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Endogenous Selection of Comparison Groups, Human Capital Formation, and Tax Policy

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We consider a setting in which the acquisition of human capital entails a change of location in social space that causes individuals to revise their comparison groups. Skill levels are viewed as occupational groups. Moving up the skill ladder by acquiring additional human capital, in itself rewarding, leads to a shift in the individual's inclination to compare himself with a different, and on average better-paid, comparison group, in itself penalizing. We shed new light on the dynamics of human capital formation, and suggest novel policy interventions to encourage human capital formation in the aggregate and reduce inter-group income inequality.

INTRODUCTION

In his Fisher–Schultz Lecture at the Seventh World Congress of the Econometric Society, Akerlof (1997) introduced into the economics literature the concept of 'social space'. *Inter alia*, Akerlof (1997, p. 1010) states: 'I shall let individuals occupy different locations in social space. Social interaction . . . will increase with proximity in this space. Current social location is acquired and dependent on the [individual's] decision . . .' In the current paper, we formalize the concept of 'social space' by linking human capital choices with social location choices; that is, we bundle the decision to acquire more human capital with the 'occupation' of a different location in 'social space'. Consequently, a revision of the comparison to distinct reference groups ensues. Put differently, we posit that individuals are more likely to associate and interact with each other, and consequently to compare themselves with each other, when their levels of human capital are more alike. The essential idea of this paper is thus to view skill levels as occupational groups, and to consider the acquisition of a higher skill level (additional human capital) as being inherently associated with a shift in the individual's inclination to compare himself with a different, and on average better-paid, comparison group: a technician who elects to acquire the additional skill requirements of an engineer also 'acquires' a heightened comparison to engineers. And on average, engineers are better paid than technicians. One implication of this idea is that in addition to the standard correlates of human capital formation—the reaping of increasing rewards and the incurring of acquisition costs—affiliation with a higher-paid comparison group also impacts on the decision whether or not to acquire additional human capital.

Treating skill levels as comparison groups sheds new light on the dynamics of human capital formation and points to novel policy interventions: when benchmarking against a new comparison group is in itself detrimental to wellbeing, because the higher incomes of others in the group cause increased dissatisfaction (relative deprivation), taxing those incomes will render the comparison with the group less intimidating and, as a consequence, the acquisition of additional human capital will become more inviting. We devise a taxation scheme that will not dilute the incentive of 'incumbents' to form

human capital, but will strengthen the incentive of would-be 'newcomers' to acquire human capital.

Our paper builds on three strands of literature: first, the literature that shows that the home environment in which children of otherwise equal abilities are raised 'produces' adults of different levels of education; second, the literature that maintains that individuals persistently compare themselves to others in their reference group who are better off than themselves, that such comparisons lead to dissatisfaction, and that individuals act to reduce or eliminate this dissatisfaction; third, the literature that identifies strong positive links between income inequality and social dissatisfaction. We briefly address these three branches of literature.

A large body of empirical work by Heckman and his collaborators (for a recent example see Cunha and Heckman 2009) suggests that different family environments lead to different levels of investment in the education of children who are otherwise not different, and that in large measure, adversity in a child's early years can be corrected or reversed by educational investments in adulthood (the efficiency of the timing of these investments in an individual's life cycle notwithstanding). In Fan and Stark (2008), it was shown analytically that the children of better-educated individuals 'who are exposed to a different value system, cultural values, and academic orientation' (p. 802) are more likely to be educated themselves than the children of poorly-educated individuals. In both Cunha and Heckman (2009) and Fan and Stark (2008), as well as in many other studies akin to them, however, there is no discussion of the natural possibility that when children become adults and observe the outcome of the educational decisions of their parents, they may choose to take up a course of study that revises the outcome of the parental decisions.

The theoretical and empirical literature on the role and significance of within-group comparisons for wellbeing and behaviour has been growing fast (for a recent review, see Clark *et al*. 2008). The primary tenet of this literature argues that individuals derive (dis)utility, or relative deprivation, from comparing their earnings unfavourably with the earnings of others in their comparison group(s). The idea that relative income impinges on welfare dates back at least to Veblen (1924), and was formally analysed in the pioneering and recent writings of, respectively, Yitzhaki (1979) and Walker and Smith (2002). For writings on relative deprivation and migration, see Stark (1993) and Stark and Wang (2005). In addition, Eibner and Evans (2005) and Luttmer (2005) are recent examples of empirical studies that demonstrate the importance of relative deprivation.

Why would policy makers and social planners want to compress human capital levels? Why should a prevailing inequality be tampered with? Our presumption is that inequality in human capital translates into inequality in earnings. The negative relationship between income inequality and economic performance has been widely researched in the growth literature. For example, Alesina and Rodrik (1994) and Persson and Tabellini (1994) establish through political economy channels a negative theoretical link between inequality and growth. Their empirical work lends support to their theoretical predictions. On another front, mounting evidence suggests that a higher level of inequality in earnings translates into social ills and poor psycho-social health. A recent illuminating study by Wilkinson and Pickett (2009) assembles data on income inequality in 20 of the world's richest nations, and in each of the 50 states of the USA. Their empirical findings are revealing. For example, rates of mental illness are five times higher across the whole population in the most unequal than in the least unequal societies. One explanation that Wilkinson and Pickett (2009) suggest is that inequality increases stress right across society, not just among the least advantaged. Much research has been done

on the stress hormone cortisol, which can be measured in saliva or blood, and it emerges that chronic stress affects the neural system, and in turn the immune system. When stressed, people are more prone to depression and anxiety, and more likely to develop a host of bodily ills, including heart disease, obesity, drug addiction, liability to infection, and rapid ageing. Societies where incomes are relatively equal have low levels of stress and high levels of trust, so that people feel secure and see others as cooperators. In unequal societies, by contrast, the rich suffer from fear of the poor, while those lower down the social order experience status anxiety, looking on those who are more successful with bitterness, and on themselves with shame. The different social problems that stem from income inequality often form circuits or spirals. For example, babies born to mothers who are educational failures are at greater risk, as they grow up, of being educational failures themselves. A correlate of this inequality-related evidence is that reducing income inequality can improve the aggregate economic performance, health, and wellbeing of the whole population.

Let there be two types of individual: *l*, who come from families with a low level of education, and *h*, from families with a high level of education. In the current paper we focus attention on individuals of the first type. Ever since the publication of the findings of the Coleman *et al*. (1966) report that family characteristics, and not those of schools, explain variability in educational outcomes, it has been recognized that inequalities in family environment translate into unequal adult educational outcomes. These outcomes are neither dictated by genes nor cast in stone. There is mounting evidence that adults can overcome adversity from initial disadvantage (Cunha and Heckman 2009) and counteract the inequality in family environments. Belley and Lochner (2007) demonstrate that the primary factor explaining differentials in college attendance in the USA is cognitive ability (not family income), and Cunha and Heckman (2009) show that cognitive deficits can be remedied substantially, even if not fully reversed. We turn next to the process of facing up to educational variance, the concern that this variance raises, the possibility of taking action to remedy it, and the manner in which public policy can support such action.

We consider a setting in which individuals derive utility from their earnings, and disutility from the relative deprivation that arises from a comparison of their earnings with the earnings of others in their comparison or reference group. There are two types of individuals: *l* and *h*.[1] Imagine a dichotomous setting in which the *l*-individuals can choose: either to acquire advanced human capital that, while enhancing their earnings, will place them in the reference group of the *h*-individuals, all of whom have acquired advanced human capital and have higher earnings; or not to acquire advanced human capital, in which case they remain in the group of the *l*-individuals who did not elect to invest in the acquisition of advanced human capital. In the former case the *l*-individuals experience relative deprivation when the earnings gap cannot be compressed; in the latter case they do not. Let us now imagine that the earnings of the *h*-individuals are taxed. The relative deprivation to which the *l*-individuals will be exposed will be lower should they acquire advanced human capital and have their reference group consist of those who are similarly equipped. At the margin, the combination of high(er) earnings and (a now muted) relative deprivation will be more attractive to the *l*-individuals than the preceding combination, and consequently they will be more likely to acquire human capital. This prediction is at variance with much of the received literature, which intimates that higher tax rates on earnings conferred by human capital either deter the acquisition of human capital and result in fewer individuals doing so or, at a minimum, hardly promote human capital formation.[2]

In the remainder of this paper we proceed as follows. We divide our analysis into two sections. In Section I we study the altered human capital formation calculus of *l*-individuals when *h*-individuals are taxed. We show that when a tax is introduced, *l*-individuals become more willing to acquire human capital, and that this shift in inclination is not achieved by, for example, subsidizing these individuals. To address the possible concern that the educational gains of the *l*-individuals could come at the expense of poorer education for the *h*-individuals, we study in Section II the behaviour of the *h*-individuals. After all, taxing the incomes of the *h*-individuals could prompt them to reduce their optimal level of human capital acquisition. Therefore, in the first part of Section II we propose a scheme in which the tax regime does not interfere with the human capital formation calculus of the *h*-individuals. In the second part of Section II we describe a setting in which, when we admit heterogeneity of the group of the *h*-individuals, the complete set of reactions to the imposition of the tax (with no subsidies at all) could result in the average level of human capital of the group of the *h*-individuals remaining unchanged.

I. THE *l*-INDIVIDUALS

Let the *l*-individuals be high-school graduates who consider undertaking advanced study, say university education, and let the *h*-individuals be high-school graduates who undertake such advanced study. In this section we study the behaviour of the *l*-individuals who, we assume, are identical to each other in all relevant respects.

The basic model

Let the utility, u, of an *l*-individual be given by the difference between his income, Y, which depends on his human capital (level of education), e, and the cost of acquiring that human capital, C.[3] In what follows, superscripts denote the type of the individual, and subscripts denote derivatives. Thus,

$$u = u(e) = Y^l(e) - C^l(e), \tag{1}$$

where

$$Y_e > 0, \quad Y_{ee} < 0; \quad C_e > 0, \quad C_{ee} > 0; \quad \lim_{e \to 0} Y_e = \infty. \tag{2}$$

The first-order condition for a maximum of (1) is

$$Y_e^l - C_e^l = 0. \tag{3}$$

Let e_1^* be the interior solution of (3); that is, e_1^* is the optimal level of human capital of an *l*-individual.

What happens when relative deprivation, RD, plays a role? What happens when individuals derive (dis)utility not only from incurring a cost of acquiring human capital, but also from an unfavourable comparison of their earnings with the earnings of others? If the *l*-individuals refrain from further study and remain in the reference group of the high-school graduates, they will not be exposed to relative deprivation, yet their earnings will be low. If they study further, they will enjoy higher earnings, but since they will increasingly belong to the group of those who acquired advanced human capital, they will experience relative deprivation upon comparing themselves with counterparts who originate from a 'high' education family environment and whose earnings are higher than

theirs. In making their choice, the *l*-individuals thus compare low earnings combined with low relative deprivation, with high earnings combined with high relative deprivation. We assume that the *l*-individuals can choose from a continuum of levels of human capital, and that their social proximity to the *h*-individuals correspondingly depends on the extent of their study.[4] The utility function of an *l*-individual is then

$$u = u(e) = Y^l(e) - C^l(e) - RD(e). \tag{4}$$

Let the relative deprivation that an *l*-individual senses within a reference group be defined as

$$F(R - Y^l) \quad \text{with } F' > 0,\ F'' < 0 \quad \text{for } Y^l < R, \tag{5}$$

where R is the average income of l's reference group, and $F(R - Y^l) = 0$ for $Y^l \geq$ R. Two comments are in order. First, (5) states that relative deprivation is sensed if and when income falls below the average income of the reference group, and it depends positively on this shortfall. The concavity of F means that a given small decrease in own income increases relative deprivation by less when one's income is further removed from the average income (or that a given small decrease in own income results in a greater increase in relative deprivation when the average income is closer). When an individual's income is further away from the group's average income, the level of relative deprivation that he senses is less sensitive to small changes in his own income. Second, both theory and evidence reveal that people's behaviour is conditioned by their dismay from others having more than they have, not by a glee from others having less. For example, the relative income hypothesis formulated and tested by Duesenberry (1949) posits an asymmetry in the comparisons of income that affect the individual's behaviour: the individual looks upward when making comparisons. In a similar vein, the comparisons that affect the allocation of the individual's time between work and leisure are those with individuals whose incomes are higher than his own (see, for example, Stutzer 2004, and Bowles and Park 2005).

The relative deprivation of an *l*-individual, RD(e), 'rests' upon two reference groups: the *l*-individuals and the *h*-individuals. We assume that relative deprivation is a weighted sum, and that the weight that an *l*-individual attaches to the relative deprivation that arises from a comparison with the *h*-individuals, $0 \leqslant \beta(e) \leqslant 1$, depends positively on l's level of human capital; that is, $\beta_e > 0$: the more advanced, university type, human capital an *l*-individual acquires, the closer he is in social space to, and the more he compares himself with, university graduates and, correspondingly, the less he compares himself with the group of high-school graduates who did not choose to invest in advanced, university level human capital. While with a higher level of human capital the income of an *l*-individual becomes closer to the average income of the *h*-individuals, we assume that no matter how much human capital an *l*-individual acquires, the average income of the *h*-individuals, Y^h, will always remain higher than his; that is, $Y^h > Y^l$. The weight attached to the relative deprivation that is sensed in the comparison with other *l*-individuals is $1 - \beta(e)$. However, since the group of *l*-individuals is homogeneous and all the *l*-individuals make the same human capital formation decisions in an identical manner, there arises no income disparity between them and hence no relative deprivation is sensed upon comparisons within the *l*-group. From the preceding considerations, RD(e) can thus be expressed as

$$RD(e) = \beta(e)F[Y^h - Y^l(e)]. \tag{6}$$

Inserting (6) into (4) we obtain

$$u = u(e) = Y^l(e) - C^l(e) - \beta(e)F[Y^h - Y^l(e)]. \tag{7}$$

For this utility function, the first-order condition for a maximum is

$$Y^l_e - C^l_e - \beta_e F[Y^h - Y^l(e)] + \beta(e)F'[Y^h - Y^l(e)]\,Y^l_e = 0. \tag{8}$$

We denote the solution to (8) by e_2^*. We also assume that the second-order condition $Y^l_{ee} - C^l_{ee} - RD_{ee} < 0$ holds, hence that e_2^* constitutes a unique solution to (8).

From a comparison of (3) with (8), we derive a proposition that provides a condition under which the incorporation of relative deprivation dampens the optimal level of the human capital that is acquired by the *l*-individuals.

Proposition 1. $e_2^* < e_1^*$ if

$$\beta_e(e_2^*)F[Y^h - Y^l(e_2^*)] - \beta(e_2^*)F'[Y^h - Y^l(e_2^*)]\,Y^l_e(e_2^*) > 0. \tag{9}$$

Proof. Suppose otherwise; that is, that $e_2^* \geqslant e_1^*$. From (2) it follows then that

$$Y^l_e(e_2^*) - C^l_e(e_2^*) \leqslant Y^l_e(e_1^*) - C^l_e(e_1^*). \tag{10}$$

From the condition in the proposition, it follows that

$$\begin{aligned} &Y^l_e(e_2^*) - C^l_e(e_2^*) - \{\beta_e(e_2^*)F[Y^h - Y^l(e_2^*)] - \beta(e_2^*)F'[Y^h - Y^l(e_2^*)]\,Y^l_e(e_2^*)\} \\ &< Y^l_e(e_2^*) - C^l_e(e_2^*). \end{aligned} \tag{11}$$

Therefore, combining (3), (10), and (11),

$$Y^l_e(e_2^*) - C^l_e(e_2^*) - \beta_e(e_2^*)F[Y^h - Y^l(e_2^*)] + \beta(e_2^*)F'[Y^h - Y^l(e_2^*)]\,Y^l_e(e_2^*) < 0, \tag{12}$$

which contradicts (8). □

To better understand Proposition 1, we study briefly condition (9). Rearranging yields

$$\beta_e(e_2^*)F[Y^h - Y^l(e_2^*)] > \beta(e_2^*)F'[Y^h - Y^l(e_2^*)]\,Y^l_e(e_2^*). \tag{13}$$

The left-hand side of (13) is the marginal change in individual *l*'s RD that arises from him getting closer in social space to the *h*-individuals. Since the income of the *h*-individuals is always higher than his, this effect is positive and therefore it is a 'bad'; it increases RD. The right-hand side of (13) represents the marginal change in RD that arises from the comparison with the *h*-individuals when income increases, and therefore it reduces RD. Thus, condition (9) will hold and Proposition 1 will be satisfied if the former effect outweighs the latter effect—namely, if the change in *l*'s reference groups (getting closer in social space to the rich *h*-individuals) due to an increase in human capital raises the *l*-individual's RD more than the corresponding increase in income reduces his RD.[5]

Augmenting the basic model by introducing an income tax

Suppose now that a progressive tax, $t > 0$, is in place such that while high incomes are taxed, low incomes are not. In our case, only the incomes of the *h*-individuals are taxed. To ensure that the tax is never high enough to reverse the income positions of the *h*-individuals and the *l*-individuals, we further assume that $t < t^*$, where

$t^* = 1 - (Y^l/Y^h) < 1$. An l-individual will now 'face' the utility function

$$u = u(e) = Y^l(e) - C^l(e) - \beta(e)F[(1-t)Y^h - Y^l(e)]. \tag{14}$$

When the tax is in place, an l-individual's decision making will be affected since his relative deprivation is affected at the margin. The first-order condition for a maximum of (14) is

$$Y^l_e - C^l_e - \beta_e F[(1-t)Y^h - Y^l(e)] + \beta(e)F'[(1-t)Y^h - Y^l(e)]\,Y^l_e = 0. \tag{15}$$

Let the solution of (15) be denoted by e^*_3.

We now derive a proposition to the effect that the imposition of a tax on the h-individuals raises the optimal level of the acquired human capital of the l-individuals.

Proposition 2. $e^*_3 > e^*_2$.

Proof. Totally differentiating (15) with respect to e and t, we obtain

$$\begin{aligned}\frac{\mathrm{d}e}{\mathrm{d}t} &= \frac{1}{\Omega}\left\{\beta_e \frac{\partial F[(1-t)Y^h - Y^l(e)]}{\partial t} - \beta(e)\frac{\partial F'[(1-t)Y^h - Y^l(e)]}{\partial t}\,Y^l_e\right\} \\ &= -\frac{1}{\Omega}\{\beta_e F'[(1-t)Y^h - Y^l(e)]\,Y^h - \beta(e)\,F''[(1-t)Y^h - Y^l(e)]\,Y^l_e Y^h\},\end{aligned} \tag{16}$$

where Ω, the derivative of the left-hand side of (15) with respect to e, is simply the second-order condition, and hence it must be negative at the optimum. From the properties of RD in (5) we know that $F'[(1-t)Y^h - Y^l(e)] > 0$ and $F''[(1-t)Y^h - Y^l(e)] < 0$. Thus, it follows from (16) that $(\mathrm{d}e/\mathrm{d}t) > 0$, and hence that $e^*_3 > e^*_2$. □

Our analysis suggests a novel way of inducing individuals of type l to become more willing to acquire human capital. This shift in inclination is achieved not by subsidizing these individuals but by taxing the incomes of the h-individuals.[6]

It is worth noting that many public finance scholars have studied optimal income taxation without endogenizing human capital formation (see, for example, Mirrlees 1971; Diamond 1998), and a few have attended to human capital formation in a dynamic framework (Kapicka 2006). However, in the received literature on human capital formation and taxation, the impact of taxes on the endogenous selection of reference groups has not been considered, nor have the repercussions of this link been studied for the selection of the optimal level of human capital.

When h-individuals are taxed, there might be a crowding-out effect; these individuals could well reduce their level of human capital formation. Hence, in the first part of the next section, we analyse a scheme in which a tax regime does not interfere with the human capital formation calculus of the h-individuals. It is important to note that applying a comparable scheme to the l-individuals would, however, lead them to acquire a lower level of human capital. In the second part of Section II we describe a setting in which, if we admit heterogeneity within the group of h-individuals, the complete set of reactions to the imposition of the tax (with no subsidies at all) could result in the average level of human capital of the h-individuals remaining unchanged.

II. THE *h*-INDIVIDUALS

The h-individuals constitute a homogeneous group

If marginal benefits and marginal costs are reduced by the same proportion, there will be no effect on the optimal level of human capital chosen by an *h*-individual, and we are 'out of the woods' (cf. Boskin 1975).

We show that if there is a subsidy such that for *taxpayers* part of their human capital formation costs are tax deductible, there will be no revision in the human capital formation of the *h*-individuals when the taxes are introduced.

Since the *h*-individuals earn more than the *l*-individuals, they are not exposed to relative deprivation. Their utility function is

$$u = u(e) = Y^h(e) - C^h(e). \tag{17}$$

Maximization of (17) yields

$$Y^h_e - C^h_e = 0. \tag{18}$$

Let the solution to (18) be denoted by e^*_4.

When an income tax is in place, (17) needs to be rewritten. This yields

$$u = u(e) = (1-t)\,Y^h(e) - C^h(e). \tag{19}$$

The first-order condition for a maximum of this utility function is

$$(1-t)\,Y^h_e - C^h_e = 0. \tag{20}$$

Let the solution of (20) be denoted by e^*_5. From (2) it must be that $e^*_5 < e^*_4$.

However, if the net cost of forming human capital is reduced at the margin by, for example, making the cost of human capital formation tax deductible, then an *h*-individual will again maximize his utility by choosing human capital level e^*_4. To see this, suppose that we implement a subsidy, s, such that

$$s = s(e) = tC^h(e). \tag{21}$$

Modifying the utility function in (19) to incorporate the provision of the subsidy yields

$$u = u(e) = (1-t)\,Y^h(e) - [C^h(e) - s(e)] = (1-t)[Y^h(e) - C^h(e)]. \tag{22}$$

In the presence of a tax and in the absence of a subsidy, an *h*-individual will find it optimal to increase his level of human capital up to e^*_5, since up to e^*_5 the marginal benefit exceeds the marginal cost. However, if a subsidy as in (21) is in place, the marginal condition of optimality for the *h*-individual's problem of maximizing (22) will not differ from (18) and hence he will form the same level of human capital, e^*_4. In addition, since $t\,Y^h(e^*_4) > t\,C^h(e^*_4)$, the tax revenue will always be greater than the subsidies disbursed. Thus, this tax-subsidy scheme will not impose on the government any fiscal burden. We summarize these results in the following proposition.

Proposition 3. The level of human capital formed by the *h*-individuals will not be affected by the imposition of the tax-cum-subsidy scheme when the cost of forming human capital is effectively made deductible from the tax. Furthermore, the net revenue from such a tax-cum-subsidy scheme is positive.

Alternatively, it could have been argued that an effective way of inducing the *l*-individuals to acquire more human capital would have been to subsidize their formation of human capital; however, such support would have entailed extra expense for the government. In addition, if a tax is levied on the *h*-individuals in order to finance the disbursement of the subsidies, the government will need to be aware of the repercussion of levying this tax on the *l*-individuals, who in response, as already noted, will be induced to acquire even more human capital upon a lowered relative deprivation. This response may lead to an excessive subsidy bill to the government. Furthermore, it can be shown that applying to the *l*-individuals a scheme that is analogous to the aforementioned scheme of taxing and subsidizing the *h*-individuals would actually lead to a lower level of human capital formed by the *l*-individuals. Intuitively, the preceding tax-cum-subsidy scheme is designed to affect to an equal extent the marginal benefit of human capital formation (through tax) and its marginal cost (through subsidy). However, a tax on the *l*-individuals will also reduce the marginal utility of these individuals by increasing their relative deprivation from the comparison of their diminished earnings (because of the tax) with the earnings of the *h*-individuals. This additional bite into the marginal utility (because of the effect of the tax on relative deprivation) then implies that such a self-financing combination of a tax and subsidy applied to the *l*-individuals will dampen their human capital formation.

The h-individuals constitute a heterogeneous group

Suppose that there is heterogeneity in the income of the *h*-individuals. Let there be two subgroups of *h*-individuals who differ in their abilities: there are ordinary *h*-individuals, henceforth *oh*-individuals, and there are excellent or exceptional *h*-individuals, henceforth *eh*-individuals. We assume that the *oh*-individuals have the same structure of a utility function as the *l*-individuals. Since, by assumption, $Y^{eh} > Y^{oh}$, *eh*-individuals are not relatively deprived. However, the average income of the entire university group, Y^h, is composed of the incomes of the *eh*-individuals and the incomes of the *oh*-individuals. Therefore, $Y^h > Y^{oh}$. Consequently, *oh*-individuals derive (suffer) (dis)utility; that is, they experience relative deprivation from comparing their income with the average income of their reference group, the university graduates. Thus, the utility function of an *oh*-individual can be written as[7]

$$u = u(e) = Y^{oh}(e) - C^{oh}(e) - F[Y^h - Y^{oh}(e)]. \tag{23}$$

In this environment, *eh*-individuals will continue to make human capital formation decisions as per (18), while *oh*-individuals will be guided in their human capital formation decisions by maximizing (23). The maximization of (23) yields the first-order condition

$$Y_e^{oh} - C_e^{oh} + F'[Y^h - Y^{oh}(e)]\,Y_e^{oh} = 0. \tag{24}$$

When an income tax is imposed on both subgroups of *h*-individuals, *eh*-individuals will (continue to) make human capital formation decisions based on (20), resulting in a lower human capital level than that which is formed in the absence of the tax. On the other hand, the post-tax utility function of an *oh*-individual is modified to

$$u = u(e) = (1-t)\,Y^{oh}(e) - C^{oh}(e) - F[(1-t)(Y^h - Y^{oh}(e))], \tag{25}$$

which leads to the revised first-order condition

$$(1-t)\,Y_e^{oh} - C_e^{oh} + (1-t)F'[(1-t)(Y^h - Y^{oh}(e))]\,Y_e^{oh} = 0. \tag{26}$$

Comparing (26) with (24) reveals that the introduction of a tax on all *h*-individuals leads to three effects regarding the optimal level of human capital formed by *oh*-individuals. First, as in the case for the *eh*-individuals, the tax bites into the marginal benefit of *oh*-individuals (see the first term on the left-hand side of (26)) and therefore reduces their human capital formation. Second, the tax also reduces the extent to which an *oh*-individual's extra human capital formation is capable of closing the gap with the group's average income (that is, $(1 - t)$ entails a lower third term on the left-hand side of (26)), resulting in yet another negative effect on human capital formation. Third, the tax shrinks the income gap between an *oh*-individual and the average income of his reference group, and hence makes human capital accumulation more effective in reducing the RD sensed by an *oh*-individual (that is, $F'[(1 - t)(Y^h - Y^{oh}(e))]$ in the third term on the left-hand side of (26) is larger), thereby entailing a positive effect on human capital formation by an *oh*-individual. If and when the third effect outweighs the first two effects, an *oh*-individual will end up forming a higher level of human capital in the wake of the imposition of taxes.

There is still one more reason why the *oh*-individuals may want to increase their level of human capital after income taxes are imposed on all *h*-individuals. If, due to the introduction of the tax, *l*-individuals (partly) join (from below) the group of university graduates, the average income of the group of university graduates decreases. This lowers the relative deprivation sensed by the *oh*-individuals. Consequently, their incentive to acquire human capital will be strengthened.

The overall effect of the tax on the average human capital of the *h*-individuals is ambiguous. If the conventional scaling-back effect for both the *eh*-individuals and the *oh*-individuals dominates the amplification effect coming from the *oh*-individuals, then the impact of the imposition of a tax on the level of human capital of all *h*-individuals will be negative. But if the amplification effect is sufficiently strong, the optimal level of human capital chosen by the *oh*-individuals will exceed the optimal level chosen by them prior to the introduction of the tax and, consequently, there may be no revision in the *average* level of human capital of the group of the *h*-individuals due to the imposition of taxes on them.

III. Conclusions

We studied a setting in which economic mobility is intertwined with social mobility: a shift in earnings is associated with a shift in social space. If an *l*-individual with a lower income moves in social space closer to high-income *h*-individuals, he will experience negative utility. If the acquisition of advanced human capital by *l* type individuals cannot be disentangled from such a move, the attractiveness of acquiring advanced human capital will be dimmed; not very much human capital will be formed. To the extent that more (advanced) human capital increases social welfare, policies aimed at countering this diluting effect (an effect that emanates from the sensing of relative deprivation by the *l*-individuals) are called for. We suggested a novel way of encouraging individuals who are relatively less educated to acquire advanced human capital. This is achieved not by subsidizing these individuals, but by taxing the incomes of the high-income individuals. The tax serves to diminish the pain felt by the *l*-individuals when they compare their incomes with those of the *h*-individuals. This reduction in loss of utility leads them to acquire more human capital. From the standpoint of a government's budget, the

advantage of a taxation scheme, compared with a subsidization scheme, to promote human capital formation is obvious.

When the *h*-individuals are taxed, there might be a crowding-out effect: some of them could reduce their human capital formation. We presented a scheme in which a tax regime does not interfere with the human capital formation calculus of the *h*-individuals. We have shown that the overall effect on the human capital formation of the taxed individuals is to leave their human capital intact. Alternatively, if the *h*-individuals constitute a heterogeneous group, there may well be no change in their average human capital formation when the tax is introduced. A subsidy system will not then be required.

We have assumed that advanced education is associated with a revision of reference group affiliation; such a revision is endogenous to any process of acquiring additional education and is intertwined with moving across educational groups. When university education is undertaken, the weight assigned to the reference group of high-school graduates is reduced, whereas the weight assigned to university-educated individuals is increased. If high-school learning is undertaken in one's home town, whereas university education is pursued in a city away from home, the spatial relocation entails a co-movement in social space.

In this paper we measured relative deprivation in terms of income, and did not endow individuals with utility-conferring social assets such as, for example, the inherent prestige, or loss of prestige, from belonging to a particular group. In a different setup it could be argued that people undertake additional education in order to garner the prestige associated with belonging to the highly-educated group. (This is done in Fan and Stark, forthcoming.) Our perspective is exactly the opposite: affiliation of an *l*-individual with the highly-educated group exposes the *l*-individual to a loss of 'prestige': it confers disutility, as when the earnings of the *l*-individual fall short of the earnings of the *h*-individual. In our framework, there is no room for 'prestige' from trailing behind others. However, our results would stand even if, in a more general model, prestige were to be added, provided that 'the prestige effect' is weaker than the relative deprivation effect.

APPENDIX

In this Appendix we assume that there are n skill types. We show that an income-specific tax scheme can increase the amount of human capital formed by individuals at the bottom of the skill hierarchy, while preserving the human-capital-formation decisions of the high-skill types. Such a tax policy will result in both larger aggregate human capital and lower income inequality in the economy.

Let the individuals be classified into n skill types indexed by i, with $i = 1$ being the most skilled type, and $i = n$ being the least skilled type. Because we assume that individuals' incomes correlate positively with their skill levels, all the individuals except for the most skilled suffer from relative deprivation. Thus, the utility function of a type-i individual, for $2 \leqslant i \leqslant n$, is given by

$$u^i = u^i(e) = Y^i(e) - C^i(e) - \beta(e)F[\bar{Y}^i_+ - Y^i(e)], \tag{A1}$$

where $\bar{Y}^i_+$ denotes the average income of individuals whose skill levels are higher than i's, and hence i's optimal human capital, e_i, is determined by the first-order condition

$$Y^i_e(e_i) - C^i_e(e_i) - \beta_e(e_i)\,F[\bar{Y}^i_+ - Y^i(e_i)] + \beta(e_i)\,F'[\bar{Y}^i_+ - Y^i(e_i)]\,Y^i_e(e_i) = 0. \tag{A2}$$

We derive the desired income-specific tax scheme recursively. First, in line with Proposition 3, let t_1 be the tax rate levied on the income of type-1 (the most skilled) individuals such that when coupled with a self-financed education subsidy, it leaves their human capital formation unchanged.

As our preceding analysis suggests, in the presence of this tax rate, type-2 individuals will have an incentive to acquire more human capital because the associated move in 'social space' towards the type-1 individuals becomes less intimidating. A simultaneous countervailing tax rate of t_2 can be levied on the incomes of type-2 individuals, such that they will elect to acquire the same amount of human capital, e_2, as in the no-tax regime. This t_2 is yielded by

$$(1-t_2)\,Y_e^2(e_2) - C_e^2(e_2) - \beta_e(e_2)F\,[\bar{\bar{Y}}_+^2 - (1-t_2)\,Y^2(e_2)] + \beta(e_2)F'[\bar{\bar{Y}}_+^2 - (1-t_2)\,Y^2(e_2)]\,Y_e^2(e_2) = 0, \tag{A3}$$

where $\bar{\bar{Y}}_+^2 = (1-t_1)\,Y^1$ is the (average) net income of type-1 individuals, and e_2 satisfies (A2) with $i = 2$. From $\bar{\bar{Y}}_+^2 < \bar{Y}_+^2 = Y^1$ and the concavity of the F($\cdot$) function it is easy to see that the left-hand side of (A3) is strictly decreasing in t_2, and that it is positive when $t_2 = 0$ and negative when $\bar{\bar{Y}}_+^2 - (1-t_2)\,Y^2(e_2) > \bar{Y}_+^2 - Y^2(e_2)$, or when $t_2 > t_1\,\bar{Y}_+^2/Y^2 = t_1\,Y^1/Y^2 \equiv t_2^*$. Thus, there exists a unique t_2, where $0 < t_2 < t_2^*$, that solves (A3), implying that the imposition of tax rates t_1 on type-1 individuals and t_2 on type-2 individuals will leave the human capital acquisition of type-2 individuals unchanged as well.

Similarly, the countervailing tax rate, t_3, on type-3 individuals that leaves their human capital formation unchanged can be obtained from solving

$$(1-t_3)\,Y_e^3(e_3) - C_e^3(e_3) - \beta_e(e_3)F\,[\bar{\bar{Y}}_+^3 - (1-t_3)\,Y^3(e_3)] + \beta(e_3)F'[\bar{\bar{Y}}_+^3 - (1-t_3)\,Y^3(e_3)]\,Y_e^3(e_3) = 0, \tag{A4}$$

where $\bar{\bar{Y}}_+^3$ is the average *net* income of type-1 individuals and type-2 individuals, which is less than $\bar{Y}_+^3$. Let t_{12} denote the average tax rate on $\bar{Y}_+^3$ such that $(1-t_{12})\,\bar{Y}_+^3 = \bar{\bar{Y}}_+^3$. Then, upon denoting $t_3^* \equiv t_{12}\,\bar{Y}_+^3/Y^3$, it can be similarly shown that there exists a unique t_3, where $0 < t_3 < t_3^*$, that solves (A4), and hence the imposition thus far of the tax scheme t_1, t_2, and t_3 will leave intact the human capital acquisitions by the individuals of type-1, type-2, and type-3.

In general, tracking the same procedure, we can come up with an income-specific tax scheme (t_1, t_2, . . ., t_{n-1}) levied on type-1, type-2, . . ., type-($n-1$) individuals, respectively, such that enacting the scheme will not alter the human capital acquisition decisions of all the individuals except those of type-n (the least skilled ones). After the imposition of the above tax scheme, the optimal human capital formed by the type-n individuals is obtained from

$$Y_e^n(e_n) - C_e^n(e_n) - \beta_e(e_n)\,F[\bar{\bar{Y}}_+^n - Y^n(e_n)] + \beta(e_n)\,F'[\bar{\bar{Y}}_+^n - Y^n(e_n)]\;Y_e^n(e_n) = 0, \tag{A5}$$

where $\bar{\bar{Y}}_+^n$ is the average *net* income of type-1 to type-($n-1$) individuals. Since $\bar{\bar{Y}}_+^n < \bar{Y}_+^n$, it follows from comparing (A5) and (A2) that the solution of (A5) is larger than that of (A2); that is, the type-n individuals will acquire a larger amount of human capital in the presence of the tax scheme (t_1, t_2, . . ., t_{n-1}) than in its absence.

Hence, the assertion made at the beginning of this Appendix is substantiated.

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NOTES

1. A two-category classification of individuals is obviously a simplification of individuals' heterogeneity in reality. However, in the Appendix we show that the principles of, and the insights yielded by, the analysis regarding the interactions between two adjacent skill levels or groups, as well as how tax policies might affect such interactions, also apply in a more realistic setting with an n-category classification of individuals.
2. For example, Eaton and Rosen (1980) show that an increase in the tax levied on earnings from interest increases human capital accumulation when the returns to the human capital investment are certain,

while the taxation of wages has no effect on the investment in human capital. Eaton and Rosen (1980) further demonstrate that when the returns to the investment in human capital are uncertain, taxation of wages or of earnings from interest either increases or decreases the investment in human capital.

3. This assumption of a utility function that is linear in the net income of an individual is made primarily for expositional convenience. It is rather straightforward to verify that our analysis will go through if, instead, we were to assume that the utility function is increasing and concave in an individual's net income.
4. Subject to some additional assumptions, our results hold also in the discrete case in which an *l*-individual compares himself either to other *l*-individuals if not acquiring advanced human capital, or to *h*-individuals upon acquiring advanced human capital.
5. Put differently, Proposition 1 holds if $RD_e > 0$.
6. In an intertemporal setting, increasing the tax on individuals with high levels of human capital may potentially have the opposite effect to that posited in Proposition 2: the incentive for individuals with low skill levels to acquire more human capital could be weakened since their investment-enhanced future earnings might be subjected to higher taxation. However, whether the investment-enhancing effect studied in the current model is strong enough to elevate the income of the low-skill individuals to a higher tax bracket and, if it is, whether the effect would be powerful enough to negate the investment-enhancing effect, are empirical issues.
7. An *oh*-individual attaches a weight of 1 to the RD that arises from comparing himself with the *h*-individuals since he is a member only of that group.

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