used as a proxy, human capital stock has also increased substantially in Indonesia during the 1980-1994 period.[13] For instance, the proportions of male labor force with secondary and tertirary education have increased from 30% to 52% and from 7% to 18%, respectively during the 1980-1994 period.

A substantial increase in human capital stock in Indonesia during the period can also be seen from the increased productivity and earnings.[14] Duflo (2001) finds that the large school expansion during the early and late 1970s in the country has led to an increase of 3% to 5.4% in wages of the individual involved in the survey. While the empirical findings suggest that human capital stock has increased non-negligibly during the 1988-1996 period, the calibrated learning time only increased by a modest amount. Glomm and Ravikumar (1998) also obtain a similar result for the US economy where learning time is not responsive to changes in capital income tax rates.

Another reason for the modest change in the growth rate in the model, compared to the data, is the possibility of factors unrelated to the fiscal policy that might have affected a household's decision to invest in physical capital. An example is the user cost of capital which in its simplest form is the real interest rates plus depreciation rates. Studies show that the elasticity between user cost and the capital stock is assumed to be unity (Razin and Yuen 1996; Imrohoroglu, Imrohoroglu, and Jones 1998). This suggests that any change in the real interest rates could affect physical capital formation non-trivially. In Indonesia, the real interest rates in the 1988-1996 period had been relatively low, with an average of 11.3%. In contrast, the average real interest rate in the preceding period was about 16%. The lower interest rates in the 1988-1996 period can be attributed to the aggressive monetary policies and financial liberalization conducted by the Indonesian government throughout the late of 1980s and early 1990s.

[12] The data for 1975-1987 are obtained from Nehru, Swanson and Dubey (1995). The authors' measure of human capital is based on the accumulated years of schooling of the working age (15 to 64) population adjusted to dropout and retention rates for all years and grades. The data for 1990 are taken from Barro and Lee (1996) which is the update of their measure of Barro and Lee (1993)'s educational attainment to include individuals aged 15 to 25 and correct for the presence of dropouts and repeaters by following an approach developed by Nehru, Swanson and Dubey (1995). The data for 1994 are from Collins and Bosworth (1996) and our calculation.

[13] In his classic study of the US economy, Denison (1962) estimates that from 1925 to 1957, the increase in education raised the average quality of the labor force at an average annual rate of 0.93%. This improvement in the quality of the labor force through additional education made a very large contribution to US growth rates equal to 23% of the growth rate of real national income. Jorgenson (1984), by analyzing the contribution of education to US economic growth during the years 1948-73, finds that education, by enhancing the productivity of labor force, contributed 93% of the improvement in labor quality. Since labor quality accounts for 41% of the contribution to economic growth, Jorgenson estimates that education accounts for about 11% of growth during the 1948-73 period.

[14] Labor economists, using survey data on the earning and characteristics of large number of individuals, have studied the link between education and productivity and find that higher earning is associated with higher productivity.

6 Conclusion

Using an endogenous growth model, this paper investigates the effects of fiscal policy on long-run economic growth and human capital formation in Indonesia. In an attempt to improve the prediction of a standard endogenous model along the lines of Lucas (1990), privately financed human capital investment is introduced into the model. This is intended to capture the notion that taxation on physical capital might affect investment in human capital. The results are somewhat different from those of Lucas (1990) and Glomm and Ravikumar (1998). Under plausible parameter values of the model, the findings suggest that tax reform can moderately affect growth rate while distortionary public spending on education affects growth significantly. The smaller growth effect of tax reform, compared to that of public spending on education is, partly, because human-capital formation is less responsive to a tax reform. In addition, the growth effects of tax reform in a model with private investment are larger than those of the model without private investment in education. A simultaneous change in the tax rate and public spending on education has a relatively important impact on growth rate. The experiment produces an increase in the growth rate within the range of 8 to 14 percentage change. While the effects on growth are non-negligible, the introduction of privately financed education in the standard model still fails to account for large increases in human-capital stock as observed in the data.

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7 Appendix

Proof of Proposition 1

Let's re-write equations (11) to (14):

$$(1+\gamma)^{\sigma} = \beta[(1-\delta_k) + (1-\tau_K)\alpha A z^{\alpha-1}], \tag{A.1}$$

$$\frac{(1+\gamma)^{\sigma}}{\gamma+\delta_h} = \beta\left[\frac{(1-v)\eta}{v} + \mu + \frac{1-\delta_h}{\gamma+\delta_h}\right], \tag{A.2}$$

$$1 = B(1-\varphi)(1-\mu)v^{\eta}[(1-v)Az^{\alpha}]^{-\mu}\left[\varphi\xi^{\rho} + (1-\varphi)\tilde{e}^{\rho}\right]^{(1-\mu-\rho)/\rho}, \tag{A.3}$$

$$\gamma+\delta_h = Bv^{\eta}[(1-v)Az^{\alpha}]^{1-\mu}\left[\varphi\xi^{\rho} + (1-\varphi)\tilde{e}^{\rho}\right]^{(1-\mu)/\rho}. \tag{A.4}$$

From (A.1)

$$\frac{dz}{d\tau} = \phi_1\frac{d\gamma}{d\tau} + \frac{z}{(\alpha-1)(1-\tau)}, \tag{A.5}$$

where

$$\phi_1 = \frac{\sigma(1+\gamma)^{\sigma-1}}{\alpha\beta(\alpha-1)(1-\tau)Az^{\alpha-2}}.$$

From (A.2),

$$\frac{dv}{d\tau} = \phi_2\frac{d\gamma}{d\tau}, \tag{A.6}$$

where

$$\phi_2 = \frac{v^2\left[\beta\left\{\frac{(1-v)}{v}\eta + \mu\right\} - \sigma(1+\gamma)^{\sigma-1}\right]}{\beta\eta(\gamma+\delta_h)}.$$

Notice that when $v > \frac{\beta\eta}{\sigma(1+\gamma)^{\sigma-1}-\mu+\beta\eta} = c_2$, $\phi_2 < 0$.

Combine equations (A.3) and (A.4) yields

$$(1-v)z^{\alpha}\left[\varphi\xi^{\rho} + (1-\varphi)\tilde{e}^{\rho}\right] = (1-\mu)(1-\varphi)(\gamma+\delta_h)\tilde{e}^{\rho-1}. \tag{A.7}$$

Totally differentiate equation (A.7) yields

$$(1-\varphi)\tilde{e}^{\rho-1}\left[\rho(1-v)z^{\alpha} - (1-\mu)(\rho-1)(\gamma+\delta_h)\tilde{e}^{-1}\right]\frac{d\tilde{e}}{d\tau} =$$

$$\left\{\varphi\xi^{\rho}+(1-\varphi)\tilde{e}^{\rho}\right\}\left[z^{\alpha}\phi_2\frac{d\gamma}{d\tau} - (1-v)\alpha z^{\alpha-1}\left\{\phi_1\frac{d\gamma}{d\tau} + \frac{z}{(\alpha-1)(1-\tau)}\right\}\right] + (1-\mu)(1-\varphi)\tilde{e}^{\rho-1}\frac{d\gamma}{d\tau}.$$

Collecting terms,

$$\frac{d\tilde{e}}{d\tau} = \phi_3 \frac{d\gamma}{d\tau} - \phi_4, \tag{A.8}$$

where

$$\phi_3 = \frac{\left\{\varphi\xi^\rho + (1-\varphi)\tilde{e}^\rho\right\}\left[z^\alpha\phi_2 - (1-v)\alpha z^{\alpha-1}\phi_1\right] + (1-\mu)(1-\varphi)\tilde{e}^{\rho-1}}{(1-\varphi)\tilde{e}^{\rho-1}\left[\rho(1-v)z^\alpha - (1-\mu)(\rho-1)(\gamma+\delta_h)\tilde{e}^{-1}\right]}$$

and

$$\phi_4 = \frac{\left\{\varphi\xi^\rho + (1-\varphi)\tilde{e}^\rho\right\}\frac{(1-v)\alpha z^\alpha}{(\alpha-1)(1-\tau)}}{(1-\varphi)\tilde{e}^{\rho-1}\left[\rho(1-v)z^\alpha - (1-\mu)(\rho-1)(\gamma+\delta_h)\tilde{e}^{-1}\right]}.$$

Totally differentiate equation (A.4) yields

$$\frac{d\gamma}{d\tau} = \gamma\left[\left\{\frac{\eta}{v} - \frac{(1-\mu)}{(1-v)}\right\}\frac{dv}{d\tau} + \frac{\alpha(1-\mu)}{z}\frac{dz}{d\tau} + \frac{(1-\mu)(1-\varphi)\tilde{e}^{\rho-1}}{\varphi\xi^\rho + (1-\varphi)\tilde{e}^\rho}\frac{d\tilde{e}}{d\tau}\right]. \tag{A.9}$$

Substituting equations (A.5), (A.6), and (A.8) into (A.9), and collecting terms yield

$$\frac{d\gamma}{d\tau} = \frac{\gamma\frac{\alpha(1-\mu)}{(\alpha-1)(1-\tau)}\left[1 - \frac{(1-v)z^\alpha(1-\varphi)}{\phi_5}\right]}{\phi_7}, \tag{A.10}$$

where

$$\phi_5 = (1-v)z^\alpha\rho - (1-\mu)(\gamma+\delta_h)\tilde{e}^{-1}(\rho-1),$$

$$\phi_6 = \frac{\left[(1-\mu)(1-\varphi)\right]^2\tilde{e}^{\rho-1}}{\varphi\xi^\rho + (1-\varphi)\tilde{e}^\rho},$$

$$\phi_7 = 1-\gamma\left[\left\{\frac{\eta}{v} - \frac{1}{1-v} - \frac{(1-\varphi)z^\alpha}{\phi_5}\right\}(1-\mu)\phi_2 + \left[\frac{1}{z} - \frac{(1-v)z^{\alpha-1}(1-\varphi)}{\phi_5}\right]\alpha(1-\mu)\phi_1 + \phi_6\phi_5\right].$$

If $\rho < -\frac{(1-\mu)(\gamma+\delta_h)\tilde{e}^{-1}}{(1-v)z^\alpha - (1-\mu)(\gamma+\delta_h)\tilde{e}^{-1}} = c_1, \phi_5 < 0$.

The derivative of $\frac{d\gamma}{d\tau}$ with respect to φ is given by

$$\frac{d(\frac{d\gamma}{d\tau})}{d\varphi} = \frac{\gamma\frac{\alpha(1-\mu)(1-v)z^\alpha}{(\alpha-1)(1-\tau)\phi_5}\phi_7(\varphi) - \phi_7'(\varphi)\gamma\frac{\alpha(1-\mu)}{(\alpha-1)(1-\tau)}\left[1 - \frac{(1-v)z^\alpha(1-\varphi)}{\phi_5}\right]}{\phi_7(\varphi)^2},$$

where

$$\phi_7'(\varphi) = -\gamma\left[\frac{(1-\mu)z^{\alpha-1}}{\phi_5}\Big\{z\phi_2+\alpha(1-v)\phi_1\Big\}-(1-\mu)^2(1-\varphi)\tilde{e}^{\rho-1}\Big\{\frac{(1+\varphi)\xi^\rho+(1-\varphi)\tilde{e}^\rho}{[\varphi\xi^\rho+(1-\varphi)\tilde{e}^\rho]^2}\Big\}\right].$$

Since $\phi_5 < 0$ (by the assumption), $\phi_7' > 0$. And since $\phi_7 > 0$, $\frac{d(\frac{d\gamma}{d\tau})}{d\varphi} > 0$. By equation (A.6), $\frac{d(\frac{dv}{d\tau})}{d\varphi} < 0$

The derivative of $\frac{d\gamma}{d\tau}$ with respect to ρ is

$$\frac{d(\frac{d\gamma}{d\tau})}{d\rho} = \gamma\frac{\alpha(1-\mu)}{(\alpha-1)(1-\tau)}\left[\frac{(1-v)(1-\varphi)z^\alpha}{\phi_5}\Big\{\frac{\phi_5'\phi_7}{\phi_5}+\phi_7\Big\}-\phi_7'\right],$$

where

$$\phi_6'(\rho) = \frac{[(1-\mu)(1-\varphi)]^2\tilde{e}^{\rho-1}}{[\varphi\xi^\rho+(1-\varphi)\tilde{e}^\rho]^2}\big[\varphi\xi^\rho(ln\tilde{e}-ln\xi)\big],$$

$$\phi_7'(\rho) = -\gamma\left[\frac{(1-\mu)(1-\varphi)z^\alpha\phi_2\phi_5'}{\phi_5^2}+\frac{\alpha(1-\mu)(1-v)(1-\varphi)z^{\alpha-1}\phi_1\phi_5'}{\phi_5^2}+\phi_5'\phi_6+\phi_6'\phi_5\right].$$

The sign of $\phi_7'(\rho)$ is determined by $\phi_6'(\rho)$. If $\tilde{e} \leq \xi$, $\phi_7'(\rho) < 0$ which implies $\frac{d(\frac{d\gamma}{d\tau})}{d\rho} > 0$, and by equation (A.6), $\frac{d(\frac{dv}{d\tau})}{d\rho} < 0$. If $\tilde{e} \geq \xi$, the sign of $\phi_7'(\rho)$ is undetermined analytically.

□

Proof of Proposition 2

From (A.10), by setting $\rho = 1, \varphi = 1$, and $\tilde{e} = 0$, the effect of taxation on growth rate in a model without private investment in education (*wop*) is given by education

$$(\frac{d\gamma}{d\tau})_{wop} = \frac{\frac{\gamma(1-\mu)}{(\alpha-1)(1-\tau)}}{1-\gamma\Big\{\frac{\eta}{v}-\frac{1-\mu}{1-v}\Big\}\phi_2-\gamma\frac{\alpha(1-\mu)}{z}\phi_1}, \qquad (0)$$

By setting $\rho = 1$ in (A.10), the effect of taxation on growth in a model with privately financed education (*wp*) is

$$(\frac{d\gamma}{d\tau})_{wp} = \frac{\frac{\gamma(1-\mu)\varphi}{(\alpha-1)(1-\tau)}}{1-\gamma\Big\{\frac{\eta}{v}-\frac{\varphi(1-\mu)}{1-v}\Big\}\phi_2-\gamma\frac{\alpha\varphi(1-\mu)}{z}\phi_1-\gamma\frac{\big[(1-\mu)(1-\varphi)\big]^2}{\tilde{e}(1-v)z^\alpha}}. \qquad (0)$$

where

$$\phi_1 = \frac{\sigma(1+\gamma)^{\sigma-1}}{\alpha\beta(\alpha-1)(1-\tau)Az^{\alpha-2}},$$

$$\phi_2 = \frac{v^2\Big[\beta\big\{\frac{(1-v)}{v}\eta+\mu\big\}-\sigma(1+\gamma)^{\sigma-1}\Big]}{\beta\eta(\gamma+\delta_h)}.$$

Notice that if $\varphi=1$, $(\frac{d\gamma}{d\tau})_{wop} = (\frac{d\gamma}{d\tau})_{wp}$. $(\frac{d\gamma}{d\tau})_{wp} > (\frac{d\gamma}{d\tau})_{wop}$ if

$$\varphi < 1 + \frac{\gamma\frac{\eta}{v}\phi_2 - 1}{\gamma(1-\mu)^2}\tilde{e}(1-v)z^{\alpha}.$$

□

Proof of Proposition 3

From equations (A.1) and (A.2), $\frac{dz}{d\tau} = \phi_1\frac{d\gamma}{d\xi}$ and $\frac{dv}{d\xi} = \phi_2\frac{d\gamma}{d\tau}$. Totally differentiate (A.7) yields

$$\Big[\rho(1-v)z^{\alpha}(1-\varphi)\tilde{e}^{\rho-1} - (1-\mu)(1-\varphi)(\rho-1)(\gamma+\delta_h)\tilde{e}^{\rho-2}\Big]\frac{d\tilde{e}}{d\xi} =$$

$$\big\{\varphi\xi^{\rho}+(1-\varphi)\tilde{e}^{\rho}\big\}\Big[z^{\alpha}G_2\frac{d\gamma}{d\xi} - (1-v)\alpha z^{\alpha-1}G_1\frac{d\gamma}{d\xi}\Big] + (1-\mu)(1-\varphi)\tilde{e}^{\rho-1}\frac{d\gamma}{d\xi} - (1-v)z^{\alpha}\varphi\rho\xi^{\rho-1}.$$

Collecting terms,

$$\frac{d\tilde{e}}{d\xi} = \phi_3\frac{d\gamma}{d\xi} - \phi_8, \tag{A.11}$$

where

$$\phi_8 = \frac{(1-v)z^{\alpha}\varphi\rho\xi^{\rho-1}}{(1-\varphi)\tilde{e}^{\rho-1}\Big[(1-v)z^{\alpha}\rho - (1-\mu)(\gamma+\delta_h)\tilde{e}^{-1}(\rho-1)\Big]}.$$

Totally differentiate equation (A.4) yields

$$\frac{d\gamma}{d\xi} = \gamma\Bigg[\Big\{\frac{\eta}{v} - \frac{(1-\mu)}{(1-v)}\Big\}\frac{dv}{d\xi} + \frac{\alpha(1-\mu)}{z}\frac{dz}{d\xi} + \phi_5\frac{d\tilde{e}}{d\xi} + \frac{(1-\mu)\varphi\xi^{\rho-1}}{\varphi\xi^{\rho}+(1-\varphi)\tilde{e}^{\rho}}\Bigg] \tag{A.12}$$

Substituting equations $\frac{dz}{d\tau}$, $\frac{dv}{d\xi}$, and (A.11) into (A.12), and collecting terms yield

$$\frac{d\gamma}{d\xi} = \frac{\gamma\frac{(1-\mu)\varphi\xi^{\rho-1}}{\varphi\xi^{\rho}+(1-\varphi)\tilde{e}^{\rho}}\Big[1 - \frac{(1-v)z^{\alpha}(1-\varphi)\rho}{\phi_5}\Big]}{\phi_7}, \tag{A.13}$$

The sign of (A.13) is determined by the numerator. The numerator is greater than zero if $(1-v)z^{\alpha}(1-\varphi)\rho$ ¡ $(1-v)z^{\alpha}\rho - (1-\mu)(\gamma+\delta_h)\tilde{e}^{-1}(\rho-1)$. Or, if $(1-v)z^{\alpha}\varphi\rho > (1-\mu)(\gamma+$

$\delta_h)\tilde{e}^{-1}(\rho-1)$. Recall the assumption that $\phi_5 = (1-v)z^\alpha\rho > (1-\mu)(\gamma+\delta_h)\tilde{e}^{-1}(\rho-1) < 0$. By the assumption and since $\rho < 0$, the condition is satisfied which implies that the numerator is positive. Thus, $\frac{d\gamma}{d\xi} > 0$.

Let's denote the numerator of (A.13) ϕ_9. Now, the derivative of $\frac{d\gamma}{d\xi}$ with respect to ρ is determined by $\phi_9^{'}(\rho)$ which is positive since $\phi_5 < 0$. Given that $\phi_7(\rho) > 0$ and $\phi_7^{'}(\rho) < 0$, $\frac{d(\frac{d\gamma}{d\xi})}{d\rho} > 0$

□

Table 1. Baseline Parameter Values

Parameter	Notation	Value
Intertemporal elasticity of substitution in consumption	$1/\sigma$	1/2
Capital/output ratio	k/y	2
Growth rate of per capita income	g	0.045
Production technology		
Share of physical capital	α	0.4
Depreciation rate of physical capital	δ_k	0.06
Human capital technology:		
Elasticity of human capital	μ	0.7
Elasticity of time input	η	0.8
Elasticity substitution between public and private spendings on education	ρ	-0.95
Share of public spending in total spending on education	φ	0.4
Depreciation rate of human capital	δ_h	0.0624
Public policy:		
Capital income tax rate	τ_K	0.30
Labor income tax rate	τ_L	0.30
Ratio of public spending on education to GDP	ξ	0.017

Table 2. The Effects of Tax Reform on Growth and Human Capital Formation (Returns to Education is 15%)

Tax Rate (%)	Growth Rate (%)	Fraction of Time Spent on Learning	Private Spending on Education (% of Income)
30	4.50	0.570	2.55
25	4.57	0.568	2.49
20	4.64	0.566	2.43
15	4.71	0.564	2.38
10	4.77	0.563	2.33
5	4.83	0.561	2.28
0	4.88	0.560	2.24

Table 3. The Effects of Tax Reform on Growth and Learning Time under the Model *without* Private Spending on Education (Returns to Education is 15%) using Indonesian Data

Capital Income Tax Rate	Growth Rate (%)	Fraction of Time Spent on Learning
30	4.50	0.587
25	4.54	0.586
20	4.58	0.585
15	4.62	0.584
10	4.65	0.583
5	4.69	0.581
0	4.72	0.580

Table 4. The Effects of Tax Reform on Growth and Learning Time under the Model *without* Private Spending on Education (Returns to Education is 15%) using US Data

Capital Income Tax Rate	Growth Rate (%) Without private investment in education	Growth Rate (%) With private investment in education
40	1.450	1.410
36	1.500	1.500
30	1.510	1.531
20	1.520	1.570
10	1.528	1.595
0	1.535	1.625

Table 5. The Effect of Public Education Spending on Growth and Human Capital Formation (Returns to Education is 15%)

Public Spending on Education (% of GNP)	Growth Rate (%)	Fraction of Time Spent on Learning	Private Spending on Education (% of Income)
3.4	5.61	0.543	3.45
2.7	5.24	0.551	3.13
2.2	4.91	0.559	2.86
1.7 (*baseline value*)	4.50	0.570	2.55
1.2	3.95	0.586	2.17
0.7	3.11	0.615	1.68

Table 6. The Effects of a Simultaneous Change in Tax Rate and Public Education Spending on Growth and Human Capital Formation (Elasticity of Human Capital, μ, equals 0.7)

	$\mu = 0.7$	$\mu = 0.8$
Growth (%)		
Baseline ($\tau_K = 0.3$, $\xi = 0.017$)	4.5	4.5
Experiment ($\tau_K = 0.25$, $\xi = 0.021$)	4.91	4.80
Learning Time		
Baseline ($\tau_K = 0.3$, $\xi = 0.017$)	0.570	0.631
Experiment ($\tau_K = 0.25$, $\xi = 0.021$)	0.560	0.620
Private Spending (% of income)		
Baseline ($\tau_K = 0.3$, $\xi = 0.017$)	2.55	2.55
Experiment ($\tau_K = 0.25$, $\xi = 0.021$)	2.73	2.70

Table 7. Alternative Parameter Values

Parameter	Notation	Baseline	Alternative
Intertemporal elasticity of substitution in consumption	$1/\sigma$	1/2	2/3
Capital/output ratio	k/y	2	2
Growth rate of per capita income	g	0.045	0.045
Production technology			
Share of physical capital	α	0.4	0.45
Depreciation rate of physical capital	δ_k	0.06	0.06
Human capital technology:			
Elasticity of human capital	μ	0.7	0.7
Elasticity of time input	η	0.8	0.8
Elasticity substitution between public and private spendings on education	ρ	-0.95	-0.95
Share of public spending in total spending on education	φ	0.4	0.4
Depreciation rate of human capital	δ_h	0.0624	0.0795
Public policy:			
Capital income tax rate	τ_K	0.30	0.30
Labor income tax rate	τ_L	0.30	0.30
Ratio of public spending on education to GDP	ξ	0.017	0.017

Table 8. The Effects of Tax Reform on Growth and Human Capital Formation under Alternative Parameter Values (Returns to Education is 15%)

Tax Rate (%)	Growth Rate (%)	Fraction of Time Spent on Learning	Private Spending on Education (% of Income)
30	4.50	0.581	2.55
25	4.62	0.580	2.49
20	4.73	0.580	2.43
15	4.84	0.579	2.37
10	4.94	0.579	2.32
5	5.03	0.579	2.27
0	5.12	0.578	2.22