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Optimal policy and the risk properties of human capital reconsidered ☆

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ABSTRACT

This paper considers how optimal education and tax policy depends on the risk properties of human capital. A key feature of human capital investments is whether they increase or decrease wage risk. In a benchmark model it is shown that this feature alone determines whether a constrained optimal allocation should be characterized by a positive or a negative education premium. In the same model a positive intertemporal wedge is optimal. The robustness of these results is explored in two generalizations: nonobservability of education and nonobservability of consumption. Finally, policies that implement the constrained efficient allocations are considered.

1. Introduction

How should nonlinear tax and education policies be designed when there is earnings risk and human capital investments may either exacerbate or reduce this risk? This paper presents an analysis of optimal education and tax policy in an environment where individuals face future wage uncertainty at the time when making their human capital investments. Investments in education will raise an individual's future wage, but it may also either increase or decrease the degree of wage risk. In particular, education may either increase or decrease the wage at good shocks relative to the wage at bad shocks.

The relevance of considering future wage risk for individuals undertaking investments in education is firmly established in the recent empirical literature.[1] E.g. based on their findings, Cunha et al. (2005, p. 253) argue that if individuals knew their ex post earnings outcomes resulting from their schooling options, a substantial fraction (25 to 30%) would change their schooling decisions. While it is thus clear that individuals do face substantial uncertainty regarding their returns to education, what is also important is whether wage uncertainty increases or decreases with the level of education. On this point there appears to be no widespread consensus.

The main finding of the current paper is that whether education increases or decreases wage risk matters for optimal policy: if education increases wage risk then education should be downward distorted at a constrained efficient allocation, i.e. there should, in equilibrium, be a positive education premium. The opposite applies when education decreases wage risk. This is first demonstrated in a simple benchmark model. In the same model it is also demonstrated that a positive intertemporal wedge is optimal. It is then shown that the risk effect continues to apply when the economic environment is generalized to allow for nonobservability of education and nonobservability of consumption.

The current paper makes a number of contributions to the existing literature. First, it amends a claim in da Costa and Maestri (2007) that the risk properties of education do not matter for optimal policy given the availability of a general nonlinear income tax. The risk effect applies in their framework, but appears to have been erroneously overlooked. Second, it extends previous work on the same topic using linear taxes, most notably by Anderberg and Andersson (2003) and, more recently, by Jacobs et al. (2008). A framework based on nonlinear taxation has several advantages over a linear tax framework. The main conceptual gain is, as usual, that it explicitly derives the constrained efficient allocations as determined by the information structure in the economy rather than by arbitrarily imposed restrictions on the set of available policy instruments. Furthermore, as

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[1] Important contributions include Carneiro et al. (2003), Cunha et al. (2005), and Chen (2008).

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shown by Golosov et al. (2003), it can readily be extended to consider virtually any dynamic stochastic framework, a feature used not least in the generalizations. Nevertheless, both frameworks represent the same underlying problem — viz. the problem of redistributing income without eroding labor supply incentives. Third, it shows that the logic of the risk effect applies also in generalized environments where either education or consumption is not observable. Fourth, in the process of verifying the robustness with respect to nonobservability of education, the current paper qualifies a recent claim by Grochulski and Piskorski (2006) that the second best optimum will feature a positive education premium (see below). Fifth, the paper highlights the complementary role played by the optimal wedges imposed on human and physical capital investments, and how it depends on the structure of the economic environment. Finally, it provides a discussion of the problem of designing policies that implement the constrained efficient allocations.

The first paper to consider the optimality of social insurance in the presence of endogenous risky investments in education was the seminal work by Eaton and Rosen (1980). They show that the introduction of a proportional income tax is welfare improving, partly because it substitutes for a missing insurance market and partly because, due to wage risk under their stochastic specification, there is underinvestment in education from a social point of view. Hamilton (1987) extended the model by Eaton and Rosen by considering a tax on capital. He notes that a positive capital income tax acts as an indirect subsidy on educational investments, and he shows that (under some conditions) such a tax is optimally introduced as a complement to the tax on earned income.

Anderberg and Andersson (2003) characterized the second best optimal level of education when the government can implement a linear income tax and when education may either increase or decrease wage risk. They show that extending the level of education has two main effects: (i) a “revenue effect” that obtains due to the complementary nature of labor supply and education, and (ii) an “insurance effect” the sign of which depends on whether education increases or decreases wage risk. More recently, Jacobs et al. (2008) used a model similar to Anderberg and Andersson (2003) to consider the simultaneous design of education and tax policy. In other words, the authors characterize what tax/subsidy on education is required to implement a second best optimal level of human capital investments. They show that, since individuals themselves take the insurance effect of education into account, the justification for an education policy obtains from the fiscal externality it generates, i.e. from the revenue effect.

da Costa and Maestri (2007) generalized the problem by considering nonlinear income taxation. They claim that the constrained efficient level of education should follow a first best efficiency rule (a zero education premium) irrespective of the risk properties of education and that the optimal policy requires encouraging human capital formation. Grochulski and Piskorski (2006) considered risky investments in human capital in an environment where the government has access to a nonlinear income tax but cannot observe the education undertaken by the individuals. Moreover, they allowed for multiple working periods with subsequent earnings shocks. In order to keep their model tractable, Grochulski and Piskorski made specific assumptions about the nature of the education risk. They found that a constrained efficient allocation is characterized by a positive education premium and a positive intertemporal wedge. The analysis in this paper (which assumes only one working period) shows that the result that a positive education premium is always optimal hinges on their assumed form for risk.

Parallel to the literature on risky investments in education and optimal policy there exists a related literature that focuses on optimal policy under pure heterogeneity. This literature thus assumes that the individuals are fully informed about their potential earnings at all levels of education. This literature includes contributions by Bovenberg and Jacobs (2005), Bohacek and Kapicka (2008), Maldonado (2008), and Jacobs and Bovenberg (2008b).

The outline of the paper is as follows. Section 2 sets up and analyzes a benchmark model. Section 3 generalizes the model by considering nonobservability of education and unobserved intertemporal trades. Section 4 considers what policies can implement the constrained efficient allocations. Section 5 concludes.

2. The model

There is a continuum of unit measure of individuals who live for two periods, $t=0,1$, and obtain utility from consumption and disutility from labor effort and education.[2] Preferences are additively separable within periods, $u(c_t)+v(l_t+z_t)$, where c_t is consumption, l_t is labor effort, and z_t is education. $u(\cdot)$ increasing, concave, and continuously differentiable while $v(\cdot)$ is decreasing, concave and continuously differentiable. Utility is also additive across periods and the individual discounts utility at rate $\beta\in(0,1]$.

Education only occurs in the first period ($z_1\equiv 0$) and we let z denote the amount of education undertaken at $t=0$. Moreover, the first period is devoted entirely to education and labor effort whereby $l_0\equiv 1-z$. An individual's effective labor supply per unit of work effort at $t=0$ is w_0. Her productivity at $t=1$ depends on education z and on an idiosyncratic productivity shock θ. There is a discrete set of shocks, $\theta\in\Theta=\{\theta_1,\ldots,\theta_N\}$, ordered increasingly. The effective labor supply per unit of labor effort at $t=1$ is then $w(z,\theta)$, which is assumed to be strictly increasing in both arguments, and continuously differentiable and strictly concave in z. Each individual's productivity shock θ is an independent draw from a probability distribution with density π. The p.d.f. $\pi(\cdot)$ is common knowledge. An individual only learns her productivity shock θ at the beginning of $t=1$, and this information then becomes private information.

Aggregate output depends on inputs of capital, K_t, and aggregate effective labor supply, Y_t. The production technology is, for simplicity, taken to be linear, $F(K_t, Y_t)=K_t+Y_t$ with

$$Y_0\equiv w_0(1-z), \quad \text{and} \quad Y_1\equiv\sum_{\theta\in\Theta}y_1(\theta)\pi(\theta), \tag{1}$$

where $y_1(\theta)\equiv w(z,\theta)l_1(\theta)$ is the effective labor supply for an individual of type θ at $t=1$. The economy is endowed with $k_0\geq 0$ units of capital per capita which are taken as given. The economy is assumed to be competitive in the standard sense, implying that w_0 and $w(z,\theta)$ also represent the individuals' wage rates in the two periods.

There is no heterogeneity among individuals at $t=0$ and all consume a common amount c_0. In contrast, at $t=1$, consumption $c_1(\theta)$ etc. generally varies with the individual shock. Given the linearity of the technology the resource constraint can be consolidated across periods and written as

$$c_0+\sum_{\theta\in\Theta}\pi(\theta)[c_1(\theta)-y_1(\theta)]\leq k_0+w_0(1-z). \tag{2}$$

Note that the marginal rate of transformation across the two periods is unity.

2.1. The unconstrained optimal allocation

As a first benchmark case, consider the optimal allocation restricted only by feasibility. To this end, consider a social planner who can observe all individual shocks and can perfectly control each individual's consumption and labor effort. The planner chooses the

[2] The basic model is the same as in da Costa and Maestri (2007) except we allow for any finite number of shocks.