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Favorite son? Specialized child laborers and students in poor LDC households

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Abstract

Though prior theoretical models of child labor nominally contain households with multiple children, they treat all children as identical in their returns to labor-market and education activities. In actuality, households with identical twins are the exception, and inherent heterogeneity implies different returns for children. We construct a theoretical model that allows child heterogeneity and bilateral altruism. Our model illuminates potential inefficiencies in the time allocation of children across labor market obligations and education opportunities in poor households. When intra-household talent differentials across children are great, an inefficient "reverse specialization" may arise and partial bans on child labor will increase efficiency.

JEL classification: J22; I20; D60

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1. Introduction

Recent years have seen the emergence of a theoretical literature exploring the economics of child labor. Two important recent works in this area are Basu and Van (1998) and Baland and Robinson (2000). Though these and other prior models contain households with multiple children, they treat all children as homogeneous in their human capital accumulation ability. In reality, households composed of identical twins are the exception rather than the rule, and inherent heterogeneity implies different returns to labor

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market and human-capital accumulation for different children. In turn, differential returns provide incentive for the unequal treatment of heterogeneous children.

Contrary to the common reflexive response, it is debatable whether egalitarian treatment of heterogeneous children in the labor market and education system is desirable in all circumstances—even for the child who would appear shortchanged in education opportunities and unduly burdened in the labor market. Indeed, asymmetric treatment (specialization) of heterogeneous children may even be beneficial for the (seemingly) disfavored child in the presence of intra-household and inter-generational transfers. The rationale is simple—comparative advantage.

In this paper, we develop a model to explore incentives for child specialization across labor market and human capital accumulation activities. We assess the efficiency properties of children's time allocation and demonstrate that, in the absence of utility balancing second-period transfers, the division of labor-burden and education-opportunity across heterogeneous children is inefficient. The model allows child heterogeneity and two-way altruism between parents and children. In this environment, optimal time allocation generally entails the unequal treatment of children—even when parents care equally about all their children and value their future consumption. The remainder of the paper is organized as follows: Section 2 provides a brief child-labor literature review and surveys empirical evidence of intra-household child specialization in labor-market/education time allocation. Section 3 presents the model, explores the efficiency properties of various outcomes, and considers policy implications. Section 4 summaries, concludes, and outlines further directions for research.

2. Literature review

The child labor literature has experienced tremendous growth in recent years. Indeed, this literature has become so voluminous that even a cursory review would far exceed the size constraint of this paper. Basu (1999) provides an excellent survey of the child labor literature. Discussion herein will be limited to a sample of works with direct relevance to our interests.

Seminal theoretical work on child labor includes Basu and Van's (1998) analysis of multiple equilibria in labor markets with and without child labor. The source of multiple equilibria in this model is simple and compelling. Namely, the augmented labor supply that obtains when both adults and children supply labor so depresses the equilibrium wage that child labor is necessary to maintain subsistence level consumption. Were child labor eliminated, the reduced labor supply might result in a high-enough wage that children need not work. This result implies that partial (as opposed to complete) bans on child labor may adversely impact precisely those they are intended to help.

A second recent important theoretical work is that of Baland and Robinson (2000). In contrast to Basu and Van (1998), Baland and Robinson focus on the efficiency properties of child labor supply and include consideration of the trade-off between child labor and human capital accumulation. In a two-period model that allows second-period transfers between parent and child they show that, if either savings or bequests are at a corner, child labor supply is inefficiently high because parents do not fully internalize its negative effects.

Though these articles are important contributions to the theoretical child labor literature, neither addresses the possibility of intra-household specialization of heterogeneous children between the labor-market and human capital accumulation. There is, however, an extensive *empirical* literature addressing intra-household specialization across the full range of activities. One early work in this area is Chernichovsky (1985), whose empirical analysis of school enrollment and attendance in rural Botswana suggests that: "...some children may be assigned to school and kept there on a comparatively regular basis, while others may be assigned to household and farm tasks." Cartwright and Patrinos (1999) also find evidence of child specialization in urban Boliva. Intra-household specialization can also manifest in the frequency of school attendance (rather than enrollment). Gibbison and Murthy (2003) find that actual attendance rates vary greatly across children and depend on the age distribution of siblings. In-depth discussion and additional references to specialization in child labor-education activities can be found in Grootaert and Patrinos (1999).

The efficiency properties of unequal income distribution, which arise in our model due to heterogeneity, are explored from a different perspective in papers by Rosen (1997) and Dahan and Gaviria (1998). Rosen (1997) argues that income inequality could be socially efficient even with originally identical agents due to the indivisibility of labor market and other life choices. Dahan and Gaviria (1998) develop a model that shows that even identical children may be treated unequally if returns to human capital increase with the *level* of human capital, and parent's decisions are based on efficiency consideration.

A final relevant literature concerns endogenous fertility (see Becker et al., 1990; Tamura, 1994; Tamura and Sadler, 2001), which suggests an additional incentive for inequality in human capital accumulation. Namely, if poor households have more children, and more children create opportunities for specialization, an "endogenous inequality" may arise. Though these models assume all children are treated equally, and we abstract from fertility choice in our model, this paper presents a framework for addressing an unexplored implication of endogenous fertility models.

3. Model

Our model takes the basic structure of Baland–Robinson as a starting point and adds intra-household child heterogeneity. There are two periods in the model and parents are treated as a single decision-making and consumption unit. In the first period, the parents of our representative family supply L units of labor inelastically, receive a wage we normalize to 1, make a labor supply decision for each of their two children, and choose a "saving" level (s).[1] We do not impose a non-negativity constraint on saving (which allows $s<0$) as capital market imperfections are immaterial to our findings. For simplicity, we assume a

[1] This assumes children cannot borrow to compensate their parents and so finance their education. Wages should be interpreted as the equilibrium price per efficiency unit of human capital. We do not explicitly model firms' problem, but with a linear technology and the resulting zero profit condition their inclusion would be straightforward.

simple storage savings technology (discount rate of zero). This assumption has absolutely no bearing on the source of inefficiency we identify.

Each child (i) is endowed with one unit of time during the first period to be allocated between labor (l_i) and human capital accumulation ($1 - l_i$). In our narrative, we use "education" and "human capital accumulation" interchangeably. Our intended interpretation of "education" is broad—it refers to all non-labor time associated with human capital accumulation. One example of the distinction between our use of "education" and the narrow interpretation of "time in school" is homework hours. The implication of this interpretation is that child labor may substitute for human capital accumulation without affecting attendance per se—for example, a child who works after school and therefore has reduced study time. With this interpretation in mind, we denote time devoted to education as: e_i=($1 - l_i$). Children cannot borrow to finance their education and compensate their parents for lost wages.

As our focus is the differential treatment of children motivated by heterogeneity, each child possesses a unique talent parameter, a_i. Though we use the term "talent" throughout, the key implication of this heterogeneity is that it is associated with differential human capital accumulation functions in the first period. Therefore, despite our nomenclature, this parameter might be associated with various environmental factors, forms of discrimination (e.g., gender), age, or birth order, as opposed to inherent "talent."[2] We assume a more talented child acquires a larger second-period human capital stock (h), for a given time investment, than a less talented child and that h is concave in e:

$$h_{\mathrm{e}}^i(e_i, a_i) \equiv \frac{\partial h}{\partial e_i} > 0, \quad h_{\mathrm{a}}^i(e_i, a_i) \equiv \frac{\partial h}{\partial a_i} > 0; \quad h_{\mathrm{ee}}^i(e_i, a_i) \equiv \frac{\partial^2 h}{\partial e_i^2} < 0 \qquad i = 1, 2 \tag{1}$$

It would also be straightforward to allow talent to affect the child's first-period wage ($w(a_i)$ with $w'(a_i)$>0). To streamline the presentation, we relegate this issue to two subsequent footnotes. Since the talent parameter is exogenous, parents' first-period choices are how to allocate their children's time between labor and human capital accumulation and how much to save. During the first period, the entire family is treated as single consumption unit and their total consumption is:

$$C = L + l_1 w + l_2 w - s. \tag{2}$$

In the second period, there are three distinct consumption units, as the parents and each child form distinct households. Allowing for bequests and transfers, the consumption levels of the three representative second-period households are:

$$\text{(i)}.\ c_p = L - b_1 - b_2 + \tau_1 + \tau_2 + s$$

$$\text{(ii)}.\ c_i = h(e_i, a_i) + b_i - \tau_i, \quad i = 1, 2 \tag{3}$$

where b_i and τ_i are, respectively, bequests from parents to their ith offspring and transfers from the ith offspring to parents. As we interpret these as net transfers, it

[2] See Emerson and Souza (2002) for a treatment of birth-order effects of child labor.

will always be the case that $b_i,\tau_i \geqslant 0$ and $b_i\tau_i = 0$. Positive bequests or transfers require some incentive in an optimizing model. It is simplest, and sufficient for our purposes, to simply assume two-way altruism (parent-to-child and child-to-parent). Consistent with these transfer motivations, the parents' first- and second-period utilities are, respectively:

$$W^1 = U(C); \quad W^2 = u^p(c_p) + \delta U^1(c_1) + \delta U^2(c_2); \qquad W = W^1 + W^2, \tag{4}$$

where U^i is the utility of the ith child, and δ the parents' altruism parameter towards their children.[3] The offspring's utility, which is realized in the second period when they establish independent households, is:

$$U^i = u^i(c_i) + \gamma_i W^2, \qquad i = 1,2 \tag{5}$$

where the γ_i's are the altruism discount parameter from offspring to parents.[4] Eqs. (4) and (5) constitute a 3×3 system with the following reduced form:

$$\text{(i)}.\ W = \left(\frac{1}{1 - \sum_{i=1}^{2} \gamma_i \delta} \right) \left(W^1(C) + u^p(c_p) + \sum_{i=1}^{2} \delta u^i(c_i) \right)$$

$$\text{(ii)}.\ U^i = \left(\frac{1}{1 - \sum_{i=1}^{2} \gamma_i \delta} \right) ((1 - \gamma_i\delta)u^i + \gamma_i(u^p(c_p) + \delta u^j)), \qquad i,j = 1,2\ i \neq j. \tag{6}$$

Much of the following analysis concerns "efficiency" properties of parental choice of education/labor for their heterogeneous children. Our notion of efficiency is Pareto, allowing for appropriate transfers. We wish to state emphatically, however, that insofar as practical policy is concerned, it is our view that "efficiency" should be but one (perhaps minor) consideration in determining the treatment of heterogeneous children. Having said this, efficiency is a clear criterion for assessing the effect of market imperfections on the parents' (constrained) education-labor choices across children.

We now examine the explicit optimization problems, beginning with the parent. The absence of any time-inconsistency incentives allows us to solve the parent's

[3] Asymmetric altruism parameters could easily be added.

[4] A necessary condition for stability is $\delta\Sigma\gamma_i < 1$.

global utility maximization problem simultaneously. The parent's optimization problem is:

$$\max_{e_i,s,b_i} W = \left(\frac{1}{1 - \sum_{i=1}^{2} \gamma_i \delta} \right) \left(W^1(C) + u^p(c_p) + \sum_{i=1}^{2} \delta u^i(c_i) \right) \tag{7}$$

subject to Eqs. (2) and (3). Denoting the partials of functions with subscripts, the resulting first-order conditions with respect to e_1, e_2, s, b_1, and b_2 are, respectively:

$$\begin{aligned}
&\text{(i)}. \ -W_c^1 w + \delta u_c^i h_e^i \leq 0 \qquad i = 1,2 \\
&\text{(ii)}. \ -W_c^1 + u_c^p \leq 0 \\
&\text{(iii)}. \ -u_c^p + \delta u_c^i \leq 0 \qquad i = 1,2
\end{aligned} \tag{8}$$

Denoting the interior solution as e_i*, s*, b_i*, manipulation of the five first-order conditions of Eq. (8) yields the efficiency condition: $h_e^1(e_1{*},a_1) = h_e^2(e_2{*},a_2)$ and the equation of children's marginal utilities ($u_c^1 = u_c^2$).[5] How do the less and more talented children's labor supply (education) compare under the efficient outcome? Suppose child "1" is the more talented child, so $a_1 > a_2$. By our assumptions on h (Eq. (1)), equating the marginal returns to education ($h_e^1 = h_e^2$) requires that the more talented child receive more education, since for identical labor supply the rate of return to education for the more talented child will exceed that of the less talented. Therefore, the less talented child is consigned to additional time in the labor market ($a_1 > a_2 \rightarrow l_1 < l_2$).

Much of the remainder of the paper will focus on the case where bequests are at a corner. The most obvious reason to focus on this case is poverty itself: below some minimum consumption level parents simply cannot afford bequests. We continue to consider interior solutions to the parent's choice of child labor (the l's). We also maintain the interior solutions in saving/borrowing (s) as it does not affect the distortion we identify. When bequests are at a corner, from Eq. (8) (i) and (ii), we have:

$$u_c^1 h_e^1 = u_c^2 h_e^2. \tag{9}$$

In this case, the efficiency condition ($h_e^1 = h_e^2$) is, in general, not satisfied. The fundamental intuition for this failure is that if these households are too poor to expect future bequests to serve as a utility balancing device for their offspring, they must adopt a second-best mechanism. The only means available for this balancing is through the

[5] When talent also affects child wages ($w'(a_i) > 0$) the efficiency condition becomes: $h_e^1(e_1,a_1)/w(a_1) = h_e^2(e_2,a_2)/w(a_2)$.That is, we now must equate the "price-adjusted" returns to education. This price adjustment reflects the fact that the opportunity cost of education may vary across children, and this must be incorporated in the efficiency condition.

(inefficient) first-period adjustment of their children's human capital stock. The consequence is that instead of efficiently equating marginal returns to education, parents equate the *marginal utility returns* to education. Note also that though parents equate the marginal utility returns to education of their offspring, this does not imply that offspring receive the same second-period utility—even when parents care equally for all their children.

A number of questions now emerge. First, how do education levels depart from the efficient level? To answer this note that at the efficient allocation ($h_e^1 = h_e^2$), child 1 (the more talented) has a larger human capital stock and therefore higher second-period income (h) and consumption. Therefore, at the efficient education level, $u_c^1 h_e^1 < u_c^2 h_e^2$. This inequality is brought into equality (Eq. (9)) by decreasing the education level of the more talented child and increasing the education of the less talented. To see this, simply note that both the return to education and second-period marginal utility are inversely related to the first-period education. Consequently, the inefficient constrained solution generates a more egalitarian distribution of human capital than the efficient outcome.

Can the ''compression'' in education between more and less talented children identified above ever lead to an absolute reversal of specialization? That is, to a situation where the more talented child receives less absolute education than the less talented. The answer, perhaps surprisingly, is yes. To see that such a solution is a possibility, first note that while $e_1 < e_2 \Rightarrow h_e^1 > h_e^2$ this *does not* imply that child two has a larger human capital stock ($h_2 > h_1$). If the more talented child's absolute advantage in human capital accumulation is sufficiently great, it is quite possible to have $e_1 < e_2$ and $h_1 > h_2$ which implies that $u_c^1 < u_c^2$. We can gain more insight into the conditions under which this reversal is likely to arise by considering the case where children are identical. Then $e_1 = e_2$, $c_1 = c_2$, $u^1 = u^2$, and efficiency obtains. Now using the implicit function theorem on Eq. (9), we can derive the following expression for the local (instantaneous) direct effect of an incremental change in talent on labor supply:

$$\frac{\partial \ell_1^*}{\partial a_1} = \frac{u_{cc}^1 h_a^1 h_e^1 + u_c^1 h_{ae}^1}{u_{cc}^1 h_e^2 + u_c^1 h_{ee}^1}. \tag{10}$$

Sine the denominator is negative, the sign of Eq. (10) turns on the numerator, whose first term is negative. Though we have made no assumption on the h-function cross-partial, it seems most natural to assume it is positive. Therefore, an increase in talent can have a positive or negative effect on labor supply. Assuming the cross-partial is positive, the direction of the effect can be linked to concavity of the utility function. To see this, rewrite the condition for a negative numerator in terms of absolute risk aversion:

$$-u_{cc}^1 / u_c^1 > h_{ae}^1 / h_a^1 h_e^1. \tag{11}$$

With concave utility, inequality (Eq. (11)) will likely be satisfied for the poor household since risk aversion becomes arbitrarily large as consumption approaches zero. Though we have few precedents for the cross-partial properties of the human capital accumulation function, there is little reason to expect such an explosive property in the h function.

When inequality (Eq. (11)) is satisfied, the distortion in the treatment of heterogeneous children (vis-à-vis the social efficient level) is towards *under-education* of the talented child, both relatively and absolutely. We call this "reverse specialization." Contrasting this result with the efficient solution, it is immediate from $h_{\mathrm{e}}^1 = h_{\mathrm{e}}^2$ that more talent is associated with less labor (more education) under the efficient outcome.[6]

We have demonstrated that it is *possible* for more talent to actually increase the labor supply of its possessor. This analysis raises the question of whether more talent could ever actually reduce the lifetime utility of a child. Such a contingency would raise complex moral hazard issues, since it might be possible for talented children to conceal their true talent level in such circumstances. However, we can demonstrate that this perverse outcome cannot occur in our model. To see this, insert the constrained (no bequest) education solutions [which we denote $\bar{e}_i(\bar{a})$] back into the reduced form objective functions (Eq. (6)) to generate value functions: $\bar{W}(\bar{e}_1(\bar{a}),\bar{e}_2(\bar{a}),\bar{s}(\bar{a}),\bar{a}),\bar{U}(\bar{e}_i(\bar{a}),\bar{e}_j(\bar{a}),\bar{s}(\bar{a}),\bar{a})$. Employing the envelope theorem on the model with full generality ($w'(a)>0$), all indirect effects can be ignored when deriving partials (of the value functions) with respect to talent. The welfare effect of an increase in talent for the possessing child and household are therefore simply:

$$\frac{\partial \bar{U}^i}{\partial a_i} = u_{\mathrm{c}}^i h_{\mathrm{a}}^i > 0, \quad \frac{\partial \bar{W}}{\partial a_i} W_{\mathrm{c}}^1 w'(a_i) + \delta u_{\mathrm{c}}^i h_{\mathrm{a}}^i > 0. \tag{12}$$

Welfare of all family members is therefore non-decreasing in the talent of another family member. This is attributable to the mutual altruism that permeates the system.

3.1. Offspring to parent transfers

We now consider the case where offspring provide second-period transfers to parents. Our inclusion of offspring heterogeneity necessitates a more sophisticated treatment of second-period sibling interaction than is found in Baland–Robinson. In particular, we model a transfer game between heterogeneous siblings who may have been provided differential opportunities for human capital accumulation in the first period. For time consistency, this case must be solved recursively from the terminal period. The second-period optimization problem of each offspring is then:

$$\max_{t_i} U^i = k\big((1-\gamma_i\delta)u^i + \gamma_i\big(u^p(c_p) + \delta u^j\big)\big), \tag{13}$$

subject to Eqs. (2) and (3), where $k = 1/(1-\sum_{i=1}^{2}\gamma_i\delta)$. Optimization by each offspring yields:

$$-(1-\gamma_i\delta)u_{\mathrm{c}}^i + \gamma_i u_{\mathrm{c}}^p = 0 \qquad i = 1,2. \tag{14}$$

These first-order conditions imply reaction functions, $\tau_i(\tau_j,e_i)$, in a transfer game between offspring. From this second-period perspective, the e_i's are parameters. A Nash

[6] A positive relationship between talent and wages would attenuate this effect, and it is possible for the comparative advantage in education to shift to the less talented child.

equilibrium in the transfer game simultaneously solves Eq. (14) and yields solutions of the form $\tau_i(e_i,e_j)$. These equilibrium transfer functions are then internalized in the parent's first-period optimization problem who recognizes that a child with more education will have a higher second-period income from which to finance transfers to parents. The parental first-period choice of child labor then becomes the solution to:

$$\max_{e_i,s} W = k\left(W^1(C) + u^p(c_p) + \sum_{i=1}^{2} \delta u^i(c_i)\right), \tag{15}$$

again subject to Eqs. (2) and (3) but with the equilibrium transfer functions, $\tau_i(e_i,e_j)$, replacing the parametric τ_i's of the prior formulation. Setting the w's equal to one, the first-order conditions with respect to e_1, e_2, and s are:

$$\text{(i).}\quad -W_c^1 + u_c^p\left(\frac{\partial\tau_i}{\partial e_i} + \frac{\partial\tau_j}{\partial e_i}\right) - \delta\left(u_c^i\left(h_e^i - \frac{\partial\tau_i}{\partial e_i}\right) + u_c^j\frac{\partial\tau_j}{\partial e_i}\right) = 0 \qquad i,j = 1,2; i\neq j$$

$$\text{(ii).}\quad -W_c^1 + u_c^p \leq 0. \tag{16}$$

Combining Eq. (16, (i)) and noting that Eq. (14) indicate that in equilibrium $u_c^1 = u_c^2$ with symmetric altruism by children we obtain:

$$(u_c^p - \delta u_c^1)\left(\frac{\partial\tau_1}{\partial e_1} + \frac{\partial\tau_2}{\partial e_1} - \frac{\partial\tau_2}{\partial e_2} - \frac{\partial\tau_1}{\partial e_2}\right) = \delta u_c^1\left(h_e^1 - h_e^2\right). \tag{17}$$

We can now apply the implicit function theorem to Eq. (14) to derive the following expressions for the partials of the transfer function with respect to education:

$$\text{(i).}\quad \frac{\partial\tau_i}{\partial e_i} = \frac{(1-\gamma\delta)u_{cc}^i h_e^i}{\gamma u_{cc}^p + (1-\gamma\delta)u_{cc}^i h_e^i} > 0 \qquad i = 1,2$$

$$\text{(ii).}\quad \frac{\partial\tau_i}{\partial e_j} = \frac{(1-\gamma\delta)u_{cc}^j h_e^j}{\gamma u_{cc}^p} > 0 \qquad i,j = 1,2. \tag{18}$$

Utilizing these expressions in Eq. (17) yields:

$$(u_c^p - \delta u_c^1)(h_e^1 - h_e^2)(1-\gamma\delta)u_{cc}^1\left(\frac{1}{(\gamma u_{cc}^p + (1-\gamma\delta)u_{cc}^1)} + \frac{1}{\gamma u_{cc}^p}\right) = \delta u_c^1\left(h_e^1 - h_e^2\right), \tag{19}$$

which can only be satisfied when $h_e^1 = h_e^2$. Therefore, when parents anticipate second-period transfers from offspring *and* internalize the relationship between their labor/education choices and future transfers, they are able to balance utility through transfers and exploit first-period comparative advantage through specialization. This result has important implications for those LDC settings where it is anticipated that children will have sufficient means to provide old-age support for parents. Namely, the foresightful parent can exploit the strategic interaction of offspring to reap the full benefits of comparative advantage.

3.2. Child labor bans and mandatory education

Now consider the efficiency implications of child labor bans noting that in our model a child labor ban is equivalent to mandatory education time. In the case of an interior solution to Eq. (8, (i)–(iii)) or Eq. (15), the outcome is already efficient and any ban can only introduce inefficiency. As previously developed, when b and τ are at corners without a ban (Eq. (8, (i)–(iii)) yields solutions e_1^{c} and e_2^{c}. Suppose a partial ban on child labor requires that $e_i > e^{\mathrm{b}}$, $i=1, 2$. If the ban is binding for both children ($e_i^{\mathrm{c}} < e^{\mathrm{b}} \forall i=1,2$), education time will be set to e^{b}. Given heterogeneity, $h_{\mathrm{e}}^1(e^{\mathrm{b}},a_1) > h_{\mathrm{e}}^2(e^{\mathrm{b}},a_2)$, and the constrained labor allocation is not efficient with the more talented child relatively undereducated.

We now turn to the case where the ban is binding for one child: $e_i^{\mathrm{c}} < e^{\mathrm{b}} < e_j^{\mathrm{c}}$. If there is reverse specialization ($e_1^{\mathrm{c}} < e^{\mathrm{b}} < e_2^{\mathrm{c}}$) in the absence of the ban, its imposition will cause $e_1 = e^{\mathrm{b}}$ and from Eq. (8, (i)), we have $\bar{W}_{\mathrm{c}}^1 > \delta \bar{u}_{\mathrm{c}}^1 h_{\mathrm{e}}^1(e^{\mathrm{b}},a_1)$, $\bar{W}_{\mathrm{c}}^1 = \delta \bar{u}_{\mathrm{c}}^2 h_{\mathrm{e}}^2(e_2^{\mathrm{b}},a_2)$. Since the ban reduces first-period family consumption, we also know that: $\bar{W}_{\mathrm{c}}^1 > \bar{W}_{\mathrm{c}}^1 \rightarrow \bar{u}_{\mathrm{c}}^2 h_{\mathrm{e}}^2(e_2^{\mathrm{b}},a_2) > \bar{u}_{\mathrm{c}}^2 h_{\mathrm{e}}^2(e_2^{\mathrm{c}},a^2) \rightarrow e_2^{\mathrm{b}},e_2^{\mathrm{c}}$. Therefore, $e_1^{\mathrm{c}} < e_1^{\mathrm{b}} = e_2^{\mathrm{b}} < e_2^{\mathrm{c}}$, and the partial ban decreases the reverse specialization distortion, and increases efficiency. However, it cannot correct the efficiency problem ($h_{\mathrm{e}}^1(e_1^{\mathrm{b}},a_1) > h_{\mathrm{e}}^2(e_2^{\mathrm{b}},a_2)$).

Finally, consider the case without reverse specialization: $e_2^{\mathrm{c}} < e^{\mathrm{b}} < e_1^{\mathrm{c}}$. After the ban, the solutions are $e_2 = e^{\mathrm{b}}$ and $e_1 = e_1^{\mathrm{b}}$, and the following will hold: $\bar{W}_{\mathrm{c}}^1 > \delta \bar{u}_{\mathrm{c}}^2 h_{\mathrm{e}}^2(e^{\mathrm{b}},a_2)$, $\bar{W}_{\mathrm{c}}^1 = \delta \bar{u}_{\mathrm{c}}^1 h_{\mathrm{e}}^1(e_1^{\mathrm{b}},a_1) \rightarrow \bar{u}_{\mathrm{c}}^1 h_{\mathrm{e}}^1(e_1^{\mathrm{b}},a_1) > \bar{u}_{\mathrm{c}}^2 h_{\mathrm{e}}^2(e_2^{\mathrm{b}},a_2)$. In turn, this implies: $e_2^{\mathrm{b}} = e^{\mathrm{b}} < e_1^{\mathrm{b}} \rightarrow c_2 < c_1 \rightarrow \bar{u}_{\mathrm{c}}^1 < \bar{u}_{\mathrm{c}}^2$. Therefore, it must be true that $h_{\mathrm{e}}^1(e_1^{\mathrm{b}},a_1) > h_{\mathrm{e}}^2(e_2^{\mathrm{b}},a_2)$ and the education allocation under the partial ban is not efficient and in fact increases inefficiency by compressing attainment levels.

4. Summary and conclusion

In this paper, we draw attention to a little explored issue in child labor—the incentive associated with heterogeneity for intra-household child specialization across education and labor market activities. We demonstrate that the time allocation of children across activities is not Pareto efficient in the absence of utility balancing future transfers or bequests. Inefficiency arises from the tension faced by altruistic parents between exploiting the comparative advantage of their children and their desire to balance their offspring's future utility. In the absence of future utility balancing transfers, the contemporaneous parental allocation of child-time across education and labor is the sole utility balancing instrument.

The manifestation of the inefficiency we identify is too much labor supply (too little education) for the child relatively talented in human capital accumulation. When the talent differential between children is large, the distortion in time allocation across children can result in a "reverse specialization." That is, a situation where children's time allocation reverses the pattern consistent with comparative advantage. We also show that child labor bans – the focus of the prior literature – may either increase or decrease inefficiency with heterogeneous children. When reverse specialization occurs, a partial ban that binds only on the more talented child increases efficiency. On the other hand, a child labor ban that binds on only the less talented child increases inefficiency in the absence of reverse specialization. If a ban is binding on both children, it may increase efficiency or decrease efficiency.

Issues that call for additional attention include the affect of discontinuities in returns to education (e.g., sheepskin or diploma effects) on the intra-household child labor distribution. It is not difficult to see how such effects may increase specialization. If one child with n years of education earns more than two with $n/2$ years (due to sheepskin effects), an incentive for specialization independent of heterogeneity exists. It would also be of interest to explore policies to correct the inefficiency. One such possibility is a first-period government education subsidy financed by a second-period progressive (utility balancing) tax on the offspring.

Beyond theoretical modeling, the pressing need is for additional empirical analysis of intra-household specialization among child laborers. As discussed in the literature review, there already exists a substantive body of empirical work pointing to significant specialization among children. However, many of the intra-household child-specialization issues raised by our analysis cannot be adequately explored with cross-section data. The prior empirical work discussed in our literature review all employ cross-section data. Since heterogeneous investment in children may take the form of additional schooling, a cross-section of child labor—force participation in multiple child households may capture primarily birth order affects. In particular, since education often extends beyond the typical definition of "childhood," total education investment is not observed in child-labor studies where children combine education and labor (the typical case). With this in mind, the ideal data to broach the issues illuminated by our model is a panel of the complete work/education history of individuals reared in multiple children households. An alternative is retrospective child-labor/education data from adults (with completed education) who can be linked to childhood-household. While such data is rare, an appropriate survey design presents no insurmountable conceptual obstacles.

Finally, the very notions of heterogeneity and altruism, upon which the model rests, are themselves controversial. In the context of intra-familial resource allocation, the interaction of offspring heterogeneity and parental altruism may have natural selection motivations that lie at the boundaries of economic and biological analysis.

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