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INVESTMENT IN HUMAN AND NONHUMAN CAPITAL, TRANSFERS AMONG SIBLINGS, AND THE ROLE OF GOVERNMENT

By

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I. Introduction

The consequences for social welfare of the fact that parents cannot control the actions of their offspring are far-reaching. The difficulty cannot be eliminated by appeal to Becker's "rotten-kid" theorem or to vaguely defined social norms.[1] In this paper we explore the implications for efficient allocation of parent's inability to force transfers among siblings. If identification of more able and less able children is impossible or prohibitively costly except for the parents themselves, a first-best solution to the problem of optimal investment in human capital and bequests cannot be achieved if transfers among siblings would be necessary to take advantage of high rates of return to human capital.[2] We consider various second-best policies and show that a linear tax on earned income and a subsidy to inheritance are welfare improving but that neither public investment in physical or human capital or a tax-subsidy scheme for education enhance welfare. Such welfare improving policies redistribute income among siblings thus making the parents better off.

II. Non Steady State

Suppose, for the sake of simplicity, that there are only two periods and only two generations. The first generation consists of identical individuals (parents) who live for one period. Each individual is endowed with W units of an all- purpose single composite good. During the first period the individual chooses to have n children; and the family consumes together c_0 units of a composite good. A proportion p of children has high ability (indexed by A) and a proportion 1-p has low ability (indexed by B).

The parent invests e^A and e^B units of the single composite good in the education (human capital) of each one of the high ability and low ability children, respectively, and bequeathes b^A units of the composite good to each child of high ability and b^B units to each child of low ability.

Each child supplies one manhour of adult labor in the second period. Investing e^i in the education of a child of type i, i = A,B, augments its labor supply, as measured in efficiency units, to $g_i(e^i)$, i = A, B. It then earns $wg_i(e^i)$, where w is the wage rate per efficiency unit. The difference between the two types of ability manifests itself in the functions g_A and g_B. It is assumed that

(1) $g_A(e) > g_B(e)$,

for all e, so that the able child is more productive than the less able. Furthermore, the marginal investment in the able child is also assumed to be more productive:

(2) $g_A'(e) > g_B'(e)$,

for all e. We also assume that there are diminishing returns to investing in each child, i.e., $g_i'' < 0$, i= A, B.

When a parent bequeathes b units of the composite good, we assume the bequest is invested (in physical capital) and yields bR units to the child when it grows up in the second period, where $R \geq 1$ is the interest factor. w and R are assumed fixed. A more general neo-classical production function with variable marginal productivities of labor and capital is considered in the next section.

We assume that parents care about the number and welfare of their children. Parents treat their children symmetrically, irrespective of ability, and plan their bequests to them and investments in their education in such a way that each child will be able to consume the same amount, c_1, in the second period.[3] The parent's utility function depends on c_o, c_1 and n:[4]

$$(3) \quad u = u(c_0, c_1, n).$$

The parent chooses c_0, c_1 and n so as to maximize (3) subject to the following constraints:

$$(4) \quad W \geq c_0 + pn(e^A + b^A) + (1 - p)n(e^B + b^B)$$

$$(5) \quad c_1 \leq wg_A(e^A) + Rb^A$$

$$(6) \quad c_1 \leq wg_B(e^B) + Rb^B.$$

Constraint (4) is the budget constraint of the parent: consumption plus investments in the human and physical capital of the children cannot exceed the parent's endowment. Constraints (5) and (6) are the budget constraints facing each one of the able and less able children, respectively, in the second period.

We assume a closed economy in which the total amount of bequests cannot be negative, i.e.:

$$(7) \quad pnb^A + (1-p)\, nb^B \geq 0.$$

Such a constraint is natural in view of the fact that the bequests form the economy's capital stock, and in a closed economy resources cannot be transferred backwards from future to present generations. We furthermore assume that no one can enforce transfers from one's offspring to oneself; formally:

$$(8a) \quad b^A \geq 0$$

$$(8b) \quad b^B \geq 0.$$

Note that, given (7), constraint (8) is equivalent to assuming that no one can enforce transfers among offspring. For if transfers among children are allowed, one can effectively achieve a negative b^A, for instance by making a nonnegative transfer of $b^A + b^B$ from oneself to child B (thus satisfying (7)) and then forcing child A to make a transfer of $-b^A > 0$ to child B (assuming, for simplicity, that $p = 1/2$ and $n=2$).

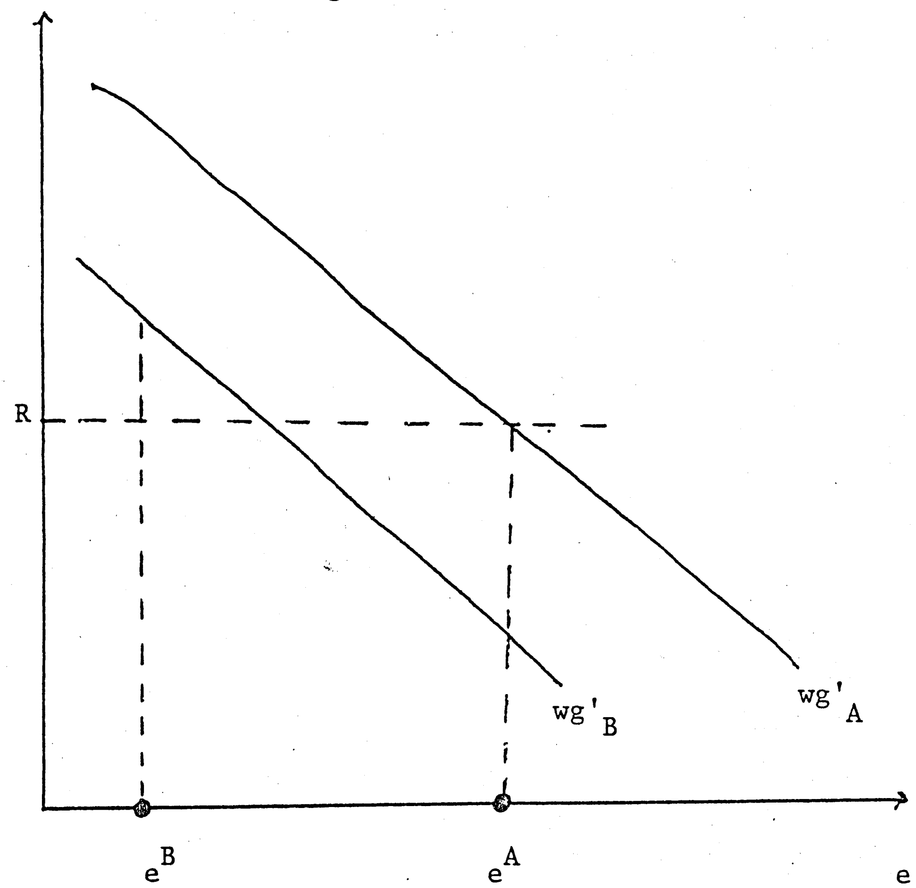
Constraint (7) will be binding, loosely speaking, whenever there is higher yield to investment in human capital than in physical capital. In this case, in order to equate the marginal yields on all forms of investment (i.e. $wg_A'(e^A) = wg_B'(e^B) = R$) , the parent may have to direct all investment to human capital, and may even wish to transfer physical resources backwards by borrowing (i.e. making $pnb^A + (1-p)nb^B$ negative), which we have ruled out. Therefore, relaxing constraint (7) will be welfare improving in this case.

However, (7) is a technological constraint which is imposed on the economy and neither man nor government can do anything about it. Assume therefore that (7) is not binding.

Things are rather different with respect to constraint (8). This constaint is essentially institutional. It stems from the inability of parents to enforce transfers among siblings. If constraint (8) is binding, there is a misallocation in aggregate between investment in human capital and in physical capital. In particular, parents are forced to invest too little in the human capital of their more able children.

Since (7) is not binding, it must be the case that either b^A or b^B is positive. Given our assumption about the relationship between g_A and g_B, it follows that b^B must be postive so that (8b) is not binding. To see this, note that (8b) is binding only if $wg'_B(e^B) > R$. Since (8a) is not binding in this case, it follows that $wg_A'(e^A) = R$. As Figure 1 shows, in this case, $e^B < e^A$ and hence, by (1), $g_b(e^B) < g_A(e^A)$. However, because $b^B = 0$, by (5) and (6), we have $wg_A(e^A) + b^A R = wg_B(e^B)$; it follows that $b^A < 0$, which is a contradiction. Therefore,(8a) is binding, while (8b) is not, i.e. $b^A = 0$ and $b^B > 0$. This means that the rate of return on investment in the human capital of more able children is above that on physical capital, i.e., parents would like borrow from the able children in order to invest more in their human capital, given the amount of resources they are transferring, but cannot.

Figure 1



If parents could enforce a transfer from their more able to their less able children, it would be equivalent to giving their more able children a negative bequest, thus eliminating constraint (8) and permitting parents to equate rates of return.

There are two ways in which parents might collectively enforce transfers among children by government action. One method is by a system of lump-sum intra-generational transfers based on innate ability. Since individual innate ability is observable only by the parents, such a system for achieving the first-best solution is infeasible. Alternatively, a system of student loans can permit parents to equate rates of return on investments in human and physical capital by enabling them to take out loans to finance the education of their more able children and obligating the child to repay the loan in the next period. Such a system of loans achieves a first-best solution, but it rests on the ability of parents to enforce intra-generational transfers <u>indirectly</u>. We now consider second-best solutions, i.e., those which alleviate rather than eliminate (8).

Among the second-best policy instruments that the government may employ are the following: (1) A linear tax on the earned income of the grown-up children in the second period with marginal tax t and a demogrant T; (2) an inheritance tax at the rate s, imposed on physical bequests only; (3) an interest income tax at rate q; (4) public investment (I) in physical capital, which is financed by a head tax in the first period and yields the same rate of return (R-1) as private investment.

A head tax may also be imposed in the second period but is redundant in view of the existence of the demogrant component (T) of the earned income tax. We could consider also direct government investment in human capital (free education), but as long as the e's are positive such a policy is redundant. If such an investment would make the parent wish to have a negative e^A or e^B, it is even sub-optimal. Instead of a direct government investment in human capital, we can also consider a tax/subsidy to education. A subsidy to education, taking place in the first period, must also be financed by a lump sum tax in the same period, because the government cannot transfer resources from the future to the present. Since a subsidy to education artificially lowers the cost of education to the parent, it therefore causes a distortion. Since such a subsidy is financed by a tax in the same period, one can show that it reduces welfare. This is because the parent can achieve the post-subsidy allocation under laissez-faire.[5] Similarly, a tax on education that is redistributed to the parents in the first period reduces welfare. if the revenues from such a tax are invested by the government, we can still view such a policy as carried out in two stages: First, the revenues are redistributed to the parents in a lumpsum which reduces welfare; secondly, a lump sum tax is imposed in order to finance an investment in physical capital. The last is the same as instrument (4) above. We can assume a tax-subsidy scheme for education is financed in the first-period and thus reduces welfare. Such welfare-reducing policies need not be considered further.

It should be emphasized that taxes (head taxes or others) which discriminate on the basis of ability are not allowed, and this is really the crux of the problem at hand. If such discriminatory taxes were allowed, then we could essentially eliminate constraint (8) and achieve a first-best allocation (continuing to assume that (7) is not binding).

Given this exhaustive list of potentially welfare improving policy tools, the constraints (4) - (6) facing the parent become (putting $b^A = 0$):

$$(4') \qquad W - I \geq c_o + pne^A + (1-p)n(e^B + b^B)$$

$$(5') \qquad c_1 \leq (1-t)wg_A(e^A) + T$$

$$(6') \qquad c_1 \leq (1-t)wg_B(e^B) + Y + (1-q')R(1-s)b^B,$$

where q' is the tax rate on the interest factor (R) which is related to the tax rate (q) on the interest rate (R-1) by $(1-q') R = 1 + (1-q) (R-1)$ or $q' = q(R-1)/R$. It is clear from (6') that either q' or s is redundant and therefore we henceforth set $q' = q = 0$. Note that I, which is public investment, is financed by a head tax of the same magnitude and this explains why it is subtracted from W on the left-hand side of (4'). In the second period, the government collects IR from its physical investment, $ntw[pg_A(e^A) + (1-p)g_B(e^B)]$ from the marginal tax component of the linear earned income tax, $n(1-R)sb^BR$ from the inheritance tax, and it pays nT in demogrants. Thus, the government's budget constraint is

$$(9) \qquad T \leq IR/n + tw[pg_a(e^A) + (1-p)g_B(e^B)] + (1-p)sb^BR.$$

A parent who maximizes $u(c_o, c_1, n)$ subject to (4') - (6'), derives the optimal c_o, c_1, n, b^B, e^A and e^B as functions $\bar{c}_o(\cdot), \bar{c}_1(\cdot), \bar{n}(\cdot), \bar{b}^B(\cdot), \bar{e}^A(\cdot)$ and $\bar{e}^B(\cdot)$, respectively, of the government's instrument vector (t,T,I,s).

The maximum (indirect) utility is a function v(t,T,I,s) of the same instruments. The first-order conditions for the parent's maximization problem with respect to $c_o, c_1, b^A, b^B, e^A, e^B$ and n are:

(10) $$u_1 - \lambda_1 = 0$$

(11) $$u_2 - \lambda_2 - \lambda_3 = 0$$

(12) $$-\lambda_1 pn + \lambda_2(1-s)R \leq 0$$

(13) $$-\lambda_1(1-p)n + \lambda_3(1-s)R = 0$$

(14) $$-\lambda_1 pn + \lambda_2(1-t)wg'_A = 0$$

(15) $$-\lambda_1(1-p)n + \lambda_3(1-t)wg'_B = 0$$

(16) $$u_3 - \lambda_1[pe^A + (1-p)(e^B + b^B)] = 0,$$

where $\lambda_1 > 0$, $\lambda_2 > 0$ and $\lambda_3 > 0$ are the Lagrangian multipliers associaed with (4'), (5') and (6'), respectively. Note that (12) is an inequality rather than an equality, because the constraint $b^A \geq 0$ is asumed to be binding. This means that there is underinvestment in the education of able children $(R < wg_A')$.

Let the government choose these instruments so as to maximize v subject to its budget constraint (9). A first-order characterization of the optimum is straightforward but unfortunately not very informative. We therefore take up the more modest task of looking for welfare improving directions of tax changes around the no intervention state, t=T=I=s=0 (the laissez-faire point).

In order to simplify the analysis we substitute the function $\bar{c}_o, \bar{c}_1, \bar{n}, \bar{b}^B, \bar{e}^A$ and $\bar{e}^B$ in(9) and use it to solve for T as a function $\bar{T}(.)$ of the other instruments t, I and s. Evaluated at $t = I = s = \bar{T}(0,0,0) = 0$, the partial derivatives of $\bar{T}$ are given by:

(17) $$\bar{T}_1 = w[pg_A + (1-p)g_B]$$

(18) $$\bar{T}_2 = R/n$$

(19) $$\bar{T}_3 = (1-p)b^B R.$$

Substituting $\bar{T}(.)$ for T in the indirect utility function v(t,T,I,s) defines V(t,I,s) as $v(t,\bar{T}(t,I,s),I,s)$. We now evaluate the effect of changes in t, I and s on the parent's welfare (V) at the laissez-faire point

$t = I = s = \bar{T} = 0$.

Employing the envelope theorem, it follows that $V_1 = v_1 + v_2 \bar{T}_1 = - w(\lambda_2 g_A + \lambda_3 g_A + \lambda_3 g_B) + (\lambda_2 + \lambda_3)w[pg_A + (1-p)g_B]$, where $\bar{T}_1$ is substituted from (17). Hence, $V_1 = w(g_A - g_B)[\lambda_3 p - \lambda_2(1-p)]$ From (12) and (13), $\lambda_3 p - \lambda_2(1-p) > 0$. Since $b^B > 0$, it follows from (5') and (6') that $(g_A - g_B)$ is positive. Hence, some tax on earned income (raising the marginal tax t and the demogrant T) is welfare improving.

In order to understand the rationale for this result, observe that because the constraint $b^A > 0$ is binding, it is desirable to increase e^A and lower b. This is also evident from (12) and (14), which imply that $wg'_A > R$, which in there means that the return to e^A is greater than the return to b^A. Note that the reason why parents cannot further increase e^A, without further increasing the transfer $npe^A + n(1-p)(e^B + b^B)$ to the children altogether, is because, by (5') and (6'), $(1 - t)wg_A$ must be equated with $(1 - t)wg_B + b^B R$, so that raising e^A must be accompanied by raising e^B or b^B as well. Since $g_A > g_B$, raising t takes from the able more than from the less able while T is given equally to both. Therefore, such a rise in t and T enables parents to increase e^A without raising transfers to the children. In this way, the transfer of wealth from the present to the future is channelled more efficiently and welfare is improved. It should be emphasized that, in this case, income taxation is justified on pure efficiency grounds in addition to the common justification on distributional grounds. Knowing that government is redistributing income among siblings makes parents better off.

In a similar way we can show that

$$V_3 = v_2 \bar{T}_3 + v_4 = b^B R[\lambda_2(1-p) - \lambda_3 p] < 0.$$

Thus, a positive inheritance subsidy, financed by lowering the demogrant component of the tax on earned income is welfare improving. Here again the inheritance subsidy enables one to overcome the deficiency in investment in the education of the able child without increasing the total transfer of wealth from present to future. To see this, observe that the required equality between wg_A and $wg_B + (1-s)b^B R$ may be preserved when s is made negative by increasing e^A and decreasing b^B.

Turning to public investment in physical capital, we see that

$$\begin{aligned} V_2 = v_2\bar{T}_2 + v_3 &= (\lambda_2 + \lambda_3)R/n - \lambda_1 \\ &= \lambda_2 R/n + \lambda_1(1-p) - \lambda_1 \qquad \text{(by (13))} \\ &= \lambda_2 R/n - \lambda_1 p < 0 \qquad \text{(by (12))} \end{aligned}$$

Thus, public investment in physical capital which is used to increase the demogrant in the second period actually lowers welfare. Since I cannot be negative, the government should simply refrain from investment in physical capital. Observe that if I is increased and the return is equally distributed between the two types of children (through T), then, in order to keep the total transfer of wealth to the second generation the same, one must lower e^A. This, of course, further exacerbates the distortion created by the underinvestment in the education of able children. It can be shown in a similar way that an increase in public investment (I) with the return used to finance an inheritance subsidy (-s) or a wage subsidy (-t), is not desirable.

Summing up, a linear tax on earned income and a subsidy to inheritance, but not public investment in a physical capital or a tax-subsidy for education, are useful in alleviating the constraint imposed by $b^A > 0$, which causes underinvestment in the human capital of the able children. Note that whether n is endogenously or exogenously determined is not relevant to this conclusion.

III. Steady State

In a steady state, there is a potential problem of unbounded intergenerational transfers (when $R > n$). For this reason, we must drop the assumption that R is fixed; assume a neo-classical constant-returns-to-scale production function F(K,L) with diminishing marginal productivities of labor and capital and Inada conditions. Total labor supply in efficiency units is $L = png_A(e^A) + (1-p)ng_B(e^B)$ and the total stock of capital is $K = pnb^A + (1-p)nb^B$. In this case, we have $R = F_K$ and $w = F_L$.

Consider a steady-state allocation where each person consumes c units of consumption, irrespective of ability or generation. Denote the wealth of each person by W. The constraints (4) - (6) are replaced by

(20) $$W > c = pn(n^A + b^A) + (1-p)n(e^B + b^B);$$

(21) $$W < wg_A(e^A) + rb^A;$$

(22) $$W < wg_B(e^B) = Rb^B.$$

Assume that the utility of each person is additively separable with discount factor $\beta < 1$, $u = \sum_{t=0}^{\infty} \beta^t U(c_t, n_t)$. Then the parent's steady-state objective is to maximize U(c,n) subject to (20) - (22) and the nonnegativity constraint (8). W itself is also determined by the parents in a steady state.

Note that from the individual point of view, R is given. If $R > n$, it follows from (20) - (22) that c can be increased without bound (keeping n constant). To see this, observe that by (21) - (22) one can increase W by R units by increasing b^A and b^B each by one unit. The LHS of (20) in this case is increased only by n units, which is smaller than the increase in W, thus allowing one to increase c. This can be repeated indefinitely so that c increases without bound. But then R cannot stay constant; it must fall via the increase in K. Similarly, if $R < n$, it pays the parent to reduce b^A and b^B until one of them reaches zero. If both go to zero (and therefore K also goes to zero), R goes to infinity, by the Inada condition.

Hence, at equilibrium, either we have (i) the steady-state golden rule R = n or (ii) $b^A = 0$. In case (i), one can easily see from (20) - (22) that the indivdual is indifferent about increasing (or decreasing) both b^A and b^B by the same amount. Hence constraint (8) cannot be binding and there is no role for the government to play. In case (ii), one might think of repeating the analysis of the preceding section. However, since the number of children (n) is itself a choice variable, the steady-state utility is unbounded. To see this note that, in a competitive context, each individual perceives R as constant. Hence, for any given R, the individual can reduce n below R and increase consumption and utility without bound.

Note that in a non-steady-state analysis, W of constraint (20) or (4) is given (that is, it is not a choice variable) and this is what makes utility in the preceeding section bounded and the non-steady-state analysis useful.

IV. Extensions

We have shown that a linear tax on earned income can enhance welfare when there are differences in the marginal productivity of investment in human capital due to differences in ability and when it is not possible to enforce intragenerational transfers among siblings. Our analysis proceeded on the assumption that the returns to various types of investment were known with certainty. If such returns are uncertain at the time bequests in physical capital are made, the case for a tax is strengthened. Such a tax reduces risk (Musgrave and Domar, 1944; and Eaton and Rosen, 1980) and thus improves the welfare of risk-averse parents.

In our model, a proportion p of each family's children is assumed to be able. A desirable extension is to recognize that p is the probability that a birth will result in an able child, so that p is the proportion in the population as a whole, not within each family. Such a modification introduces an additional element of risk, which however can be removed in the economy as a whole by pooling if the moral hazard can be avoided. This issue is related to whether information on ability is publically available. If it is not, one must seek another device to improve welfare in this case.

FOOTNOTES

[1]See Becker (1974,1976b) and Hirschleifer (1977). Becker and Tomes (1976, footnote 26) notes the difficulty, but suggests that "...social and family "pressures" can induce... children to conform to the terms of implicit contracts with their parents."

[2]In this case, transfers in the form of investment in human capital from parents to children are too low relative to bequests.

[3]An alternative specification to equal consumptions is to replace c_1 by c^A and c^B and to assume that u is symmetric and quasi-concave in c^A and c^B. In this case, the consumption of each child may be unequal but the parent reveals a preference towards equality (see, for instance, Becker and Tomes (1976) or Sheshinski and Weiss (1982)). It can be shown that in this case if $p = 1 - p = 1/2$ and if constraint (8) below is not binding, so that it is equally costly to increase the consumption in each child via investment in nonhuman capital, then the parent will equate c^A and c^B.

[4]It is assumed that u is increasing in c_o and c_1 but not necessarily in n. For example, u can be of the form $u(c_o, c_1, n) = U(\frac{c_o}{1+n}, c_1, b)$: where u is increasing in the per-capita consumption in the first period, $\frac{c_o}{1+n}$, the per-capita consumption in the second period (c_1) and in the number of children (n). In this case the derivative of u with respect to n, $u_3 = U_1 c_o (1+n)^{-2} + U_3$, is not necessarily positive. However, since, as is shown below, n is costly for parents, it follows that, at the optimal choice of n, u_3 must be positive.

[5]This is the standard theorem in taxation theory that a tax which is redistributed to the consumer in welfare-reducing (e.g., Diamond and McFadden, 1974).

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