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Endogenous growth and welfare effects of education subsidies and intergenerational transfers☆

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ABSTRACT

We consider an overlapping generations model with endogenous growth and embrace the Two-Part Golden Rule criterion to analyze the welfare effects of intergenerational transfers and education subsidies. The results are compared with those obtained within the well-known exogenous growth framework. In both cases, pay-as-you-go social security enhances welfare if the growth rate is larger than the interest rate at the laissez-faire. However, with endogenous growth, pay-as-you-go social security may also increase welfare even if the growth rate of the economy is less than the interest rate. Education subsidies have an ambiguous impact because they simultaneously transfer resources across generations and change the relative price of investing in human capital. Overall, the paper shows the existence of important non-monotonicities associated with the welfare effects of modifying the tax parameters in an endogenous growth framework.

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1. Introduction

The welfare effects of education subsidies and intergenerational transfers and, in particular, whether the provision of positive old-age pensions is optimal, have been the object of some interest in the literature of endogenous growth with overlapping generations. Assuming that individuals save for life-cycle reasons, [Docquier et al. \(2007\)](#) analyze a model where children inherit the level of human capital of their parents and invest in education by borrowing in perfect credit markets. They maximize a discounted sum of individual utilities, identify the optimal education subsidy, and argue that optimal pensions cannot be expected to be positive in general. Using the same framework, [Boldrin and Montes \(2005\)](#) show that, in the absence of credit markets to finance education investment, two systems of independent intergenerational transfers, to the young from the middle-aged (education subsidies) and to the old from the same middle-aged (pensions), can be used to replicate the laissez-faire equilibrium with credit markets. Also within the same setting, but pursuing a yet different social objective, [Del Rey and Lopez-Garcia \(2013\)](#) find that the optimal education subsidy to the repayment of loans in middle-age is negative (i.e., a tax) and that optimal pensions are always positive.

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The adoption of alternative individual preference structures naturally yields as well different roles to pay-as-you-go social security. For example, [Caballé \(1995\)](#) and [Kaganovich and Zilcha \(1999\)](#) consider altruistic parents that invest in their offspring's human capital. They both identify alternative conditions on the parameters of their respective models under which it is and it is not optimal to allocate funds for social security. Also, [Ehrlich and Lui \(1998\)](#) show, in an extended-family insurance setup, that the decentralized equilibrium maximizes the steady-state growth rate of human capital. They conclude that introducing a pay-as-you-go social security in this context is likely to reduce the growth rate in developed economies. [Glomm and Kaganovich \(2003\)](#) focus on redistribution effects of public education in an economy with altruistic, heterogeneous agents and public pensions. They show that increased spending on public education may lead to higher inequality. [Yew and Zhang \(2009\)](#) investigate the optimal scale of pay-as-you-go social security in a dynastic family model with human capital externalities (spillovers of average human capital), fertility and endogenous growth. When fertility is treated as exogenous, the welfare effect of social security is negative. However, when it is endogenous, it can be the case that social security is welfare enhancing by reducing fertility and raising human capital investment per child.

As some research has emphasized, it is not surprising that different settings and/or social objectives imply different policy recommendations. For example, within the context of multiperiod lived agent overlapping generations models, [Cassou et al. \(2013\)](#) have shown that different assumptions concerning the output production function impacts the results of policy analysis. Also, focusing on the situation where individuals are strict life-cyclers, [Del Rey and Lopez-Garcia \(2012\)](#) have compared the optimal policies resulting when the social

objective is to maximize a discounted sum of individual utilities defined over consumption levels per unit of efficient rather than natural labor (as in Docquier et al. (2007)).

In this paper we consider pure life-cyclers and embrace, as a social objective, the counterpart in an endogenous growth setting of the Two-Part Golden Rule criterion that has been widely used in exogenous growth models, e.g., Diamond (1965) and Samuelson (1968, 1975a, 1975b). Under this approach, the social planner selects the balanced growth path that maximizes the lifetime welfare of a representative generation subject to the constraint that everyone else's welfare is fixed at the same level. In this setting, and with exogenous productivity growth, the introduction of a pay-as-you-go social security is welfare improving only when the interest rate is too low relative to the economy's growth rate. The intuition is simple: this situation entails a too high physical capital–labor ratio, and the introduction of social security, by depressing savings, reduces the difference between the above-mentioned rates, leading the economy closer to the Two-Part Golden Rule. We show that this may no longer be the case when we allow for human capital accumulation and endogenous productivity growth. In particular, we cannot rule out the possibility of a pay-as-you-go social security being welfare improving even when the interest rate is too high relative to the growth rate. The reason for this result lies in the non-trivial interaction between physical and human capital that can generate important non-monotonicities in the welfare effects of modifying the fiscal instruments. These effects do not exist in the exogenous growth setting and are worth exploring. It is important to emphasize that the introduction of an education decision in an otherwise life-cycle model implies significant differences with other contributions to the literature in which a pay-as-you-go social security may be welfare enhancing. As stated above, in Samuelson (1975b) such a system improves [reduces] social welfare when there is overaccumulation [underaccumulation] of physical capital, and the optimum system is one consistent with the Two-Part Golden Rule. Hu (1979) extends this model to allow for an endogenous retirement decision and finds that the optimal social security does not necessarily lead to the Golden Rule. Finally, in a rather different vein, Feldstein (1985, 1987) discusses the role of myopia as a justification for introducing social security and the desirability of means-testing versus universal provision in a simple a life-cycle exogenous growth model.

We proceed as follows. First, we discuss the consequences of changes in education subsidies and intergenerational transfers for the accumulation of both physical and human capital. And, second, we assess the welfare effects of these changes. A situation that deserves particular attention is that in which the starting point is the *laissez-faire* balanced growth path. We show that, in such a case, the introduction of a (strictly speaking, infinitesimal) pay-as-you-go social security system increases welfare whenever the growth rate of the economy is larger than or equal to the interest rate. However, nothing can be said with generality when the relationship between these rates is reversed. It is worth emphasizing this asymmetry: while the first result parallels its counterpart in overlapping generations models with exogenous growth, the second one is in open contradiction with it. More surprisingly, as a fully-funded social security in the current framework is equivalent to the *laissez-faire* [Samuelson (1975b)], it can well be the case that a pay-as-you-go system is superior to a fully-funded one even when the interest rate exceeds the growth rate.

As the pattern of responses may be very different from the ones arising when the initial position is the *laissez faire*, it is also important to assess the comparative dynamic effects of policy reform along any arbitrary, non-optimal balanced growth path. We show that an increase in the lump-sum tax paid by the working middle-aged reduces the accumulation of both physical and human capital (and thus implies a smaller growth rate). Such a tax reform, however, can either increase or decrease welfare depending on the interaction of two effects: (i) the relationship between the interest rate and the economy's growth rate, and (ii) the effect of a change in the amount of output devoted to

education on the present value of the individual's lifetime resources. This second effect is absent in life-cycle models with exogenous growth, and its interplay with (i) is the reason for the general indeterminacy and the non-monotonicities suggested above. It follows that when the starting point is a pre-existing pay-as-you-go scheme and there are no education subsidies, enlarging the size of social security implies an ambiguous effect on welfare even when the growth rate exceeds (or is equal to) the interest rate. In turn, a change in the rate of education subsidy can either have a positive or a negative effect on the accumulation of both physical and human capital. As for the effect of education subsidies on welfare, the impact is in general indeterminate, although we have derived sufficient conditions (related to (i) and (ii) above) that guarantee that they are welfare increasing.

Finally, the comparative dynamics approach is used to discuss the optimal policy that allows the social planner to maximize social welfare. The analytics provide a neat way to arrive at the optimality conditions obtained in Del Rey and Lopez-García (2013), implying that the optimal education subsidy is negative (i.e., a tax) and that the optimal lump-sum tax on the older generation is negative (i.e., that optimal pensions are positive). However, it is important to emphasize that the sign of the optimal lump-sum tax on the middle-aged is ambiguous: it can be either positive or negative. The fact that, starting from an arbitrary balanced growth path, increasing the (positive) lump-sum tax on the middle-aged and/or the (positive) education subsidy may be welfare improving in spite of their optimal values being both negative, illustrates once again the non-monotonicities concerning welfare effects that have been pointed out above. These non-monotonicities are important from the point of view of policy design because they suggest that the effects of modifying the tax parameters may differ from those emerging from the received theory.

The rest of the paper is organized as follows. Section 2 presents the model and discusses the decentralized equilibrium in the presence of government. Section 3 characterizes the balanced growth paths and provides expressions for the ratios of physical and human capital per unit of efficient labor as functions of the tax parameters. It also obtains the indirect utility function that is the basis of the welfare analysis. Section 4 works out the comparative dynamics associated with changes in the tax parameters and provides numerical examples that illustrate the ambiguity of some results. Section 5 focuses on the optimal configuration of fiscal policy and emphasizes the asymmetries between the optimal configuration of tax parameters and the effects of piecemeal tax reforms. Section 6 concludes.

2. The model and the decentralized equilibrium with government

We consider the overlapping generations model with both human and physical capital in Boldrin and Montes (2005), Docquier et al. (2007) and Del Rey and Lopez-García (2013). At period t , L_{t+1} individuals are born, and coexist with L_t middle-aged and L_{t-1} old-aged. Population grows at the exogenous rate n so that $L_t = (1+n)L_{t-1}$, with $n > -1$. Agents are born with some level of human capital h_{t-1} , measured in units of efficient labor per unit of natural labor. Human capital in period t results from the interaction of the amount of output invested in education d_{t-1} and the inherited human capital h_{t-1} according to the production function $h_t = E(d_{t-1}, h_{t-1})$. Assuming constant returns to scale, the production of human capital can be written $h_t/h_{t-1} = e(\tilde{d}_{t-1})$, where $e(\cdot)$ satisfies the Inada conditions and $\tilde{d}_{t-1} = d_{t-1}/h_{t-1}$ is the amount of output devoted to education per unit of inherited human capital. Therefore, the growth rate of productivity from period $t-1$ to period t , g_t , satisfies $h_t/h_{t-1} = e(\tilde{d}_{t-1}) = (1+g_t)$.

The economy is closed and produces a single good, Y_t , by means of physical capital K_t and human capital H_t , according to a constant returns to scale production function $Y_t = F(K_t, H_t)$. Only the middle-aged work, supplying inelastically one unit of natural labor, so that $H_t = h_t L_t$. Physical capital fully depreciates each period. Letting $k_t = K_t/L_t$ be the

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