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Human capital, externalities and growth in an overlapping generations model

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ABSTRACT

We consider an overlapping generations model with endogenous labor supplies by young and old and a human capital accumulation process that relies on the interaction of these two types of labor. This interaction is not understood by the market hence we analyze fiscal policies designed to remedy this. We argue that taxes must be acceptable to people alive at the time of planning. This makes many proposed taxes unfeasible. Two distinct paths to growth emerge; one through increased savings and another through increased workforce participation. The long run rate of growth depends entirely on human capital but we find this to be of little relevance. Some simulation results are presented for two stylized economic blocks calibrated on the USA and the EURO-zone.

1. Introduction

"How efficiently is productive knowledge passed on from one generation to the next?" Jovanovic and Nyarko (1995, p. 1033). This is a question of fundamental importance in studying the dynamic paths of economies, especially when this knowledge is one of the engines of growth. In this paper, we model the transmission of technological knowhow as disembodied human capital that adheres to the firms themselves. The development of ideas and technological improvements are facilitated by the interaction of young workers and old workers in the production process. Thus the productive activities of a firm in one period contribute the stock of knowledge in the next period. However as this knowledge is readily available in the industry, it cannot be sold.

The role of experience in the production of goods was formalized by Arrow (1962) as the phenomenon of "learning-by-doing". It was empirically found that a good proxy for experience was the stock of physical capital (Schmookler, 1966), but Benhabib and Jovanovic (1991) found that spillovers are not fueled by physical capital. The process of learning-by-doing necessarily passes through the accumulation of knowledge by workers, that is, human capital. In order to model precisely how this knowledge is passed on we are naturally led to identify two categories of workers: the young and the old, hence to use an overlapping generations model. If, as in the spirit of Arrow's concept, or that of Romer (1986) in the context of optimal growth, we suppose that economic agents are not aware of the learning-by-doing phenomenon, we are led to consider a human capital accumulation process where efforts by the young and old interact but where this process is not understood by its beneficiaries. Hence an externality exists and it becomes legitimate to investigate which fiscal policies an enlightened government may choose in order to attempt to remedy it. To study the interaction of young and old labor, it is necessary that both of these be chosen endogenously, therefore we include leisure in the utility function in both periods.

Overlapping generations models that extend the work of Allais (1947), Samuelson (1958) and Diamond (1965) to endogenous labor supply fall into two categories. Those where first period labor is endogenous and those where second

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period workers retire (see for instance Ordover, 1976, Flemming, 1977, Phelps and Riley, 1978 and Park, 1991). Other models assume that labor is inelastically supplied in the first period and endogenously chosen in the second (for instance Hu, 1979 or Crettez and Le Maitre, 2002). This allows the analysis of the effects of superannuation schemes on retirement behavior. However these authors only consider the system in the steady-state. Kohn and Marion (1992) point out that overlapping generation models are particularly suited to the analysis of the externality that forms the core of our model. It allows for endogenous savings and, in our model, the endogenous supply of labor. Our model is close in spirit to the third model of Lucas (1988, p. 27) where the time spent producing a consumption good also contributes to the accumulation of human capital useful in the production of that good. Lucas calls it a learning-by-doing process. Jovanovic and Nyarko (1995) also argue that learning-by-doing takes place on the factory floor when young and old work together. Although they recognize that this process is plagued by inefficiencies they allow the young to purchase training from the old whereas we do not, arguing that the knowledge will be readily available in the next period. Bottazzi and Peri (2003) also consider that existing ideas are a public (not private) input into the process of generating new ideas, hence not purchasable. Iqbal and Turnovski (2008) study optimal capital and labor income taxes when the benefits of public goods are age-dependent. There, government sets its expenditures in each generation as specified fractions of output. A uniform taxation of labor across generations, with an equal consumption subsidy, allows the planner to reach the first-best allocation of resources with a zero tax on capital. They also consider policies where a consumption tax is not an option.

Our model goes beyond these papers in several ways: we allow for endogenous labor choice in both periods thereby permitting the analysis of the impact of taxes on labor supply; the labor of young and old are substitutes in both physical production and the accumulation of human capital.

The main features of our model are as follows. The interaction of young and old in the formation of human capital requires an overlapping generations structure. This interaction is not perceived by the interested parties and generates an externality, thus providing scope for a corrective fiscal scheme. The endogenous nature of the labor supply allows for taxes and subsidies to influence it, hence the accumulation of human capital.

Some of the following results are of particular interest. The long run rate of growth is shown to be entirely dependent on the human capital accumulation process. However this turns out to be true only for the very long run (several centuries). In the short or medium term, growth in physical capital plays the dominant role in the case where the externality commands to tax the old. In the other case human capital accumulation again dominates. Therefore we identify two distinct paths to improved performance, depending on the relative strength of the contribution of young or old to human capital accumulation. Policies that attempt to maximize the long run rate of growth are shown to be undesirable because they requires drastic reductions in standard of living for earlier generations.

The paper is organized as follows. Section 2 presents the basic model. Section 3 analyzes the dynamic equilibrium path with taxes. Section 4 briefly examines alternative modeling of human capital accumulation, Section 5 discusses planning criteria, Section 6 provides some simulations for three typical examples and Section 7 offers some concluding comments.

2. The basic model

There is a single perishable good which is produced with physical and human capital plus two kinds of labor, endogenously supplied by the young and the old. There are constant returns to scale with respect to physical capital and the two kinds of labor. We can thus refer to the firm or the industry indifferently.

While young and old workers together produce the physical good, their workplace interaction modifies the stock of human capital in a "learning-by-doing" process. This process operates distinctly from that of the physical production. The modified human capital stock is available in the next period, as in Jovanovic and Nyarko (1995, p. 1038). We emphasize that the levels of participation of both young and old determine the amount of human capital accumulation and that economic agents are unaware of the phenomenon. This is the source of the externality.

2.1. The firm

The firm exists for two periods. In the first period it collects savings from the young and this forms the physical capital which it uses in its second period for production; physical capital depreciates totally in one period as commonly assumed in overlapping generation models (see for instance De La Croix and Michel, 2002, p. 4).

The production function in period t is

$$Q_t = AH_t^{\omega} e_t^{\nu} \theta_t^{\sigma} K_t^{1-\sigma-\nu}, \quad \sigma, \nu, A > 0 \tag{1}$$

where subscripts indicate the period, Q is the amount of good produced, e and θ are the supplies for young and old labor, respectively, H is the stock of human capital and K is the physical capital. Note that there are constant returns to scale to all purchased inputs (K, θ, e) but that returns to human capital are arbitrary. Physical capital depreciates totally at the end of the period, which represents half a potential working life — around 30 years. Under competitive conditions the firm maximizes profit in its period of production.

$$\max_{e_t, \theta_t, K_t} \{\Pi_t = AH_t^{\omega} e_t^{\nu} \theta_t^{\sigma} K_t^{1-\sigma-\nu} - w_t e_t - p_t \theta_t - R_t K_t\}, \tag{2}$$