Financing of Public Education in a Debt Constrained Economy: Investigation of Fiscal Alternatives in an OLG Model of Endogenous Growth for Turkey

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Abstract

The purpose of this paper is to investigate the effects of fiscal policies of domestic debt management and financing of public spending on education, on cohort welfare and growth. We focus on two issues: the increased burden of debt servicing on public funds for investments in education and the resulting effects on consumer welfare and growth, and tax policy alternatives to relieve productive government spending. To this end, we use a simple, dynamic overlapping generations model, roughly reflecting the Turkish economy in 1990s. We illustrate the ruinous effects of bounded human capital accumulation due to insufficient public funds to education in a debt-constrained fiscal environment. We then examine the direct and indirect taxation alternatives to mitigate the reductions in the availability of public funds for education. In the context of the simple model we employ, the growth path of the economy under the alternative taxation schemes yields a similar outcome. However, even though we observe comparable welfare gains to future generations, choosing consumption taxation or wage income taxation produces diverse effects on the welfare of current generations.

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1 Introduction

Recent advances in the "new growth theory" identify, among many others, the degree of educational attainment as a crucial determinant of the long-run rate of economic growth. Following the lines of Uzawa (1965) and Lucas (1988), many theories have been developed to explain the process of human capital accumulation via investments in education, public and private.[1] In Lucas (1988) human capital is the engine of growth and is produced by a technology where the only input is human capital itself. Rebelo (1991) extends this model to add physical capital in the production of human capital. Becker and Tamura (1990) present a model where human capital is accumulated through parent's home teaching.

From another perspective, educational attainment is also regarded as one of the key factors influencing the distribution of income both across households and labor categories. On the one hand, educational attainment and individual's stock of human capital formation enable its owner to obtain better-paying jobs, more bargaining power and flexibility in the job market. On the other hand, initial distribution of wealth and household income have direct impacts on the family's capacity to invest in its offspring's human capital formation, as most of the investments in education are made when agents are young. This two-way causality between income distribution and investment in human capital signifies that the families who are on the bottom of the strata of income ladder and are dependent on subsistence earnings, would likely to be caught in a low-education, low-income trap. Hence, the manner in which the society stratifies will automatically determine who has access to education, what skill levels are to be accumulating, and, therefore, the patterns of income distribution.

Under these conditions, provision of public funds to education and the government's

[1] Barro and X.Sala-i Martin (1995) point to the significance of both the stock of human capital (part of which is the school enrollment rates) and government expenditures on education (as a ratio of GNP) as an important determinant of economic growth. Among the studies that document the importance of human capital in the context of conditional convergence and persistent economic growth are Romer (1989) and Barro (1991). Borjas (1992) presents empirical evidence for human capital externalities by showing that the average level of human capital of the previous generations positively affect the current generation's productivity level.

ability to invest in education and human capital formation play a crucial role in both attaining greater equality and in promoting growth. Such observations bring issues of human capital formation and optimal design of public policies in terms of investments in education, fiscal debt management and the inter-household and inter-generational burden of taxation into forefront of analysis.

It is the purpose of this paper to investigate the growth consequences of fiscal policies of domestic debt management and financing of public spending on education in a debt-constrained economy -Turkey. Turkey initiated its long process of integration with the world commodity and financial markets with the 1980 structural adjustment reforms. Throughout this process of liberalization, many of the instruments of macro and fiscal control have been transformed and the constraints of macro equilibrium and economic growth have undergone major structural changes. The general picture of the Turkish development path, however, portrays abrupt swings in the modes of adjustment of a developing economy trapped with the needs of domestic industry towards integration with the world markets; poor fiscal debt management leading to extremely high real interest rates; and persistent inflation with cycles of boom and crisis throughout 1990s. In fact, the decade of 1990s meant a drastic deterioration of fiscal balances of the public sector in Turkey. The public sector borrowing requirement (PSBR) as a ratio of GDP, which averaged 4.5% during 1981-88, rose over 9% in the 1989-99 period. This had the effect of raising the real rate of interest in excess of the international standards and also to well above the real rate of growth of the domestic economy.

The continued expansion of public debt under conditions of raising interest rates and inflation resulted in the expansion of interest expenditures within aggregate public spending and within GDP. In the absence of any deficit preventing mechanisms via tax reforms, the rising interest burden led to crowding-out of available funds for investments in education and other wealth-oriented expenditures. This process, severed in self-feeding cycles, led to an overall deterioration of the macroeconomic balances and contributed to both the decline of the real rate of growth and to the culmination of future fiscal deficits.

We attempt to address these issues in the framework of an overlapping generations (OLG) model of endogenous growth to study the growth effects of fiscal and social policies of the government under constraints of debt servicing and a binding fiscal gap. The model developed has an OLG structure with 15 generations that optimally choose lifetime patterns of consumption and saving. The growth process is characterized by the accumulation of both physical and human capital. Public spending on education as well as the human capital endowment of the previous generation contribute to the formation of human capital as a social factor of production. The model is calibrated roughly to post-1990 growth trajectory of the Turkish economy.

We exclusively focus on two issues: *first*, we analyze the consequences of the increased burden of debt servicing on public funds for investment in education, and the resultant effects on growth and consumer welfare. *Second*, we investigate the tax policy alternatives to mitigate the reductions in the availability of public funds for education investments and to re-invigorate the initial rates of growth. We specifically look at two taxation alternatives: a wage tax and a consumption tax. We find that, even though the fiscal outcomes and growth patterns generated by the two tax regimes are comparable, their incidence across factor owners and across generations have important diverse results.

The paper is organized as follows. Section 2 presents a synopsis on endogenous growth literature emphasizing the formation of human capital and the role of public policy on economic development. Section 3 provides a broad overview of the recent development path of the Turkish economy and the public accounts. Section 4 describes the model in detail. Section 5 reports on the simulation methodology, presents experiments and discusses their results. Section 6 concludes and suggests directions for future research.

2 Synopsis on Literature

The endogenous growth literature captures the insight that the crucial force behind positive growth rates is the elimination of the tendency of diminishing returns to

investment in a broad class of capital goods, including human capital. Antecedents of this literature utilize theories of technological progress, innovation and imitation (Romer (1987), Grossman and Helpman (1991)), learning by doing (Stokey (1991)), population change, fertility and human capital investment (Becker and Barro (1988)) in order to introduce increasing or constant returns to scale to the cumulative factor of production.

Such developments in endogenous growth theory have opened a new avenue of research to study the influence of government spending on both consumption-saving decisions and, through the education system, on human capital accumulation itself. King and Rebelo (1990), Lucas (1990), Rebelo (1991) and Jones and Rossi (1993) are among the studies of endogenous growth that analyze the consequences of distortionary taxation.

While the studies mentioned above employ an infinite-horizon framework, Blanchard (1985) carries the argument of debt management into finite horizons. Jones and Manuelli (1992) highlight the role of government as an income re-distributor in an OLG framework which allows for persistent growth. Likewise, Buiter and Kletzer (1991), (1995) use OLG models to present the theoretical analysis of fiscal policies.

Ni and Wang (1994) and Glomm and Ravikumar (1997), both under the assumption of finite lifetimes, let public spending on education directly enter the production function of human capital. Ni and Wang (1994), adopt the theoretical framework of Becker and Barro (1988) and Becker and Tamura (1990), and examine the role of public expenditures on human capital formation. In their model, public spending on education is financed by income tax. Glomm and Ravikumar (1997), in turn, focus on the growth effects of productive government spending and growth-maximizing level of taxation in a dynamic general equilibrium model.

A promising avenue of research within the theoretical framework of endogenous growth with human capital accumulation would be building large scale general equilibrium models where rational agents with finite lifetimes and a public sector with an infinite time horizon interact within a market setting. In contrast to simple models, large-scale models

enable one to consider simultaneous changes in a variety of fiscal instruments and provide ways to understand short-to-medium run responses by making it possible to observe the transition paths of the modeled economies. The large -scale models, with assumptions of longer time-spans on the part of each individual provide more realistic setups that will point to the income distribution effects of permanent policy changes. It is also possible in this framework to obtain and analyze quantitatively the transition path of real economies from one steady state to possible-other.

The main reference to large-scale OLG models is that of Auerbach and Kotlikoff (1987). In this seminal work, growth is exogenous. Yet, by building up a model with 55 overlapping generations, the authors look at a large set of fiscal issues including deficit finance, changes in level and timing of government spending, choice of tax base, social security and demographic changes. The last two issues , in particular had been the subject of most quantitative studies in OLG framework including Auerbach, Kotlikoff, Hagemann and Nicoletti (1989), Hviding and Mérette (1988), Fougère and Mérette (1999) and Sayan and Kenç (1999), Kenç and Sayan (2000).

Hviding and Mérette (1988), Fougère and Mérette (1999) and Sayan and Kenç (1999) investigate the macroeconomic effects of pension reforms in the context of demographic transitions. Hviding and Mérette (1988) and Fougère and Mérette (1999) focus on the aging problem in OECD economies and look over for pension funding alternatives. The latter model extends the former by employing endogenous growth features under human capital accumulation. Kenç and Sayan (2000), on the other hand, study the shocks of demographic transmission from large to small scale economies in an OLG, computable general equilibrium analysis. Lau (1999) and Jensen, Nielsen, Pedersen and Sorensen (1998) are both built for the Danish economy. Lau (1999) analyzes how capital and labor income taxes may affect human capital accumulation, employment, retirement and welfare. Jensen et al. (1998) simulate their model with imperfect competition in the labor market and a public pension system to investigate the macroeconomic and distributional effects of a policy experiment involving a 10% cut in the capital income tax rate.

In an endogenous growth model where savings take place in the form of both physical and human capital, Mérette (1998) investigates the effects of alternative debt-reduction policies. This model represents a small open economy calibrated to match Canadian data. His analysis investigates how transferring the government solvency burden of future generations to current generations affects growth and inter-generational welfare. The simulations show that growth can vary significantly during the transition from a high to a low debt-GDP ratio. GDP rises in the long run and in general, old generations suffer a small welfare deterioration, while welfare of future generations rises significantly.

Thus, a more general aim of this study is to contribute to this literature by investigating the growth and welfare effects of fiscal policies of financing of public spending on education within the context of an OLG model of the Turkish economy. In the next section, we provide a brief review of the major swings of the post-1990 growth path of the Turkish economy and discuss the behavior of the key macro-aggregates which are critical for the model.

3 Broad Overview of the Recent Development Path of the Turkish Economy

Table 1 portrays the evolution of macro-fundamentals and selected fiscal variables of the Turkish economy throughout the 1990s.[2] At a first glance, the table reveals that the Turkish growth experience throughout the period, has been on a fluctuating trend, starting at 9.4% in 1990, decreasing to 0.3% in 1991, and even reaching to -6.1% during the crisis of 1994. Concomitant with this observation is the cyclical behavior of consumption and investment. The 20% decline in the public expenditures in 1988 could not be recovered until 1996-1997. Private investments, on the other hand, were not sustained. The peak of private capital accumulation in 1993 at 38.8% was immediately followed by the contraction in 1994. The overall expansion of both private and public capital accumulation could not

[2]For broader overviews of the Turkish economy since 1980s, see Boratav, Turel and Yeldan (1996), Kose and Yeldan (1998), Celasun (1994), Senses (1994) and Metin-Ozcan, Voyvoda and Yeldan (2000).

provide a sustained invigoration to the overall economy.

One of the major signs of the vulnerability of the Turkish macroeconomic balances in 1990s has been continued inflation. Price inflation, which rested at the plateau of 60-65% in 1980s, has accelerated after 1998 and reached the plateau of 75-80%. One of the main reasons of the continued disequilibrium and persistent inflation rates in Turkish economy has been identified as the deterioration in the fiscal balances of the public sector and the resulting borrowing requirement. Data in the lower panel of the table reflects that the PSBR ratio has stood around 10% on average between 1990-99. Throughout this period, the budget deficit has been the main actor in the accumulation of PSBR. The ratio of the public deficit to PSBR, which has been on the order of 40-50% until 1994, increased to 77.6% in 1995, and to 92% in 1997.

It is important to note, however, a fundamental change in the financing of the PSBR, breaking away with pre-financial liberalization period of 1980s and 1990s. Under the financially repressed conditions of the 1970s and the 1980s, deficit financing through central bank advances (monetization) was the most direct method. However, after the embarkment of structural adjustment reforms, the state has been financing its borrowing requirements from domestic borrowing through issues of the government debt instruments.

A direct consequence of this regime switch has been the rise in the stock of the securitized debt, which was about 6% of GNP in 1989. Yet, during 1990s, the ratio of interest payments on existing debt to budget expenditures increased from 20.6% in 1990 to 38.3% in 1999. The Table reveals that the main burden of interest payments originated from the domestic component of the public debt.

It is certain that the main reason for persistent budget deficits has been the accumulating debt stock and rising share of interest payments on domestic debt. In this vein, fiscal debt management not only acts as an income transfer mechanism to domestic rentiers, but also constraints the state's ability to act as a "productive" and a "regulating" agent. For instance, the share of public investment expenditures in total was 14.7% in

1990, decreased to 8.1% in 1994, and further to 5.1% in 1995.

There is no doubt that the outstanding government debt and its composition create not only a financial burden but also have adverse effects on the growth trajectory of the Turkish economy in the 1990s. The share of public spending on education decreased from 18.8% in 1990 to 11.8% in 1999. Given that post-secondary education is provided mainly through public schools, it becomes more urgent to study the growth effects of government public education funding policies under the constraining effects of the public debt.

4 Model

The model can be viewed as a version of Auerbach and Kotlikoff (1987). Here, labor supply is inelastic on the part of every individual. However, each individual entering the labor force is endowed with some level of human capital through a human capital accumulation function. The economy is assumed closed and there are no bequest motives.[3]

The economy consists of overlapping generations of finitely lived individuals who are assumed to have G periods to live, starting from the time they enter the workforce. During the first GW periods the individual works, receives an exogenous labor income which she divides between consumption, taxes and saving. In the last $(G - GW)$ periods, the agent is retired and consumes her accumulation of assets. So, at any point in time, there are G overlapping generations in the economy, GW working, and $(G - GW)$ retired. Households are assumed rational, having perfect foresight. There is a single production sector that behaves competitively. The single commodity is produced under a neo-classical technology using capital and effective labor. Government taxes consumption, capital and labor incomes, issues debt, and spends its income on purchases of goods or investing in education.

The model incorporates features of endogenous growth through a human capital

[3]No bequest motive, either in the form of physical or human capital (education) is a strong simplification at this stage given the effect of intergenerational altruism on capital accumulation of the economy, and given the typical Turkish household behavior.

accumulation function, where public spending on education enters directly as an argument.[4] Growth is generated by the accumulation of both physical and human capital.

The model can be separated into several sets of equations relating to human capital accumulation, household behavior, production sector, government sector, and aggregation and equilibrium conditions. We shall discuss each of these in detail.

4.1 Human Capital Accumulation

In what follows, for any variable v, subscript g stands for the age group and subscript t stands for time period.

At any date t, $n_{1,t}$ individuals enter the workforce and the basic education system endows each of these entrants with a human capital stock $h_{1,t}$ that is generated according to the accumulation function:

$$h_{1,t} = H(h_{1,t-1}, GE_{t-1}) \tag{1}$$

where GE_{t-1} is public expenditures on education in period $t-1$.[5] The existence of $h_{1,t-1}$ in the accumulation function of human capital embodies the externality pointed by Lucas (1988).

One way to interpret the sequence of human capital endowments is as follows: the time until the agent enters the workforce is recognized as the period of education or period of learning and acquiring skills. During this period, individuals accumulate human capital according to the learning technology given in Equation 1, by inelastically allocating their time to learning. The effect of GE_{t-1} here can be interpreted as the provision of public schools.

[4] With a human capital accumulation function in which public spending on education enters directly as an input, enables the study the growth effects of productive government spending in a dynamic general equilibrium context.

[5] This functional form is proposed by Glomm and Ravikumar (1997).

4.2 Households

We work with a representative agent for each generation in the economy. Each individual, once born into working life, derives utility from consuming $c_{g,t}$ units of consumption good when she lives her g^{th} period at time t.

Formally, an agent entering the workforce at time t is assumed to have preferences of the form:[6]

$$U_t(c_{1,t}, c_{2,t+1}, ..., c_{G,t+G-1}) = \sum_{g=1}^{G} \beta^{g-1} u(c_{g,t+g-1}) \tag{2}$$

Here, β is the discount factor, $0 < \beta < 1$. $u : \Re_+ \rightarrow \Re$ is the current period utility function.[7] Leisure does not enter as an argument in the utility function because of the assumption of inelastic labor supply.

The optimization problem of the representative agent is subject to the physical wealth accumulation conditions. Each agent, following the education period, enters the workforce at time t with zero level of initial physical assets and $h_{1,t}$ level of human capital. The current period budget constraint governs the physical wealth accumulation in the following manner:

$$a_{g+1,t+1} - a_{g,t} = (1 - \tau w_t) w_t h_{g,t} + (1 - \tau r_t) r_t a_{g,t} - (1 - \tau c_t) c_{g,t+g-1} \tag{3}$$

where $a_{g,t}$ is the physical wealth asset of an individual of age g at time t, w is the wage rate per unit of effective labor, and r is the interest rate. τw, τr and τc are tax rates on labor income, interest income and consumption, respectively. When an individual is a member of an active population, she inelastically supplies her labor endowment to production and allocates disposable income to consumption and savings. During the periods of retirement, she consumes her accumulation of assets.

[6] The period of education is assumed to bring no utility to the agent.

[7] Here, the utility function $U(c)$ is continuously differentiable, strictly increasing, strictly concave and homothetic. It turns out that the homotheticity of U allows a balanced growth path under a labor-augmenting technology. See Caballé (1998).

4.3 Firms

Firms face competitive output and input markets to maximize profits. Non-negative quantities of the two factors of production, human capital (or efficiency units of labor) and physical capital can be varied costlessly.[8] All firms are identical. The representative firm's production function exhibits non-increasing returns to scale in its two factors of production, increasing in its both arguments, strictly concave, twice continuously differentiable and satisfies Inada conditions. No depreciation is assumed on the part of physical capital.

The aggregate production function then is of the form

$$Y_t = F(K_t, L_t) \tag{4}$$

K_t is the physical capital and L_t is the amount of effective labor. In equilibrium L_t is given by the summation of human capital factor of each cohort, multiplied by the population over the working generations:

$$L_t = \sum_{g=1}^{GW} h_{g,t} n_{g,t} \tag{5}$$

where $n_{g,t}$ is the population of age group g at time t.

Hence, factor demands, resulting from profit maximization decisions of the firms are determined by the two first order conditions:

$$r_t = \frac{\partial F(K_t, L_t)}{\partial K_t} \tag{6}$$

$$w_t = \frac{\partial F(K_t, L_t)}{\partial L_t} \tag{7}$$

4.4 Government

Government may enter the economy in several ways including lump-sum transfers, public good expenditures, pension system or debt accumulation. Yet, in the current

[8] Auerbach and Kotlikoff (1987) find that the presence of installation costs do not affect the results of the simulations significantly.

model, to keep the analysis focused on productive government spending vs. government consumption. We hypothesize that the government spends on education of young, levies taxes on wage and capital incomes and consumption, pays interest on its debt, and borrows to finance any excess of current spending over current revenue. So, the government has a single-period budget identity given by:

$$B_{t+1} - B_t = r_t B_t + GC_t + GE_t - T_t \tag{8}$$

where B_t is the outstanding government debt and T_t is the total tax revenues of the government at time t. GC_t represents government non-education expenditures. GC_t and GE_t, add up to form total government expenditures G_t.

It is assumed that government as no other income than what it collects through general taxes and does not invest in physical capital. The tax income of the government is determined as a function of proportional taxes on labor income τw_t, capital income τr_t and consumption, τc_t.

$$T_t = \tau w_t \sum_{g=1}^{GW} w_t h_{g,t} n_{g,t} + \tau r_t \sum_{g=1}^{G} r_t a_{g,t} n_{g,t} + \tau c_t \sum_{g=1}^{G} c_{g,t} n_{g,t} \tag{9}$$

4.5 Aggregation and Equilibrium Conditions

In order to ensure that the model is logically consistent and the economy is in equilibrium, the following conditions are introduced.

The aggregation condition for effective labor supply is given in Equation 5. Resource constraint on physical capital stock requires that physical capital and government debt equals total private wealth every period:

$$K_t + B_t = \sum_g a_{g,t} n_{g,t} \tag{10}$$

Finally, output equals household and government consumption plus investment:

$$Y_t = C_t + G_t + K_{t+1} - K_t \tag{11}$$

where $C_t = \sum_g c_{g,t} n_{g,t}$.

5 Simulation Analysis

5.1 Model Specifications

In this section, we specify the functional forms, parameter values and the calibration methodology. In the current set up, G is set to 15 and GW is set to 12; thus, there are 15 overlapping generations, 12 working and 3 retired at each point in time of the economy. Assuming that every agent enters the workforce at the age of 16, retires at the age of 63, and lives until 75, each period in the model can be regarded as 4 years. So, $g = 1$ indicates the age group 16 to 19 years and $g = 15$ indicates the age group 72 to 75 years.

Throughout the simulations, population growth rate is assumed zero, keeping the population of each generation constant at some $n_{g,t} = \bar{n}$ for all (g, t). Each of the $\bar{n}$ agents entering the workforce at time t accumulates its human capital through the human capital accumulation function specified as:

$$h_{1,t} = \delta h_{1,t-1} + \lambda G E_{t-1}$$

where $(1-\delta)$ is the exogenous depreciation rate of human capital and λ measures the rate at which government spending on education enhances the human capital of the agent. We shall call λ the effective rate of human capital investment. In the following stages, λ turns out to be one of the calibrated parameters of the model to assure each agent entering the workforce at the base year is endowed with one unit of human capital.

For each agent, the working life starts at the age of 16; during the period of childhood, the agent is assumed fully dependent on the parents to which they neither constitute extra burden nor any utility. An agent retires at the age of 63, and leaves the economy at the age of 75 maximizing a utility function U_t, time separable and constant elasticity of substitution (CES) type:

$$U_t = \frac{1}{1 - 1/\gamma} \sum_{g=1}^{15} \left(\frac{1}{1+\rho} \right)^{g-1} c_{g,t+g-1}^{1-1/\gamma}$$

Here, ρ is the pure rate of time preference and γ is the intertemporal elasticity

of substitution. Differentiating the household utility function with respect to $c_{g,t}$, and subject to individual's lifetime budget constraint yields the following first order condition for consumption:

$$c_{g+1,t+g} = \left(\frac{1 + r_{t+g}(1 - \tau r_{t+g})}{1 + \rho}\right)^{\gamma} c_{g,t+g-1} \quad g = 1, ..., 14$$

The economy's production technology is represented by a simple Cobb-Douglas form:[9]

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha}$$

A, the technology-scale parameter is one of the calibrated parameters in the model. In this setup, factor demands are determined by the two first order conditions of maximum profit:

$$r_t = \alpha A K_t^{\alpha-1} L_t^{1-\alpha}$$

$$w_t = (1 - \alpha) A K_t^{\alpha} L_t^{-\alpha}$$

where α denotes the capital income share.

5.2 Calibration

Following the functional specifications, calibration of the model to post-1990 Turkish data proceeds in two steps. The first step is fitting the steady state -the long-run path with constant productivity growth- to a set of macroeconomic variables of the Turkish economy over the 1990s. In the calibration procedure, several country specific parameters are given as rough averages of 1990s. The government debt to GNP ratio, for instance is taken to be 20%. The balanced rate of growth (Φ) is the average rate of productivity growth over the decade.[10] Other parameters, such as the intertemporal elasticity of substitution(γ) and human capital depreciation rate (δ) are either chosen to be consistent with other empirical

[9]Specification of a Cobb-Douglas technology in a numerical model seems to be a plausible assumption. Stokey and Rebelo (1995) find that the elasticities of substitution in production are rather insignificant for the quantitative impact of fiscal experiments.

[10]Population growth rate is taken zero in the model.

studies or were assigned "reasonable" values. The elasticity of substitution is taken from Auerbach and Kotlikoff (1987). Human capital depreciation rate is assumed to be 0.1 which is higher compared to the empirical findings of the industrialized countries which lies between 0.02-0.04 (Mérette (1998)).

The model is calibrated such that the value of the income share of capital (α) is 45%. This is also a higher value compared to the values calibrated for OECD economies for example, (Hviding and Mérette (1988)) but is consistent with quantitative studies on Turkish economy[11]. The rate of time preference is one of the parameters calibrated to ensure that the model is in equilibrium and takes the value -0.002. Table 2 presents the main parameters of the model.

The second step of the calibration is creating the benchmark model, in which the economy is allowed to run for a certain period of time (100 periods) under the parameters used. At this stage the tax rates, national saving rate, debt to GNP ratio and public spending to GNP ratio are all constants. The results of the experiments then, are compared with this benchmark model.

5.3 Experiments

We now implement our simulation experiments to address issues of education investments and domestic debt management. First, we analyze the consequences of the increased burden of debt servicing on public funds for investments in education, and the resultant effects on growth and consumer welfare. In the modeling framework, such an effect is simulated through a 20% decrease in the share of public spending on education (GE_t) in total revenues (total taxes, T_t in the model), together with increased share of government non-productive expenditures (GC_t). This specification keeps the growth rate of government debt constant at the growth rate of the economy. Thus, the experiment adheres to the hypothesis that the behavior of government in accumulating debt is left unchanged. Such a setting roughly presents the deterioration of fiscal expenditures

[11] See Mercenier and Yeldan (1999)

destined for education over 1990s. Given that no further policy instrument has been introduced to change the characteristics of the behavior of government in its consumption activities or debt accumulation, government debt to GDP ratio stays constant throughout the analysis.

The shock is introduced in period zero (base year -could be thought to represent roughly year 1995) and the model is run for 100 periods, a time span long enough for the model economy to reach the new steady state. We concentrate on consumer welfare, growth and a number of key macro-variables in order to come up with a panorama of the economy after the shock, relative to the benchmark model.

Figure 1 demonstrates the effects of the 20% decrease in productive government spending on welfare across generations.[12] Each point in the Figure should be interpreted as how many percentage points a consumer that has entered the workforce at period t (w.r.t. base period -0) loses on average from each period's consumption under the shocked economy, compared to the base run. As consumption is a function of lifetime wealth, the burden of insufficient funding of education affects mostly the future generations that are yet to achieve their education (i.e. human capital endowments). On the other hand, the generations that have already accumulated their human capital (working or retired generations in the current period) are also negatively affected because of the reduction in total output -therefore consumption- now to be produced with much less amount of effective labour.

The overall picture of the macro-economy can be traced from Table 3 under the column "decrease in edu. exp". As productive government expenditure is reduced, the economy gradually contracts and the new steady state is achieved with more than half of the output -otherwise to be produced- lost. Similar paths are observed in the behavior

[12] The welfare analysis is based on the one used by King and Rebelo (1990). Denote $U_t \{c_g\}_{g=1}^{15}$ the utility of an agent entering the workforce at time t extracts by following a consumption path $\{c_g\}_{g=1}^{15}$ under the initial steady state. The welfare loss associated by a decrease in education funds is denoted by θ such that $U_t(\{c_g(1-\theta)\}_{g=1}^{15}) = U_t(\{c_g'\}_{g=1}^{15})$. $\{c_{g'}\}_{g=1}^{15}$ is the path of consumption after the unanticipated decrease in education funds.

of other macro-aggregates such as total consumption and total savings. As government is collecting taxes out of income and consumption, its ability to generate higher level of taxes is also reduced with the overall contraction of the economy, relative to the benchmark.

The analysis of consumer welfare and macro-aggregates gives a picture of the transition path and the new steady of an economy constrained in financing productive government spending, such as investment in education, in the framework of the model presented in Section 4. The model being as simple, is nevertheless capable of capturing the destructive effects of a case where government is trapped by financing of non-productive expenditures and interest payments of the accumulating debt. Figure 2, demonstrates both the transition and long-run growth effects of such a shock. In the short-to-medium run, as less and less resources are allocated to production of human capital -the driving force of the model economy- relative to the benchmark, the economy experiences sharp decreases from the initial level of steady state growth rate. In the long run, because the government's ability to finance government consumption and to accumulate debt is dependent on the growth rate of the economy, the widening-gap narrows down a bit, and at the steady state, the new growth rate of the economy lies well below the one to be achieved if the government were capable of sustaining the benchmark levels of education investment.

The detrimental consequences of the new environment on the government's education investment capabilities are easily seen. The government, being constrained by its debt-servicing requirements, necessarily contract its available funds to human capital accumulation. As the rate of expansion of skilled labor via education is slowed down, the overall rate of growth of output tapers off. Our results suggests a decline of the base-run output level by as much as 8.4% by period 10, reaching to a cumulative of 57.9% under the new steady state. Decline in effective supply of labor calls for an upward adjustment in the wage rate by 2.8%. Yet, the net renumeration of labor falls, and together with the 3.3% decline of the rate of return on capital, lead to a fall of household income in the economy. Hence, aggregate private consumption, savings and assets all fall, by 54.5%,

68.3% and 56.5%, respectively, as the economy converges to its new steady state.

The simulation results in a contraction of government education expenditures by 20.0% upon impact, and by 65.9% under the new steady state equilibrium. Thus, over the long run equilibrium position of the economy, we find that a unit decline of aggregate public expenditures on education is associated with an output decline of 0.88%. Here, even though the model results capture the essence of the detrimental growth consequences of deceleration in the rate of investments to education, one necessarily has to use caution in interpreting the simulation results in strict quantitative terms. In evaluating such elasticities, it has to be remembered that the results heavily depend on the choice of a set of smooth functional forms which admit sizable externalities, allowing for magnified results. Given this caveat, however, we find the performance of the model's behavioral equations in response to a variety of sets of shocks to be quite robust and stable .

We now turn to investigate tax policy alternatives to relieve the reductions in the availability of funds for education investments and to re-invigorate the initial rates of growth. Here, we limit our focus to alternatives of direct taxation whose revenue is automatically destined to education, rather than searching for policy alternatives of debt-reduction or indirect sketches of funding productive government expenditures. The two taxation alternatives are increasing wage income tax rate, and increasing consumption tax rate.[13] By focusing on these alternatives of direct vs. indirect taxation, we aim to capture the welfare effects of different taxation schemes across generations. There are two main underlying hypotheses in each experiment. The first is that a "credible" government assures channeling the additional revenue into education; yet, does not change its behavior on non-education spending. Thus the government is still accumulating debt at the endogenous growth rate of the economy. The second assumption is that the policy shocks are unexpected, but once put in operation, agents are informed on their durations. Specific to the experiments in this study, every generation is assumed to take its life-time decisions on consumption and savings while the policy implication (here the increase

[13] We regard the wage income as the type of income from which the government can be sure to extract any extra taxes, therefore we do not consider any increase in capital income taxation in our simulations.

in wage income tax rate or the increase in consumption tax rate) remains in function. Thus, the analysis does not focus on the generations that should enjoy any possible tax reductions in the future.

The first experiment is a 5% increase in the wage income tax rate. The welfare implications of the experiment is presented in Figure 3. Under the new policy environment, an increase in wage income tax rate is borne mainly by current generations. The generation that suffers most is the one which enters the workforce at the period of the implementation of the shock. This generation has just completed its education and does not benefit from additional tax revenue increasing the human capital endowment of future generations, but has to live through all the periods of increased taxes. Generally, currently working generations have to fund increased taxes through their wage incomes but their rest-of-life horizon is shorter to live any positive effects of increased human capital on the whole economy. Yet, the cohorts that are currently retired are the major exceptions to this group, since they have already been out of the working force, and are exempt from the extra taxes on wage income. The overall changes in the household decisions across generations can also be traced from the transition paths of the macro-aggregates of the economy (See Table 3). In the short-run, due to the negative effects of increased taxes on current generations, total consumption and total savings tend to decrease, although the positive impact of accumulating more human capital immediately overcomes the burden of squeezed funds to education and stimulates total production in the economy.[14]

Thus, by period 10, output recovers and already exceeds the base-run level by 2.4%. Recovery of private aggregates is slower, where by the end of period 10, private consumption still lies below the base-run path. Recalling that each period covers 4-calendar years in our modeling context, the observed trade-off between current and future generations' consumption sets calls for attention. Even though the future generations are clearly better-off as a result of the wage taxation policy, current generations become

[14] Yet the time span to observe the effects of policy implications depend on the structure of the human capital accumulation function, which allows for undelayed effects of any funds to education. For this reason, the magnified results of the simulations in Table 3 should be regarded as the upper bounds of any outcomes that would qualitatively follow a similar path.

worse-off lowering the aggregate private consumption by as much 40 calendar years. The necessary postponement of consumer welfare for this long brings issues of political economy and strategic behavior in manipulating government's decision to tax reform topics over which the model is not equipped to address.

Unlike the wage income tax, the burden of consumption tax is rather evenly shared by all currently alive generations, including the already-retired generations. Figure 4 shows the welfare effects of increased consumption tax whose extra revenue is equal to the one generated by increased wage income taxes of the previous experiment. The positive impact of additional tax revenue directed into education is quite similar under both scenarios of taxation. What is common in the two alternative taxation experiments is that the currently living generations suffer welfare deteriorations in comparison to welfare improvements of future generations.

In designing the two experiments, we took advantages of the laboratory characteristics of the model and implement the tax increase so as to achieve a comparable rate of output growth. The approximate uniformity of the output effects of the two instruments enable us to focus entirely on the inter-generational consequences of identified policy regimes.

Welfare differences across generations under all scenarios, with respect to no-intervention equilibrium of the model economy are demonstrated in Figure 5. From the figure, it is possible to compare the welfare losses incurred by taking public funds away from productive activities, with the expected welfare gains to be achieved as a result of the different taxation policies. Figure 2 on the other hand, enables to carry out a similar comparison for future growth rates of the economy. The growth path that the economy is destined under the "decreased public funds to human capital accumulation" policy environment is well-below the benchmark equilibrium path. On the other hand, as the additional revenue from increased taxation (of both types), is diverted to funds for education investment in productive activities, the economy is able to sustain a higher growth rate in comparison to the benchmark rate.

6 Concluding Remarks

This study tries to investigate the effects of fiscal policies in a debt-constrained economy on consumer welfare and growth. Our focus is twofold: first, we analyze the growth and welfare consequences of the increased burden of debt servicing on public funds for investment in education. Second, we investigate two different taxation schemes, namely the wage income taxation and consumption taxation, to mitigate the reductions in the availability of productive government expenditures. To this end, we employ a large scale, OLG, dynamic general equilibrium model of endogenous growth, emphasizing the "productive" characteristic of public funds through a human capital accumulation function, in which government spending on education is an argument. The model is designed to capture the dynamics of capital accumulation, government debt management process and taxation alternatives, and is not proposing options for funding government expenditures on education or managing debt.

The model, being as simple, is nevertheless capable of capturing the destructive effects of bounded funds to human capital formation and the growth and welfare enhancing effects of different taxation schemes. Although we observe quite comparable growth effects under both types of taxation alternatives, the welfare effects of increased taxation on age groups that are to suffer the burden, are quite diverse. The wage income tax is mainly borne by currently working generations whereas the consumption tax burden is more evenly shared. Common to both taxation alternatives, current generations suffer welfare deteriorations in comparison to welfare gains of future generations.

The observations that come out of this simple modeling framework suggest possible directions of expanding the current research. Introducing the inter-generational linkages through altruistic agents, living bequests and investing in the human capital of their offsprings are important given the impact of altruism on capital accumulation and given the behavior of a typical Turkish household. The government's decisions of consumption-accumulation of debt and investing in education are taken exogenous in the current model.

Endogenizing the government's strategic decisions will enable the model to study in the framework of optimal design of public policies. Further research also points to the introduction of heterogeneity across individuals in terms of human capital endowment so as to come up with the analysis of income inequality in a more realistic set up.

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Table 1. Main Economic Indicators and Public Accounts, Turkey (1990-1999)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Annual Rate of Growth										
GNP	9.4	0.3	6.4	7.8	-6.1	8.0	7.1	8.3	3.9	-4.5
Fixed Investment										
Private	20.6	8.1	3.3	38.8	-9.6	9.8	9.2	9.7	-4.2	-11.0
Public	6.7	12.7	2.2	14.1	-39.5	-7.6	33.0	26.5	4.6	7.4
Consumption										
Private	13.1	1.9	3.3	8.4	-5.3	4.8	9.3	8.4	0.6	-3.8
Public	7.9	4.5	3.8	2.3	-3.5	6.8	8.6	4.1	7.8	7.1
As Share of GNP (%)										
Current Account Balance	1.7	-0.2	0.6	3.5	2.0	-1.4	-1.3	-1.4	1.0	-0.7
Public Disposable Income	13.4	11.9	11.4	9.6	9.6	9.4	7.9	9.5	8.7	7.0
Public Savings	3.4	0.7	-0.8	-2.7	-1.1	-0.1	-1.9	-1.7	-2.6	-6.8
Public Investment	-8.6	-7.6	-6.8	-7.3	-3.6	-3.8	-5.3	-6.0	-5.8	-6.6
Public Sector Borrowing Requirement	7.4	10.2	10.6	12.0	7.9	5.2	8.9	7.6	9.2	15.0
Budget Balance	-3.0	-5.3	-2.4	-6.7	-3.9	-4.0	-8.3	-7.6	-6.9	-11.6
Outstanding Domestic Debt	14.4	15.4	17.6	17.9	20.6	17.3	21.0	21.4	21.7	29.3
Interest Payment on Domestic Debt	2.5	2.7	3.1	4.2	5.9	6.0	8.9	6.7	10.6	12.7
Annual Inflation Rate	60.3	66.0	70.1	66.1	106.3	93.6	80.4	85.7	84.6	64.9
Real Interest Rate on Government Bonds	1.1	16.2	15.8	18.4	19.8	19.3	33.7	25.0	29.5	36.8
Share in Public Expenditures (%)										
Health	4.7	4.6	4.7	3.9	3.5	3.3	3.0	3.2	2.6	4.1
Education	18.8	19.3	19.7	16.6	13.4	12.2	11.0	11.1	11.1	11.2
Interest Payment on Debt	20.6	19.2	17.9	23.7	33.1	33.4	37.8	29.8	39.9	38.3

Table 2. Benchmark Parameter Values and Initial Tax Rates

A	production function shift parameter	0.61
	capital income share (%)	45.0
	consumer rate of time preference	-0.0016
1-	human capital depreciation rate (%)	0.1
	effective rate of government spending on human capital	0.0054
$h_{1,0}$	human capital of the agent born to base year	1.00
K/Y	capital to GNP ratio	3.00
S/Y	national savings to GNP ratio	0.192
B/Y	domestic public debt to GNP ratio	0.20
w	tax rate on wage income	30
r	tax rate on capital income	20
c	tax rate on consumption	10

Table 3. Experiments: Selected Macro-Aggregates

	OUTPUT			***WAGERATE***			***INT RATE***		
	decrease in educ.exp	increase wtr	increase ctr	decrease in educ.exp	increase wtr	increase ctr	decrease in educ.exp	increase wtr	increase ctr
BASE-0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	-8.40	2.39	3.22	2.78	-1.75	-0.96	-3.27	2.20	1.20
20	-22.09	7.65	8.78	2.75	-1.82	-0.87	-3.27	2.27	1.07
30	-33.19	12.87	14.32	2.82	-1.84	-0.91	-3.33	2.27	1.13
40	-42.74	18.36	20.15	2.82	-1.84	-0.91	-3.33	2.27	1.13
Steady state	-57.94	30.17	32.74	2.82	-1.84	-0.91	-3.33	2.27	1.13

	TOTAL CONSUMPTION			***TOTAL ASSETS***			***TOTAL SAVINGS***		
	decrease in educ.exp	increase wtr	increase ctr	decrease in educ.exp	increase wtr	increase ctr	decrease in educ.exp	increase wtr	increase ctr
BASE-0	0.19	-0.25	-1.50	0.00	0.00	0.00	-0.57	-3.54	0.21
10	-1.59	-0.69	-0.83	-5.47	0.34	2.09	-29.24	7.51	11.20
20	-16.09	4.17	4.70	-19.64	5.42	7.70	-40.43	13.79	16.63
30	-27.76	9.05	9.81	-31.03	10.50	13.13	-49.78	19.84	23.23
40	-38.11	14.37	15.45	-40.89	15.87	18.91	-56.88	25.63	29.40
Steady state	-54.55	25.77	27.55	-56.58	27.43	31.37	-68.33	38.16	42.96

	TOTAL TAXES			***GOV. EDUCATION EXP.***			***GOV. CONSUMPTION***		
	decrease in educ.exp	increase wtr	increase ctr	decrease in educ.exp	increase wtr	increase ctr	decrease in educ.exp	increase wtr	increase ctr
BASE-0	0.03	2.59	2.38	-19.98	7.89	7.75	2.10	2.16	2.01
10	-7.31	4.61	5.22	-25.85	10.12	10.20	-6.01	4.31	5.11
20	-21.13	9.95	10.92	-36.91	15.75	16.21	-19.96	9.58	10.77
30	-32.32	15.25	16.53	-45.86	21.34	22.04	-31.33	14.87	16.38
40	-42.00	20.86	22.48	-53.60	27.25	28.28	-41.15	20.46	22.32
Steady state	-57.40	32.92	35.31	-65.92	39.94	41.72	-56.77	32.48	35.14

Figure 1. A 20% Decrease in the Share of Education Expenses : Intergenerational Welfare Differences

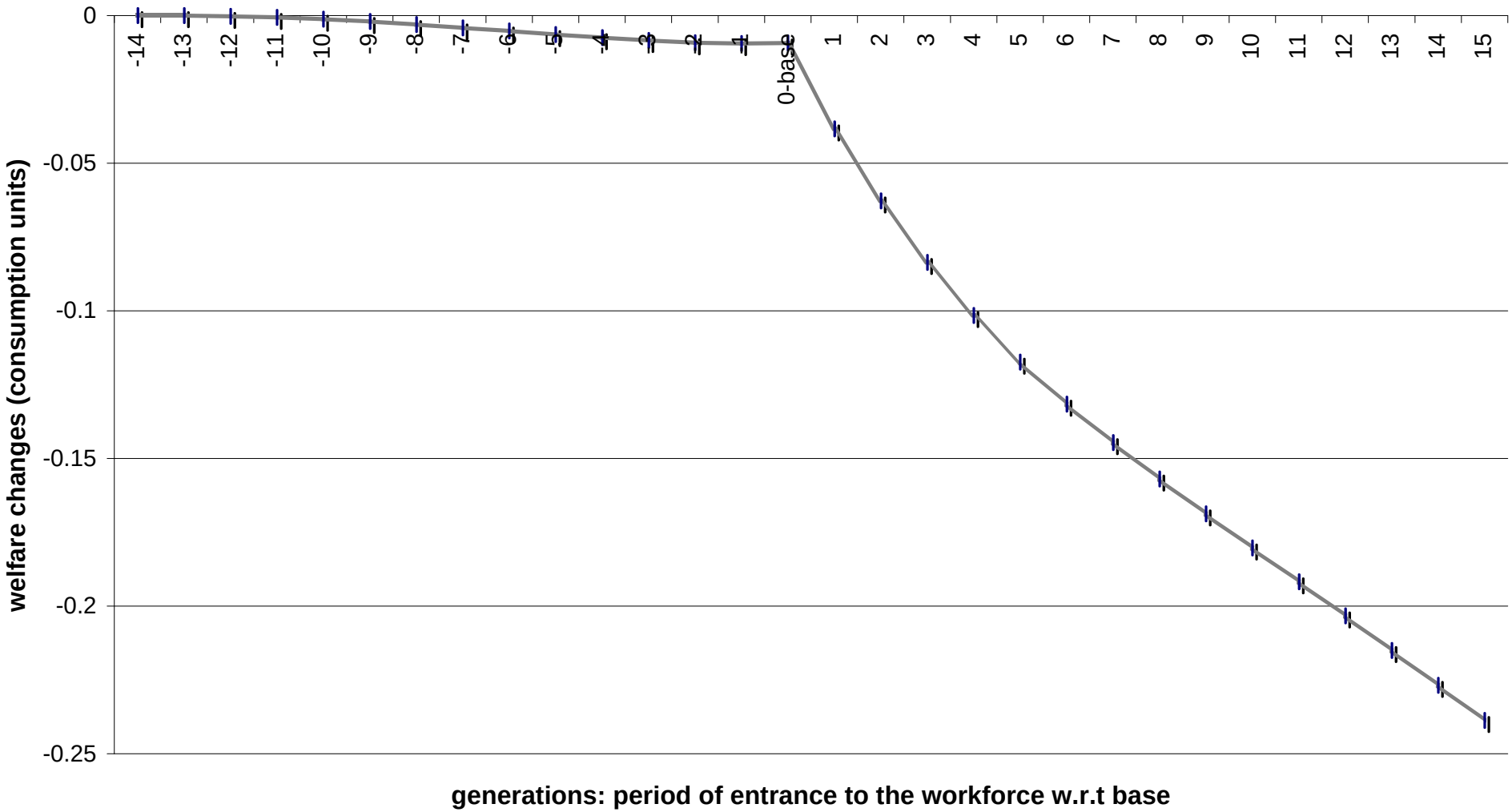

Figure 2. Growth Rate Differences w.r.t. Benchmark

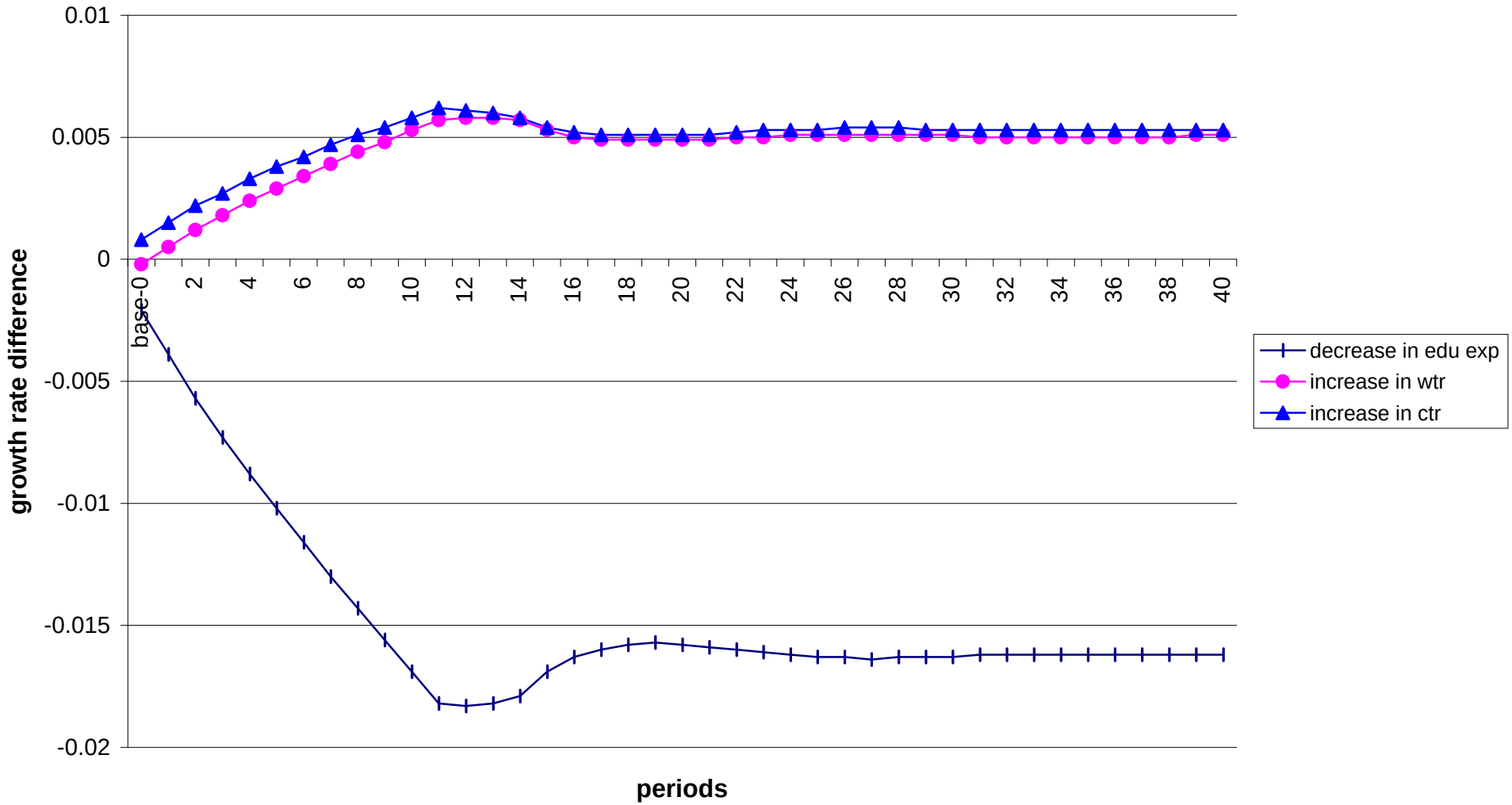

Figure 3. A 5% Increase in Wage Income Tax Rate: Intergenerational Welfare Differences

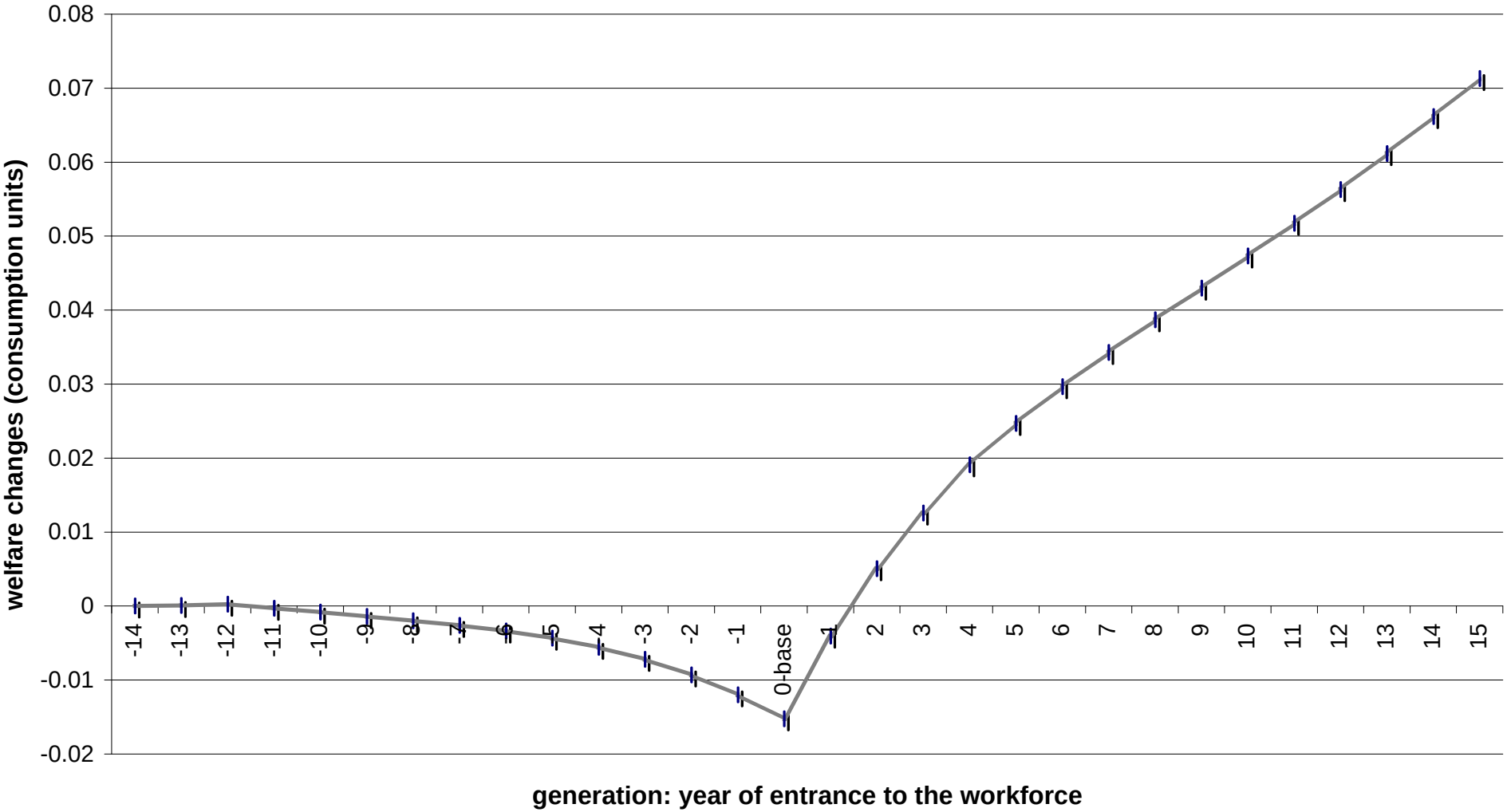

Figure 4. Increase in Consumption Tax Rate: Intergenerational Welfare Differences

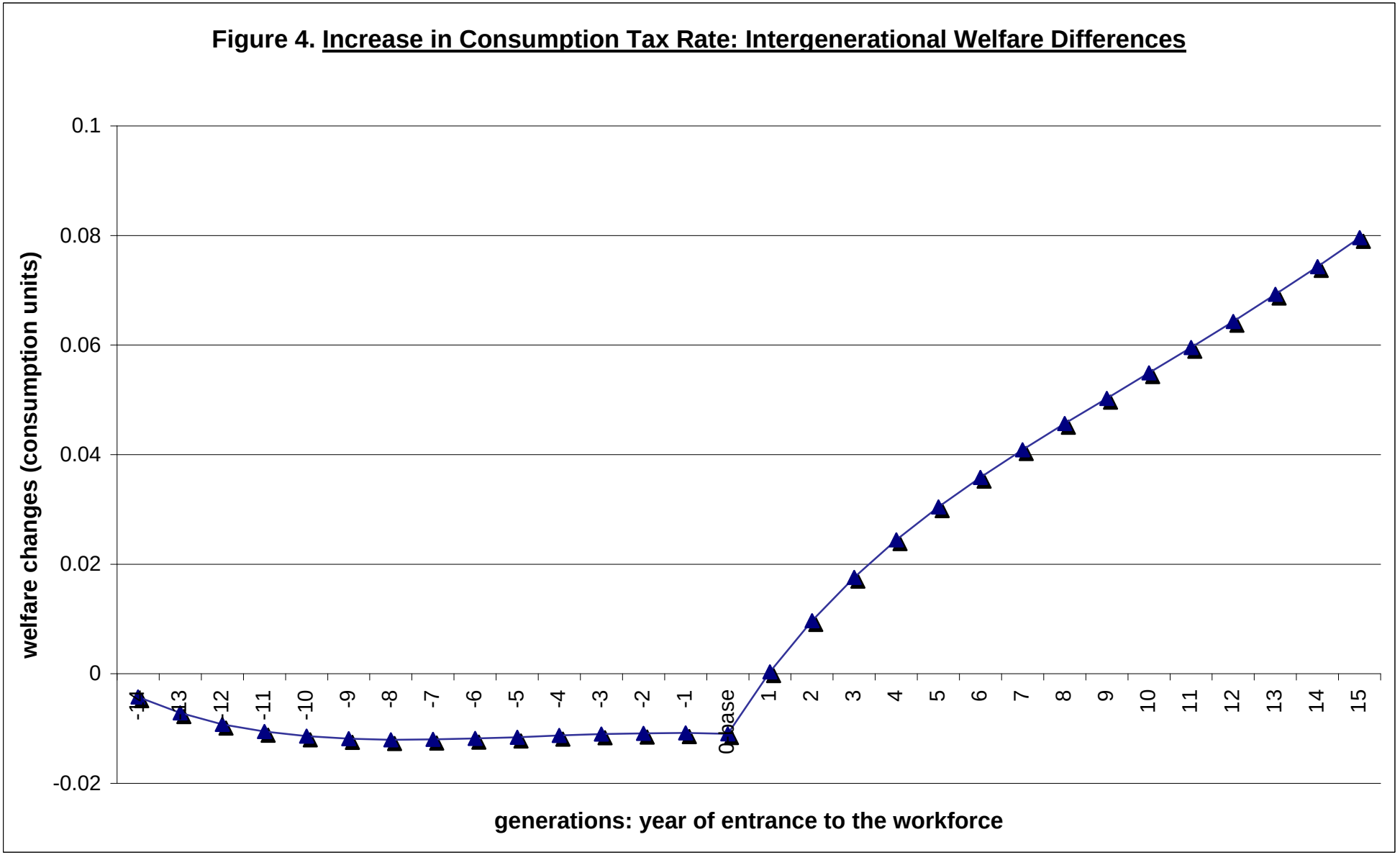

Figure 5. Welfare Differences w.r.t. Benchmark