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A note on multiple general equilibria with child labor

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Abstract

It has been conjectured that the child-labor market may exhibit multiple equilibria. This paper develops the concept of a 'wage bill curve', and establishes the multiple-equilibrium result in a general-equilibrium model, thereby clarifying the circumstances where child labor should be banned.

Keywords: Child labor; Multiple equilibria; Wage–bill curve; Legal intervention

JEL classification: J20; D51

1. Introduction

Consider a poor country in which children are viewed as potential workers and there is no law — at least none that is properly enforced — that prohibits child labor. The fact that around 250 million children work the world over (see Basu, 1999) suggests that the case we are considering is the norm rather than the exception. There is now quite a substantial empirical literature demonstrating that the typical parent sends a child out to work only when threatened by extreme poverty (see, e.g., Grootaert and Patrinos, 1999; Ray, 2000). There is also a small analytical literature which argues that if a child's non-work is a luxury good (as the above empirical findings suggest) then the economy is likely to have multiple equilibria with one equilibrium in which children do not work and another in which they do (Basu and Van, 1998; Swinnerton and Rogers, 1999; Bardhan and Udry, 1999; Lopez-Calva, 1999). However, in the existing literature this result is established in a partial equilibrium framework.

If this theoretical claim is generally valid, then it has important policy implications. It will mean that a legal ban can (under some circumstances) be an effective way to deal with the problem; because the ban could prevent the economy from getting into the equilibrium in which children work and

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deflect it to the equilibrium where they do not. This has implications also for international policy initiatives, such as those concerning labor standards (Brown, 2000; Dixit, 2000; Jafarey and Lahiri, 1999).

The aim of this paper is to construct a general equilibrium model of an economy in which children are potential workers and then show that under some natural restrictions on preference, multiple equilibria are indeed likely in this model. The paper also develops the simple geometric idea of a 'wage bill curve' and shows how this can be used to understand the possibility of multiple equilibria. While there has been some attempts to bring elements of general equilibrium argument into the picture (Swinnerton and Rogers, 1999; Baland and Robinson, 2000; Ranjan, 2000), there has as yet been no full general equilibrium treatment of the problem of child labor. Hence the objective of this paper is essentially a methodological one — to show how arguments made in the context of partial equilibrium models can be extended to a general equilibrium framework. Viewed in the abstract, the model considers the possibility of multiple equilibria when a single decision-making unit (household) decides on the labor supply of more than one agent.

2. The model

We consider an economy with 1 worker household, 1 capitalist household and 1 firm. These are all price-takers and so the restriction of there being one of each kind causes no loss of generality.

Each worker household has 1 adult and 1 child. The adult has an endowment of labor equal to 1 unit and the child has an endowment of labor equal to γ unit, where $\gamma \in (0, 1]$. Using c to denote aggregate household consumption and ℓ aggregate leisure, the household's utility function is given by

$$u = u(c, \ell)$$

where $c \geq 0$, $\ell \in [0, 1+\gamma]$, where leisure ℓ is simply the amount of household labor endowment that is not sold. Hence, if it consumes ℓ units of leisure, it supplies $1+\gamma-\ell$ units of labor. It will be assumed that when the household supplies e units of labor, it begins with the adult's labor, and supplies child labor only after it has supplied the 1 unit of adult labor. This means that it does not matter if the child's leisure is measured in some units different from adult leisure (see Basu, 2000). This assumption also means that as soon as we know how much leisure, ℓ, the household consumes, we know not only how much labor the household supplies $(1+\gamma-\ell)$ but how much child labor is supplied $(\max\{\gamma-\ell, 0\})$.

Next consider the following assumptions concerning the household's utility function.

Assumption 1. The utility function $u: \Re_+ \times [0, 1+\gamma] \to \Re$ is continuous, (weakly) monotonic and quasi-concave.

We shall on some occasions use a stronger concavity assumption as follows:

Assumption 2. The utility function u is strictly quasi-concave.

Let p be the price of the consumable good and w the price of labor. Let α be the share of the firm owned by the worker household. Hence, if the total amount of profit earned by the firm is π, the worker household's problem is as follows.

$$\max_{c,\ell} u(c, \ell)$$

subject to $pc \leq w(1+\gamma-\ell)+\alpha\pi$, $c \geq 0$, and $\ell \in [0, 1+\gamma]$.

Assumptions 1 and 2 ensure that for every p (>0), w and $\alpha\pi$, there is a unique solution to the above problem. Also, since we confine our attention entirely to Walras equilibria it is harmless to normalize and set $p=1$. We do so from now on; and hence write the solution to the above problem as follows.

$$c = c(w, \alpha\pi)$$
$$\ell = \ell(w, \alpha\pi)$$

Next let us turn to the capitalist household. This household never supplies labor. We may equivalently assume that this household has no endowment of labor. This assumption causes no loss of generality. As a matter of fact we could have assumed the capitalist household to be exactly like the worker household, excepting for the fact that it has rights to a larger share of the firm's profits. Then there could be price ranges where the capitalist household's profit share is so large that it *prefers* not to send the child to work. Continuing with our description of the capitalist household let us assume that it owns a share $(1-\alpha)$ of the firm. Since its utility depends only on its consumption, c', and its budget constraint is given by

$$c' \leq (1-\alpha)\pi$$

we know that this household will choose c' so that

$$c' = (1-\alpha)\pi$$

The firm's production function is given by

$$x = f(L)$$

where L is the amount of labor used and x the amount of output produced. The production function is required to satisfy the following.

Assumption 3. The production function $f: \Re_+ \to \Re_+$ is strictly monotonic, strictly concave, bounded from above, and has the properties that $f(0)=0$ and there exists $b>0$ such that $f(L) \leq bL$, for all $L \geq 0$.

The firm's problem is to:

$$\max_L \hat{\pi} = f(L) - wL$$

Given Assumption 3, for every $w \in \Re_+$ there is a unique L chosen by the firm. We denote this by

$$L = L(w)$$

Define

$$x(w) \equiv f(L(w))$$

and

$$\pi(w) \equiv x(w) - wL(w)$$

In this paper, an economy, Ξ, is fully described by u, f and α. Hence

$$\Xi = \langle u, f, \alpha \rangle$$

Given an economy, $\Xi = \langle u, f, \alpha \rangle$, we define w^* to be a *Walras equilibrium* if

$$c(w^*, \alpha\pi(w^*)) + (1 - \alpha)\pi(w^*) = x(w^*) \tag{1}$$

In stating the Walras equilibrium in this manner we are making use of the Walras law of markets, which ensures that if the goods market is in equilibrium (i.e. (1) is true) then the labor market must be in equilibrium.

To ensure that we are not working in a vacuum it is worth noting:

Theorem 1. *Every economy, $\Xi = \langle u, f, \alpha \rangle$, satisfying Assumptions* 1–3, *has at least one Walras equilibrium.*

Proof. Define $z(w) \equiv c(w, \alpha\pi(w)) + (1 - \alpha)\pi(w) - x(w)$. That is, $z(w)$ is the excess demand function for the good. Assumptions 1–3 guarantee that z is a function.

Choose $b > 0$ such that $f(L) \leq bL$, $\forall L \geq 0$. This exists by Assumption 2. It is obvious that if $w = b$, $x(w) = 0$, $\pi(w) = 0$. Hence, $z(b) = b(1 + \gamma - \ell(b, 0))$, from the definition of $z(\cdot)$ and the worker-household's budget constraint. Hence $z(b) \geq 0$. If $z(b) = 0$, then $w = b$ is a Walras equilibrium.

So suppose $z(b) > 0$.

Clearly, $\exists \hat{w} < b$ such that

$$\begin{aligned} & L(\hat{w}) > 1 + \gamma \\ & \quad \rightarrow L(\hat{w}) > 1 + \gamma - \ell(\hat{w}, \alpha\pi(\hat{w})) \\ & \quad \rightarrow x(\hat{w}) - \pi(\hat{w}) > w[1 + \gamma - \ell(\hat{w}, \alpha\pi(\hat{w}))] \\ & \quad \rightarrow z(\hat{w}) < 0 \end{aligned}$$

by the worker-household's budget-constraint. It is easy to check that c, π and x are continuous functions. Hence, z is continuous and so $\exists w^* \in [\hat{w}, b]$ such that $z(w^*) = 0$.

3. Multiple equilibria

To see how multiple equilibria can arise in this model and how that is more plausible if households treat child leisure (or, more generally, non-work) as a luxury good I will develop a diagrammatic representation of the above model. In doing so, we will consider the two polar cases $\alpha = 1$ and $\alpha = 0$.

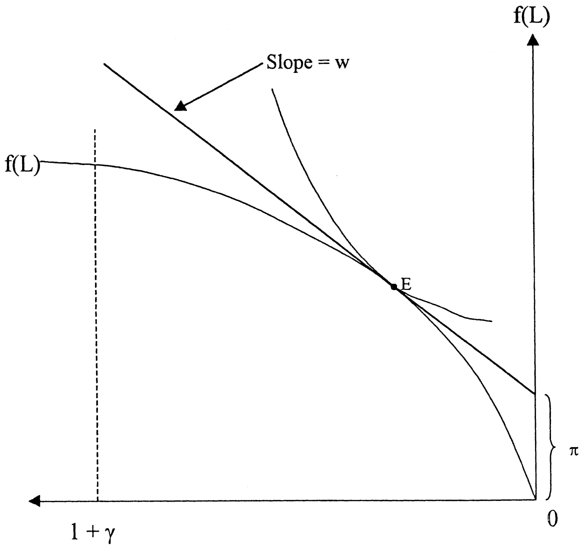

Fig. 1.

If $\alpha = 1$, it is as if there is only one household — the worker household. The geometric depiction of the Walras equilibrium in this case is fairly standard (Mas-colell et al., 1995, Chapter 15). In Fig. 1, the horizontal axis measures the amount of labor used by the firm. The production function is as shown. If we treat the point marked $1 + \gamma$ as the origin and measure the household's leisure consumption in the eastward direction and goods consumption along the broken vertical line, we can depict the household's indifference curves in this space. The Figure assumes $p = 1$.

Given Assumptions 1 and 2, there will exist a unique point where the production function is tangential to an indifference curve. E denotes this point in the Figure. By a well-known argument, the slope of the tangent at E is the Walras equilibrium wage rate. The profit earned by the firm is shown by the vertical intercept of the tangent on the $f(L)$-axis. What this Figure clarifies is that, if the workers earn all the profits, the economy will have a unique equilibrium. Hence, we know that a necessary condition for the existence of multiple equilibria is that $\alpha < 1$. This is quite a realistic assumption, since one cannot think of any country in the world where workers earn all the profits.

While the possibility of multiple equilibria arises, as soon as we have $\alpha < 1$, for ease of exposition, I will consider the polar extreme of $\alpha = 0$. Hence, there is a separation between the laboring households and the capitalist households. But once the logic of my argument and the diagrammatic technique is understood, it will be evident that the analysis carries over to all cases of $\alpha < 1$.

Now, every time we are given a w, the (worker) household's budget constraint is given by a line having a slope of w (a negative slope of w to be more precise), *through point 0.* There will be no positive intercept, such as π shown in Fig. 1, since the household earns no profit. So if the household's leisure consumption is $1 + \gamma$, its income is zero.

A crucial instrument in depicting a Walras equilibrium in this case is what will be called the 'wage bill curve'. This is illustrated in Fig. 2 and it is derived as follows. Consider any point on the graph of the production function, such as A. Consider the wage, w, for which A would be the profit-maximizing point of the firm. Let $\pi(w)$ be the profit of the firm at that w. Hence, this is given by OB in Fig. 2.

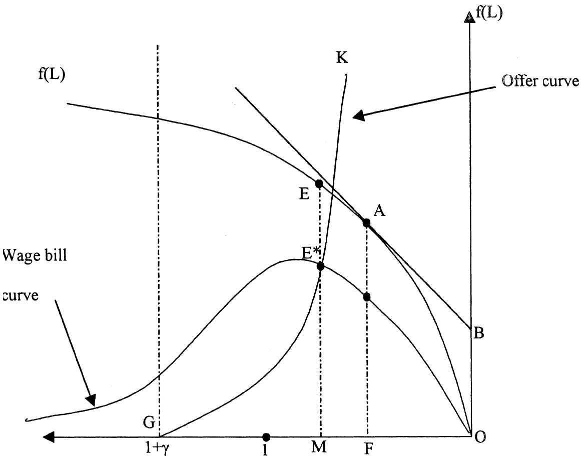

Fig. 2.

From the line segment AF, starting from point *A*, deduct the profit. The point one gets by so doing (D in Fig. 2) is a point on the wage bill curve. By varying *A* we get a locus of points like D. That locus is the wage bill curve.

Since $f(0) = 0$, the wage bill curve must start at 0 in Fig. 2. Since by assumption 2, f is bounded from above, as L becomes large, the wage bill curve converges to zero. This explains the shape of the wage bill curve shown in Fig. 2.

In brief, if the wage is such that the firm chooses point A, then the height of the wage bill curve (DF) is the total wage bill generated at that point and the vertical gap between the production function and the wage–bill curve at that point (namely, AD) depicts the aggregate profit in the economy.

Next consider the worker household's problem. Treating the point $1 + \gamma$ as its origin, let us measure its leisure on the horizontal axis and goods consumption on the vertical axis (the broken line). Now consider all possible budget constraints through point 0 and on each budget constraint mark the household's optimal point. By joining such points we get the standard offer curve. Let us suppose that the offer curve is GK. There is no reason to suppose that G will coincide with the point marked $1 + \gamma$. The Figure suggests this purely for reasons of aesthetics.

Theorem 2. *The Walras equilibria of an economy,* $\Xi = \langle u, f, 0\rangle$, *are depicted by the points of intersection between the offer and wage bill curves.*

To see this consider point E^* in Fig. 2 where the wage bill curve intersects the offer curve. Suppose the wage rate w^* is given by the slope of the line joining E^* and 0. Clearly, given w^*, the household will choose leisure and consumption depicted by E^*, since E^* lies on the offer curve. Since EE^* is the total profit in the economy, and a line of slope w^* at E has an intercept on the $y(L)$ axis equal to EE^*, given w^*, the firm chooses point E. Since the capitalist household uses the entire profit to consume goods, the total demand for goods $(EE^* + E^*M)$ equals total supply of goods EM.

It is now easy to see how multiple equilibria can arise. All one needs is for the offer curve to intersect the wage bill curve more than once as, for instance, illustrated in Fig. 3.

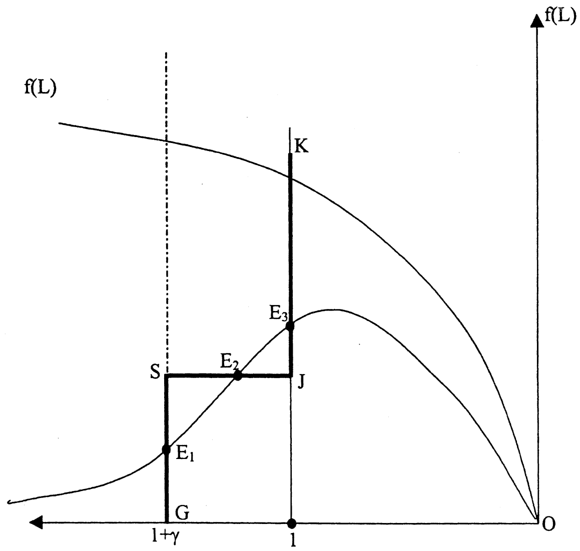

Fig. 3.

It has been often suggested that parents send their children to work only when that is necessary in order to attain some critical minimum consumption, *S*. This was called the 'luxury axiom' in Basu and Van (1998). One formal and somewhat extreme interpretation of this is as follows.

Assumption 4. There exists $S > 0$, such that, if $S \geq c \geq c' \geq 0$, then $u(c, \ell) \geq u(c', \ell')$, for all ℓ, $\ell' \in [0, 1+]$.

This axiom simply asserts that the offer curve rises vertically at *G*, at least up to *S*. The offer curve *GSK* in Fig. 3 satisfies Assumption 4. A familiar example of a utility function satisfying Assumption 4 is the Stone–Geary utility function.

I had argued in Basu (1999) that there is a large literature and evidence that supported this axiom. It is worthwhile exploring the implications of this axiom in a general equilibrium model of an economy. The next theorem states a necessary and sufficient condition for the existence of a Walras equilibrium in which the children of worker households do full-time work.

Theorem 3. *Suppose* $\Xi = \langle u, f, 0 \rangle$ *is an economy satisfying Assumptions* 1 *and* 3. *For this economy to have a Walras equilibrium in which worker household children do full-time work it is necessary that Assumption* 4 *be satisfied. This becomes a sufficient condition if* (*assuming* $f(\cdot)$ *is differentiable*) $f'(1+\gamma)(1+\gamma) \leq S$.

The condition $f'(1+\gamma)(1+\gamma) \leq S$, simply says that, when all adults and children of worker households work, the marginal product of labor is so low that wage bill is less than the subsistence wage bill. The proof of Theorem 3 is obvious by using the diagrammatic technique developed above.

Note that Assumption 4 implies that child leisure is a luxury good. Hence, to have a Walras equilibrium in which worker household children do full time work it is necessary for child leisure to be a luxury good.

4. Policy

If an economy is as depicted in Fig. 3, and suppose it is, currently, in equilibrium at E_1, a ban on child labor would push the economy to the sole remaining equilibrium at E_3. It is obvious that at E_3 worker households are better off. Note also that once the equilibrium has moved to E_3, the legal ban is not, strictly speaking, needed any more. Legislative actions of this kind, which, once put into effect, can be removed without the economy reverting back to the original situation may be called 'ratchet legislation'. This model suggests that if child labor is driven by subsistence needs, it is possible that there will be multiple equilibria, and in that case there is scope for putting an end to child labor through the use of ratchet legislation.

This general equilibrium analysis sheds light on an important policy question, which remained unclear in the partial equilibrium model. It makes it plain that, in an economy in which child labor is prevalent, a ban on child labor could result in an equilibrium outcome which is Pareto optimal but, nevertheless, a ban on child labor cannot be justified on a purely Paretian ground. As is obvious from Fig. 3, all equilibria in this economy are Pareto optimal. We have to think of social welfare functions, which attach a special weight to workers' welfare or a negative weight to child work, in order to justify a ban. The welfare function can be Pareto inclusive, but the inclusion of the Pareto criterion is not sufficient.

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