# Liquidity Constraint and Child Labor: Is Market Really Incapable Of Eradicating It From Wage-Labor Households?

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**Abstract**

One way to measure the lower steady state equilibrium outcome in human capital development is the incidence of child labor in most of the developing countries. With the help of Indian household level data in an Overlapping Generation framework, we show that production loan under credit rationing is not optimally extended towards the firms because of the adverse selection problem. More stringent rationing in the credit market creates a distortion in labor market by increasing adult wage rate and demand for child labor at the same time. Lower availability of funds under stringent rationing coupled with increased demand induce the high risk firms to replace the adult labors by the child labors. A switch of regime from the credit rationing to the revelation regime can clear such imperfection in the labor market. This higher wage rate elevates the household consumption to a significantly higher level than the subsistence under credit rationing and therefore, higher level of human capital development is assured for no supply of child labor.

JEL Classification: O16, O17, E26

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# 1 Introduction

The purpose of this study is mainly twofold. First, to bring out the stylized facts why does child labor exist under credit rationing and second, whether the problem can be arrested by proposing alternative financial development. The income inadequacy to maintain the subsistence level of consumption is a very common phenomenon in the developing countries and such inadequacies in income originates from lower human capital development. Lower adult income induces parents to supply child labor to smooth their consumption. Therefore, one way to measure such lower steady state value of human capital development is the incidence of child labor in most of the developing countries. According to the ILO Report (2001), over 250 million children work worldwide. Among all sectors, agriculture alone uses 70 percent of these child workers(Ashagrie (1998)).

Child labor is the outcome of the failure of over all development process. Tagging it to one particular imperfection or distortion is, therefore, not wise enough to address this issue. But, given the nature and complexity of this problem, finding out the gravity of any one particular cause and exploring the remedial measure to cure it, is never uncalled for. The problem has been addressed from many different socio-economic angles but the cure, 'whether we need policy intervention or should we leave it in the hands of the market' – is still unresolved.

The degree of parental selfishness is often given a significant weightage by many researchers to explain the incidence of child labor. The high incidence of child labor in the poor countries have a comparative advantage in the production of labor intensive goods with unskilled workers (Ranjan (2001)). In such situations with high demand for unskilled worker and with no or minimum altruism, parents send their children to work in order to increase both, their family income as well as their leisure. Trade sanction is suggested to be one of the effective policy measures to banish it with the expectation that a trade sanctions on such countries would reduce the unskilled wage and increase the skilled wage and, would in turn, induce the parents to send their children to school. However, the alternative argument suggests that a decline in unskilled wage reduces the income of the unskilled workers. According to Ray (2002), in a world with credit constraints, it would make the matter worse

by driving the children from credit starved households on to the labor market.

According to Nardinelli, (1990), if child labors is the product of market then it must be efficient and legal interventions are futile. Alternatively, Basu (2003) with a reference of Satz, argues, when one person (parents) decides for the other (child)–It's against the consumers' sovereignty and should not be considered as the outcome of market. Baland and Robinson (2000) mentioned that socially inefficient child labor may arise in equilibrium because parents fail to fully internalize its negative effects. They pointed out two main reasons for child labor. First, the imperfection of capital market in translating future earning potential into present spending power. Second, the inability of parents to make negative bequest to their children. Similar results by Ranjan (1999) indicates that non existence of markets for loans against future earnings of children gives rise to inefficient labor supply.

According to this view, borrowing constraints may play the key role in the allocation decision of households between consumption and investment, particularly, investment in human capital. By creating such borrowing constraint, the capital market imperfections leads to an under investment in the human capital of their children even when the parents are altruistic. Therefore, better access to credit may contribute to a reduction in child labor ( Basu and Van (1998), Baland and Robinson (2000), Ranjan (2001), Cigno, Rosati, Tzannatos (2002) and Guarcello (2003)).

Most of the above mentioned studies consider present loan against the future human capital development of their child in order to smooth consumption. As we find "human capital" loan is very unlikely for children at or below 16 years. In most of the developing countries this market is absent and even if some form of it is present, it is applicable only for those who has qualified a minimum level of education, mostly undergraduate or graduate level. Therefore, one has to be really aware of the existing markets and complex interaction between the households behavior and the economy in order to come up with effective policy measures.

The labor market failure is an outcome of underdevelopment and consumption smoothing with the help of borrowing can not lead to a permanent solution. Child labor is an outcome of insufficient adult income and such insufficiency results from suboptimal production relation.

To make a permanent dent into the problem of child labor, therefore, requires more attention on the capital market imperfection related to production loan.

We incorporated informal moneylenders in our model to capture the broader credit channel for production loans. The reason behind this incorporation is that informal credit channel coexist in most of the developing countries under credit rationing and they are either vertically or horizontally integrated to each other. In the case of India, our country of interest for this study, these two channels are horizontally integrated and a spill over of demand for production loan takes place under credit rationing from the formal to the informal credit market.

Another contribution of this paper is the proposal of an alternative credit regime to ensure financial development. We find that firms with different degrees of success rates can be separated based on incentive mechanism and such separating equilibrium automatically takes care of the adverse selection problem. Once the banks can hedge against risk by charging differentiated loan rates, appropriate amounts of loan can be extended to different firms based on their risk type. This mechanism not only clears the credit market imperfection significantly but also reduces the incidence of child labor drastically by banishing the informal credit markets.

Given this backdrop, the main objectives of this study is to find out

- Under asymmetric information, can credit rationing for production loan reduce child labor in the presence of informal credit market?
- Can market based pricing of credit through the self revelation mechanism promise better outcome?

In this study we try to find out the necessary and sufficient conditions to overcome the child labor problem. While our first objective tries to capture the interactions among different socio-economic factors and finds out these necessary and sufficient conditions, our second objective tries to explore whether some alternative is still possible to satisfy these conditions when credit rationing fails.

The outline of this study is planned as follows: In section 1 we introduce the problem with the existing literature. In section 2 we outline an Overlapping Generation model in a

dynamic general equilibrium framework. We also lay out the equilibrium conditions in this section. Section 3 is devoted to the estimation and calibration of the equilibrium outcomes. Section 4 concludes.

# 2 Base line Model:

There are four decision making units in our model. In a three period Overlapping Generation set up we consider that our agent household uses her unit time allocation either in human capital development or work in her childhood. In the next period, when she is adult, she work as adult labor full time and allocates her income between present consumption, savings for the next period when she is old and households loan to firms. Our agent also cares about her child's welfare.

We assume heterogenous firms in our model as another decision making unit based on their degree of risk. Firms use only labor for production and make the wage payment by borrowing from the bank. Under credit rationing firms go to the informal credit market for loan when they are rejected by the banks. No firm has initial endowment in our model.

We assume two different financial regimes to describe banks' problem. First, we consider the existing situation where credit rationing is prevalent in the economy due to lack of proper risk identifying instrument with the banks. The heterogeneity in firms type leads to the adverse selection problem in this regime when banks do not have enough information regarding firms' type. Banks' inability to identify different types of firms results in credit rationing in the production loan market. We analyze the consequence of credit rationing on adult wage and child labor by introducing informal credit market in our model.

Next, we propose revelation regime as an alternative to credit rationing. In this regime banks offer different loan contracts to high and low risk firms based on incentive compatibility. Our fourth agent is the informal moneylender. We introduce informal credit market in our model to capture the spill over of demand for loan from the formal to the informal market and it flourishes under more stringent credit rationing.

## Households

We consider a three period Over Lapping Generation model for our analysis. In period $t-1$ our agent is a child and is endowed with 1 unit of time. She can distribute her time between education ($e_{t-1}$) or work (1-$e_{t-1}$). If she works then wage rate she gets as a child labor is $w_{c,t-1}$. The agent does not consume when child, her income is used for households consumption. There is some technology that converts her time in education in period $t-1$ into human capital $h_t$. This technology is considered to be a function of parental educational level. The children do not participate in household decision making. Human capital development takes place only when our agent is a child and, takes its final form in the next period.

In period $t$ the agent becomes adult and uses her entire time endowment to work. She gets an adult wage $w_{a,t}$, based on their human capital. The agent distributes her entire income in period $t$ between consumption, saving in the bank ($D_t$) and some low risk loans $H_t$ to the firms. $D_t$ matures in the beginning of the period $t+1$. Households do not have any profit motive in providing loan to a fraction of low risk firms. They charge no interest on this loan. As a consequence of such altruistic decision, the households incur an opportunity cost. The agent also maximizes her child's welfare in the next period. In our model parental altruism is endogenous. According to our model the determinants of parental altruism are their educational level and efficiency wage ratio of child to adult labor. The reason behind choosing the parental altruism level endogenously is to capture the gap between actual and required supply of child labor. Instead of assuming the required child labor supply as the sufficient condition like the luxury axiom by Basu and Van (1999), we consider it as necessary condition and the endogenous altruism decides the sufficient condition for no child labor supply. The existence of such gap between the actual and required, thus, will have an important role in our analysis in crafting accurate policy measure.

In period $t+1$ the agent grows old and retires from work. In period $t+1$ she consumes all her savings along with the households loan they offered in period $t$ to the low risk firms.

Based on the above description, the budget constraint of our agent in period $t$ and $t+1$

are

$$
\begin{aligned}
c_t^{t,A} + D_t + H_t &\leq w_{a,t} n_t && (1)\\
c_{t+1}^{t,O} &= (1 + r_{d,t}) D_t + H_t && (2)\\
\text{where,} \quad w_{a,t} n_t &= w_{a,t} n_{a,t} h_t + \omega w_{a,t} n_{c,t} && (3)\\
n_{c,t} &= 1 - e_t && (4)\\
0 &< e_t \leq 1 && (5)\\
\text{and,} \quad \omega &= \frac{w_{c,t}}{w_{a,t}} && (6)
\end{aligned}
$$

From the above budget constraints for the period $t$ and $t+1$ we get the following life time budget constraint of our agent as

$$
c_t^{t,A} + \frac{c_{t+1}^{t,A}}{1 + r_{d,t}} \leq w_{a,t} n_t - \frac{r_{d,t} H_t}{1 + r_{d,t}} \tag{7}
$$

Where, $e_t$ is the fraction of the child's time devoted to human capital development and $h_t$ is the technology that converts time in education to human capital. The last term in the RHS represent the opportunity cost of households for households loans with no interest rate. In our model we also consider that our agent maximizes the discounted value of their child's welfare. In that regard the life time budget constraint for the period $t$ children for period $t+1$ and $t+2$ becomes

$$
c_{t+1}^{t,C} + \frac{c_{t+2}^{t,C}}{1 + r_{d,t+1}} \leq w_{a,t+1} n_{t+1} - \frac{r_{d,t+1} H_{t+1}}{1 + r_{d,t+1}} \tag{8}
$$

We assume the technology that converts education into human capital has the following equation of motion

$$
h_{t+1} = \xi_1 e_t^{\xi_2} h_{A,t}^{\xi_3} \quad \text{where } 0 < \xi_2, \xi_3 < 1 \text{ and } h_A > 1 \tag{9}
$$

Where, $\xi_2$ and $\xi_3$ represent the share of the devoted time by children in human capital development and their parent's human capital respectively. The households have a minimum subsistence level of consumption, $\underline{c}$. Therefore, households objective is to maximize the discounted life time utility from their inter-temporal consumption over the minimum

subsistence level as well as their child's welfare.

$$V_t(h_{A,t}) = \max_{e_t, h_{t+1}, c_t} \ln(c_t^{t,A} + \frac{c_{t+1}^{t+1,O}}{1+r_{d,t}} - \underline{c}) + \sigma V_{t+1}(h_{t+1}) \tag{10}$$

$$c_t^{t,A} + \frac{c_{t+1}^{t+1,O}}{1+r_{d,t}} \leq (1-e_t)\omega w_{a,t} + w_{a,t} n_{a,t} h_t - \frac{r_{d,t} H_t}{1+r_{d,t}} \tag{11}$$

$$h_{t+1} = \xi_1 e_t^{\xi_2} h_A^{\xi_3} \tag{12}$$

The F.O.Cs with respect to

$$e_t : \quad \frac{c_t^{t,A} + \frac{c_{t+1}^{t+1,O}}{1+r_{d,t}} - \underline{c}}{c_{t+1}^{t+1,A} + \frac{c_{t+2}^{t+2,O}}{1+r_{d,t+1}} - \underline{c}} = \sigma \frac{\xi_1 \xi_2 h_{A,t}^{\xi_3} n_{a,t+1} w_{a,t+1}}{\omega w_{a,t} e_t^{1-\xi_2}} \tag{13}$$

Where, $\sigma$ represents the parental altruism towards their children. Considering no growth in the economy the above Equation gives us the child's education level, $e_t$ as

$$e_t = \left[ \frac{\sigma \xi_1 \xi_2 h_{A,t}^{\xi_3} n_{a,t+1} w_{at+1}}{\omega w_{a,t}} \right]^{\frac{1}{1-\xi_2}} \tag{14}$$

And therefore, supply of child labor, $n_{c,t}$ becomes

$$n_{c,t} = 1 - \left[ \frac{\sigma \xi_1 \xi_2 h_{A,t}^{\xi_3} n_{a,t+1} w_{at+1}}{\omega w_{a,t}} \right]^{\frac{1}{1-\xi_2}} \tag{15}$$

## Firms

There are two types of firms in our model. Given the technology, the expected production is same for both types of firms when they succeed or fail.[1] But the demand for loan for the low risk firms are higher than the high risk firms because of their higher probability of success. The technology is labor intensive and the firms use only labor for production. There are two types of labors available - the adult labor and child labor. Adult labor and child labor are considered to be substitutes in our model. Firms choose either one over the other or an optimum combination of both of them. Given this backdrop, the labor demand for firms at period $t$ can be written as

$$n_t = n_{a,t} h_t + \omega n_{c,t} \tag{16}$$

[1]Similar type of assumption has benn made by DeMeza and Webb (1987)

where, the use of child labor, $n_{ct} = (1 - e_t)$ and $\omega$ is the ratio of marginal product of the child labor to that of the adult labor. Considering children's marginal product less than that of the adult labors, $\omega$ is less than 1.

Let the expected production function of each firm be

$$E_t f(n_t) = A\gamma_i n_t^m \tag{17}$$

Where, $\gamma_i = \phi_i(1 + \psi)$, $\phi_i$ is the respective success rate of the $i^{th}$ type of firm, $i$ being high risk or low risk. Labors' share in the production is $m$ and $z$ is the systemic production shock. We assume firms do not have any endowments. They borrow from either formal sector or informal sector under credit rationing, for the wage payment to labors. Under credit rationing, a proportion of firms, $\alpha$, gets loan firm the formal sector and the rest, $1-\alpha$ proportion, does not get formal loan. This fraction of borrowers take loan from the informal sector at exorbitantly higher rates. To the firms the loan from the formal sector and that from the informal sector are close substitutes which implies, total loan demand by firms

$$\begin{aligned} L_t^D &= w_{a,t} n_t \\ &= w_{a,t} h_t n_{ai,t} + \omega w_{a,t} n_{c,t} \end{aligned} \tag{18}$$

The expected Profit maximization can be stated as

$$\max_{n_t} E_t \pi_t = A\gamma_i n_t^m - (1 + l_t) L_t^D \tag{19}$$

S.T.

$$L_t^D = w_{a,t} n_t \tag{20}$$

After solving the maximization problem we get

$$n_t = \left( \frac{A\gamma_i m}{(1 + l_t) w_{a,t}} \right)^{\frac{1}{1-m}} \tag{21}$$

From the above equation of firms' demand for total labor we can derive the firms' demand for loan

$$L_t^D = \left( \frac{A\gamma_i m}{w_{a,t}^m (1 + l_t)} \right)^{\frac{1}{1-m}} \tag{22}$$

and corresponding willingness to pay

$$l_t = \frac{A\gamma_i m}{w_{a,t}^m L_t^{1-m}} - 1 \tag{23}$$

where, $l_t$ is the loan rate for per unit formal loan.

In the next part of our analysis we solve the banks' and money lender's optimization problems under credit rationing to determine the steady state formal and informal loan amounts and rates that dictate the above mentioned wage rates. Then, for a comparative analysis, we also propose an alternative regime where banks separate the high risk and low risk firms and offer loans accordingly to hedge against risks. Banks, in our proposed model, can do it by devising a price incentive mechanism. The main objective of this exercise is to find out whether the alternative regime can improve the consumption level by increasing the wage rate.

## Banks

As mentioned above, we solve banks' maximization problem for two different regimes. First, we model the existing credit rationing regime prevalent in the economy and then we propose an alternative, termed as revelation regime, to analyze their policy implications in the context of financial development.

### Credit Rationing Regime

This regime characterizes the imperfection in the credit market due to asymmetric information. Due to lack of proper separating tool banks ration credit and supply only a fraction of total demand for loan. We assume that the banks supply only $\alpha$ fraction of loan demanded under this regime and $\alpha$ is endogenously determined based on the administered loan rate and the success rate of the firms. In such situation, firms are rationed out with probability $(1-\alpha)$ and go to the informal market to get loans. This implies that, if the total demand for loan revealed is $L_t^{FD}$ in the formal sector, then banks supply only $\alpha L_t^{FD}$. The pool will be identical because the low risk firms with high demand will take the guise of the high risk firms with low demand for the formal loan. This adverse selection problem arise because the

low risk firms with high demand knows that there is a possibility of getting loans from the households at no interest rate. Therefore, this hidden extra demand of the low risk loans spills over to the informal market. This adverse selection problem in the formal loan market leads the high demand firms to reap the benefit of certain amount of surplus by operating on the lower demand curve in the guise of low demand or high risk firms. With the assumption that$\rho$ is the proportion of high risk firms, we get

$$L_t^D = \rho\left(\frac{\gamma_{HR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} + (1-\rho)\left(\frac{\gamma_{LR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} \tag{24}$$

as the actual demand for production loan generated from both high risk and low risk firms. But total demand revealed in the formal market by the identical pool will be

$$L_t^{FD} = \rho\left(\frac{\gamma_{HR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} + (1-\rho)\left(\frac{\gamma_{HR,t}Am}{(w_{a,t})^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}}$$

$$\text{or,} \quad L_t^{FD} = \left(\frac{\gamma_{HR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}}$$

because of the adverse selection problem. In that case, total supply of formal loan will be

$$L_t^{FS} = \alpha\left(\frac{\gamma_{HR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} \tag{25}$$

Now, the hidden demand of the low risk firms to maintain an identical pool to the banks is

$$L_t^D - L_t^{FD} = \rho\left(\frac{\gamma_{HR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} + (1-\rho)\left(\frac{\gamma_{LR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} - \left(\frac{\gamma_{HR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} \tag{26}$$

$$= (1-\rho)\left[\left(\frac{\gamma_{LR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} - \left(\frac{\gamma_{HR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}}\right] \tag{27}$$

Now, not only the $(1-\alpha)L_{t^{FD}}$ fraction spills over to the informal sector, the hidden demand also gets accumulated with it. This makes a total spill over of total demand for informal loan as

$$T_{i,t} = (1-\alpha)\left(\frac{\gamma_{HR,t}Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} + (1-\rho)\left[\left(\frac{Am}{w_{a,t}^m(1+\overline{l}_t)}\right)^{\frac{1}{1-m}}\left(\gamma_{LRt}^{\frac{1}{1-m}} - \gamma_{HRt}^{\frac{1}{1-m}}\right)\right] \tag{28}$$

where $T_{i,t}$ is the total demand for informal loan. Let us assume that $\eta$ be the proportion of high risk firms in the informal demand mix. Then demand from the high risk firms that goes to the moneylenders is

$$M_{HR,t} = \eta(1-\alpha)\left(\frac{\gamma_{HR,t}Am}{w^m_{a,t}(1+\overline{l}_t)}\right)^{\frac{1}{1-m}} \tag{29}$$

The rest of the demand for informal loan comes from the low risk firms and gets distributed between the households and informal moneylenders. Now, as we mentioned earlier that households having a capacity constraint, cater only a fraction, $\lambda$ of the less risky firms and charge no interest rate. In that case supply of household sector loan will be

$$H_{LR,t} = \lambda\left(\frac{Am}{w^m_{a,t}}\right)^{\frac{1}{1-m}}\left[\gamma_{HR,t}^{\frac{1}{1-m}}(\rho+\eta\alpha-\eta-\alpha)+(1-\rho)\gamma_{LR,t}^{\frac{1}{1-m}}\right] \tag{30}$$

and the residual demand from residual low risk firms goes to the moneylenders. Therefore, demand for moneylenders loan from low risk firms will be

$$M_{LR,t} = (1-\lambda)\left(\frac{Am}{w^m_{a,t}(1+\overline{l}_t)}\right)^{\frac{1}{1-m}}\left[\gamma_{HR,t}^{\frac{1}{1-m}}(\rho+\eta\alpha-\eta-\alpha)+(1-\rho)\gamma_{LR,t}^{\frac{1}{1-m}}\right] \tag{31}$$

Notice that the value of $\lambda$ is endogenously chosen from our model although households resources are given. The reason behind $\lambda$ being endogenous is the endogenous demand for households loan.

For banks' profit maximizing problem under credit rationing regime, we assume that

i. there is no reserve requirement for the banks. So, they can convert their entire deposit into loan.

ii. banks choose the proportion of demand for loan to be catered, $\alpha$ endogenously, based on the available funds with them in order to make zero profit in the long run.

In that case, banks' profit maximization problem can be written as

$$\max_{L_t,\alpha} E_t[\Pi^B_t] = \alpha\phi_{HR}(\overline{l}_t)L^D_t - (r_{d,t})D_t \tag{32}$$

$$\text{S. T. } L^D_t \geq D_t \tag{33}$$

Solving for $\alpha^*$ from the zero profit condition, we get

$$\alpha^* = \frac{r_{d,t}}{\overline{l}_t \phi_{HR}} \tag{34}$$

Given the fixed share of households loan, this optimum value of $\alpha$ then decides the share of informal loans under credit rationing.

Notice that $\alpha$ is inversely related to the success rate of the high risk firms, $\phi_{HR}$. This indicates that for higher success rate of the high risk firms, banks can reach its long run zero profit goal even for a lower value of $\alpha$. This becomes important in the latter part of our analysis when we describe the distorting effects of stringent credit rationing.

**Self-Revelation Regime**

Self revelation regime is proposed as an alternative to credit rationing in order to compare relative efficiencies under different regimes. As discussed in our earlier papers (Dasgupta (2004a, 2004b)) that banks set prices for differentiated loans in this regime. The difference of this regime from the credit rationing is that banks intend to disburse loan to different types of investment projects at different rates instead of single prime lending rate in this case. Loans are differentiated on the basis of the associated degree of risk. In our model we adopted 'Direct Revelation Principle' from Myerson (1979). Under asymmetric information, revelation mechanism leads to a Bayesian Nash equilibrium under induced communication game among many other Bayesian equilibria iff it is incentive compatible.

As we have discussed earlier that the firms have different demand coefficients based on their success rates. Between two types of firms in our model,

1. high risk firms with lower demand coefficient, $\gamma_{HR}$, operate on a lower demand curve. In this case, banks set the price in such a way so that it can take way all the surplus from high risk firms. Therefore, for the high risk firms with low demand and a probability of success, $\phi_{HR}$, participation constraint is binding - i.e,

$$E_t[R_{HR,t}] = \phi_{HR} L_{HR,t}(l_{HR,t}) \tag{35}$$

where, $E_t R_{HR,t}$ is the banks' expected total revenue from the high risk firms.

2. low risk firms with higher demand coefficient, ($\gamma_{LR,t}$), should operate on a higher demand curve. But they have incentive to operate on the lower demand curve because, by doing so, they can enjoy a surplus. This creates an adverse selection problem. Therefore, under self selection regime, the low risk firms with higher demand should be bounded by the incentive constraint.

Under revelation regime, the borrowers will reveal their type only if, at least, their previous payoff is assured. To do that banks have to know the actual surplus the low risk firms were enjoying by operating on a lower demand curve. As we see from the firms demand functions (equation (23)), that the willingness to pay for the high risk firm for any given level of loan, $L_{HR}$ is

$$1 + l_{HR,t} = \frac{\gamma_{HR,t} Am}{w_{a,t}^{m} (L_{HR,t})^{1-m}} \tag{36}$$

and that for the low risk firm for the same amount of loan is

$$1 + l_{LR,t} = \frac{\gamma_{LR,t} Am}{w_{a,t}^{m} (L_{HR,t})^{1-m}} \tag{37}$$

These above two equations imply that a less risky firm has a $\frac{\gamma_{LR,T} - \gamma_{HR,t}}{w_{a,t}^{m} L_{HR,t}^{1-m}}$ times higher willingness to pay for the same amount of loan. In this case, the amount of surplus the low risk or high demand firms enjoy from $L_{HR,t}$ unit of loan is

$$Q_t = \left[ \frac{\gamma_{LR,T} - \gamma_{HR,t}}{w_{a,t}^{m} L_{HR,t}^{1-m}} \right] L_{HR,t} \tag{38}$$

Or,

$$= Am \left( \frac{L_{HR,t}}{w_{a,t}} \right)^{m} (\gamma_{LR,t} - \gamma_{HR,t}). \tag{39}$$

where $Q_t$ is total surplus. Therefore, the incentive constraint for the high demand or low risk firms to self select themselves is

$$E_t[R_{LR,t}] = \phi_{LR} L_{LR,t}(l_{LR,t}) - Am \left( \frac{L_{HR,t}}{w_{a,t}} \right)^{m} (\gamma_{LR,t} - \gamma_{HR,t}) \tag{40}$$

where $E_t[R_{LR,t}]$ is the expected revenue from low risk firms, $L_{LR,t}$ and $L_{HR,t}$ are the loan amount for low risk and high risk firms and $l_{LR,t}$ is the loan rate for low risk firms. $\phi_{LR}$ is the

success rate of the low risk firms. To induce the firms with high demand to reveal their type, banks under such communication game with mediation, can promise to return the surplus they were enjoying. This way banks can motivate the less riskier firms to demand for $L_{LR,t}$ amount instead of $L_{HR,t}$. Now with $\rho$ as the fraction of high risk firms and $(1-\rho)$ as the fraction of low risk firms, as assumed earlier in firm's problem, banks' profit maximization problem can be written as :

$$\max_{L_{LR,t},L_{HR,t}} E_t\Pi_t^B = \rho E_t(R_{HR,t}) + (1-\rho)E_t(R_{LR,t}) - r_{d,t}D_t \tag{41}$$

$$\text{S.T. } E_tR_{LR,t} = \phi_{LR}L_{LR,t}(l_{LR,t}) - Am\left(\frac{L_{HR,t}}{w_{a,t}}\right)^m(\gamma_{LR,t} - \gamma_{HR,t}) \tag{42}$$

$$E_tR_{HR,t} = \phi_{HR}L_{HR,t}(l_{HR,t}) \tag{43}$$

$$D_t = \rho L_{HR,t} + (1-\rho)L_{LR,t} \tag{44}$$

From the F.O.Cs w.r.t $L_{HR,t}$ and $L_{LR,t}$ we get :

$$l^*_{HR,t} = \frac{r_{d,t}}{\phi_{HR}} + \frac{(1-\rho)}{\rho\phi_{HR}}\frac{Am^2(\gamma_{LR,t} - \gamma_{HR,t})}{w^m_{a,t}(L_{HR,t})^{1-m}} \tag{45}$$

$$l^*_{LR,t} = \frac{r_{d,t}}{\phi_{LR,t}} \tag{46}$$

Notice that the surplus under such pricing mechanism can be considered as cost irrespective of success of the low risk firms.

## Informal Moneylenders

Informal moneylenders are risk neutral. Money lenders are price setters and set the price based on the expected degree of risk associated with the firms. Since a fraction of low risk firms goes to the households after being rejected by the formal sector, the money lenders are left with the pool of residual high and low risk firms. Money lenders do not have prior information regarding firms' type. But since they operate under a small jurisdiction, they can glean this information by incurring certain cost. We assume moneylenders has certain market power in setting the price so that they can keep a margin of profit over their cost.

This acts as rent of the moneylenders. Given this backdrop, moneylenders maximize their expected profit in the following way:

$$\begin{aligned}\max_{M_{HR,t},M_{LR,t}} E_t\pi_{m,t} =&\phi_{HR}(1-\alpha)\eta l_{hHR,t}M_{HR,t} + \phi_{LR}(1-\alpha)(1-\eta)(1-\lambda)l_{hLR,t}M_{LRt} \\ &- (c_{LR}M_{LRt} + c_{HR}M_{HRt})\end{aligned} \tag{47}$$

where $M_{i,t}$ is the loan amount offered by the money lenders, $\phi_i$ is the success rate and $c_i$ is the cost coefficient of the $i_{th}$ type of firm in the informal sector.

F.O.C with respect to $M_{HR,t}$ and $M_{LR,t}$ :

$$M_{HR,t} \quad : \quad l_{hHR,t} = \frac{c_{HR}}{(1-\alpha)\eta\phi_{HR}} \tag{48}$$

$$M_{LR,t} \quad : \quad l_{hLR,t} = \frac{c_{LR}}{(1-\eta)(1-\alpha)(1-\lambda)\phi_{LR}} \tag{49}$$

Now, given $\eta$, $\lambda$, $\alpha$ and

$phi_i$, $l_{hi,t}$ depends directly on the corresponding information cost of the moneylenders for different types of loan.

## 2.1 Steady State Equilibrium under Credit Rationing Regime

To evaluate the steady state equilibrium we use the solutions to the maximization problems of households, banks, firms and the informal moneylenders together with the equilibrium conditions. Along this path we assume no growth in the economy. The economy is characterized by the following equations:

1. From Equation (25), (34) and (54) we get total supply of formal loan under credit rationing as

$$\alpha\left(\frac{\gamma_{HR}Am}{w_{a,t}^m(1+\bar{l})}\right)^{\frac{1}{1-m}} \tag{50}$$

2. From Equation (29), (34), (48) and (54), we get demand for moneylender's loan by high risk firms

$$M_{HR} \quad = \quad \eta(1-\alpha)\left(\frac{\gamma_{HR}Am}{w_{a,t}^m(1+l_{h,HR})}\right)^{\frac{1}{1-m}} \tag{51}$$

Since the money lenders supply the entire amount therefore, this is the optimum value of high risk moneylenders' loan.

3. We find from Equations (30), (34) and (54) that due to resource constraint the fraction of low risk loan, $H$, supplied by the households at no interest rate

$$H = \lambda \left(\frac{Am}{w_{a,t}^m}\right)^{\frac{1}{1-m}} \left[\gamma_{HR}^{\frac{1}{1-m}}(\rho + \eta\alpha - \eta - \alpha) + (1-\rho)\gamma_{LR}^{\frac{1}{1-m}}\right] \quad (52)$$

4. Rest of the demand from residual low risk firms is supplied by moneylenders. Therefore, from Equations (31), (34), (49) and (54) we get the supply of moneylenders loan from low risk firms as

$$M_{LR} = (1-\lambda)\left(\frac{Am}{w_{a,t}^m(1+l_{h,LR})}\right)^{\frac{1}{1-m}} \left[\gamma_{HR}^{\frac{1}{1-m}}(\rho + \eta\alpha - \eta - \alpha) + (1-\rho)\gamma_{LR}^{\frac{1}{1-m}}\right] \quad (53)$$

5. According to our model, the total loan that firms get,either from formal or informal sources, use to hire labor. Therefore, given the efficiency of each type of labors, we get from Equation (50) through (53) and (16), the equilibrium wage rate of the adult under credit rationing

$$w_a = (Am\gamma_{HR}) \left[\frac{\frac{\alpha}{(1+\bar{l})^{\frac{1}{1-m}}} + (1-\alpha)\left((1-\eta)(\gamma_{HR}^{\frac{1}{1-m}}(\rho+\eta\alpha-\eta-\alpha)+(1-\rho)\gamma_{LR}^{\frac{1}{1-m}})(\lambda^2 + \frac{(1-\lambda)^2}{(1+l_{h,LR})^{\frac{1}{1-m}}}) + \frac{(1-\alpha)\eta^2}{(1+l_{h,HR})^{\frac{1}{1-m}}}\right)}{h+\omega n_c}\right]^{1-m} \quad (54)$$

6. From the above Equations from (50) through (54), we get total supply of loan under credit rationing as

$$L^{CR} = \left(\frac{Am\gamma_{HR}}{w_a^m}\right)^{\frac{1}{1-m}} \left[\frac{\alpha}{(1+\bar{l})^{\frac{1}{1-m}}} + (1-\alpha)\left((1-\eta)(\gamma_{HR}^{\frac{1}{1-m}}(\rho+\eta\alpha-\eta-\alpha)+(1-\rho)\gamma_{LR}^{\frac{1}{1-m}})(\lambda^2 + \frac{(1-\lambda)^2}{(1+l_{LR})^{\frac{1}{1-m}}}) + \frac{(1-\alpha)\eta^2}{(1+l_{HR})^{\frac{1}{1-m}}}\right)\right] \quad (55)$$

7. We assume that in the steady state the wage rate of each type of labor is equal to their marginal products. This leads to a situation where $\omega$ is equal to the ratio of child labor wage to that of the adult labor. In this situation firms are indifferent between the use of child labor or adult labor. The use of child labor in the production, therefore, depends exclusively on the supply of child labor by the households.

   Now, households supply child labor only when the households earning from adult labor is not sufficient to maintain consumption at the subsistence level. The gap in earning to

maintain it is fulfilled by the child labor income. Therefore, a nonzero supply of child labor ensures that respective level of consumption is the subsistence level minimum required consumption.

$$w_{a,t}(n_a h_t + \omega n_c) = \underline{c} \tag{56}$$

8. Given the values of $\sigma$ and $\omega$ and $n_a = 1$, Equation (15) gives us the equilibrium value of child labor under credit rationing as

$$n_c = 1 - \left[\frac{\sigma\xi_1\xi_2 h_A^{\xi_3}}{\omega}\right]^{\frac{1}{1-\xi_2}} \tag{57}$$

9. It also shows that, given the education level of parents and the ratio of efficiency wages of the child to adult labor, the supply of child labor, $n_{c,t}$, will be zero for a particular steady state value of $\sigma$. In other words, there will be no supply of child labor when

$$\sigma = \frac{\omega}{h_A^{\xi_3}\xi_1\xi_2} \tag{58}$$

10. Now from Equation (56) we get the minimum required wage rate for child labor supply to be zero. Considering $n_c = 0$ and $n_a = 1$, we get from this equation that

$$\underline{w_a} = \frac{\underline{c}}{h} \tag{59}$$

While this is the necessary condition for zero supply of child labor, Equation (58) serves as the sufficient condition for that. Therefore, the degree of altruism of the parents, given their education and efficiency-wage ratio, decides the child labor supply.

## 2.2 Steady State Equilibrium under Self-Revelation Regime

To evaluate the steady state equilibrium under this regime we use the solutions to the maximization problems of households, banks, moneylenders and firms, together with the equilibrium conditions. In this regime banks can identify different types of firms using truth telling incentive mechanism and can decide the corresponding prices for each type of firms. Due to banks total coverage, there will be no households or moneylenders' loan in

the equilibrium. Along this path also we assume no growth in the economy. The economy is characterized by the following equations:

1. By equating high risk firms' willingness to pay from Equation (23) with banks' willingness to accept, Equation (45), we get the optimum value of high risk loan supplied

$$L_{HR}^{SR} = \left(\frac{Am(\gamma_{HR}\rho\phi_{HR} - m(1-\rho)(\gamma_{LR}-\gamma_{HR})}{w_a^m\rho(\phi_{HR}+r_d^{ss})}\right)^{\frac{1}{1-m}} \tag{60}$$

2. By equating low risk firms' willingness to pay from Equation (46) with banks' willingness to accept, Equation (23), we get the optimum value of low risk loan supplied

$$L_{LR}^{SR} = \left(\frac{\phi_{LR}\gamma_{LR}Am}{w_a^m(\phi_{LR}+r_d^{ss})}\right)^{\frac{1}{1-m}} \tag{61}$$

3. By using the optimum high risk loan amount in Equation (23), we get the optimum loan rate for high risk loan

$$l_{HR}^{ss} = \frac{\gamma_{HR}\rho r_d^{ss} + m(1-\rho)(\gamma_{LR}-\gamma_{HR})}{\gamma_{HR}\rho\phi_{HR} - m(1-\rho)(\gamma_{LR}-\gamma_{HR})} \tag{62}$$

4. From Equation (46) we get the low risk loan rate,

$$l_{LR}^{ss} = \frac{r_d^{ss}}{\phi_{LR}} \tag{63}$$

5. From Equation (60) and (61) we get total loan supply under this regime as

$$L^{ss} = \rho L_{HR}^{ss} + (1-\rho)L_{LR}^{ss} \tag{64}$$

6. Using the same equations we get the adult wage rate offered by firms under self revelation regime without child labor

$$w_a = \left[\frac{1}{h}\left(\rho\left(\frac{Am(\gamma_{HR}\rho\phi_{HR} - m(1-\rho)(\gamma_{LR}-\gamma_{HR})}{\rho(\phi_{HR}+r_d)}\right)^{\frac{1}{1-m}} + (1-\rho)\left(\frac{Am\phi_{LR}\gamma_{LR}}{\phi_{LR}+r_d}\right)^{\frac{1}{1-m}}\right)\right]^{1-m} \tag{65}$$

# 3 Equilibrium Estimation and Calibration

The quantification of our model consists of two important parts. First, we used the sample data to find out some parameter values required for the model. We used the loan history of

a sample of 700 rural agricultural households from 27 villages chosen from 12 different states in India. The survey has been conducted by *Agro-economic Research Centers and Units, Ministry of Agriculture, Government of India*. Second, used these values to find out rest of the parameter values from our model. The reason behind estimating some parameters from the sample data is not only to increase the degrees of freedom of our model. It also makes the outcome of our model more realistic.

## 3.1 Parameter Estimates taken from the Literature

Some parameters like inflation rate, weighted cost of capital, share of labors in agriculture and deposit rate are macroeconomic in nature. We use these parameter values directly from the literature in the Indian context. The following Table 1 represents these parameters.

[Table 1 comes here]

## 3.2 Parameters Estimated from Sample Data

As discussed in the beginning of this section, we use a sample of 700 borrower households and their loan history collected by *Agro-economic Research Centers and Units, Ministry of Agriculture, Government of India*. We used different regression models to estimate the following parameters.

Estimations of the parameters in Table 2 are done in the following way:

i. $\psi$ = Percentage gain in production over mean level when the project is successful: We first regressed the log of real value of production on the log of different inputs and implements used. Percent deviation of actual from the estimated real production is considered as the expected gain for each firms. Since there is no technological differences assumed between high risk and low risk firms therefore, this expected gain is considered to be same for all types of firms.

ii. $A$ = Technology parameter: The intercept value of the following model of real value of output on capital inputs gives us the value of A.
$\log(\text{value of output}) = \beta_1 + \beta_2 * \log(\text{value of labor inputs}) + \beta_3 * \log(\text{Land})$.

iii. $h_A$ = Parental education level in terms of average years of attendance in school or college: We find the average number from the maximum number of years spent by the mother or father to get their highest degree. We used our sample data to find this number.

iv. $n_c$ = Percentage child labor supplied by labor households: We used directly the average value of this percentage from the same sample.

v. $\omega$ = The ratio of child to efficient adult wage rate: We used Table 1.a of Labour Bureau, Government of India (2003) published monthly average wages for adult men, women and child labors for different agricultural activities. We converted the posted adult wage rate into efficiency wage by dividing it by the corresponding human capital of that adult. We estimate $\omega$ by using the ratio of the annual average of efficiency wage of adult to the child wage. Child wage is taken as it is and has not been converted to efficiency wage with the idea that all children are equally efficient and unless they finish their schooling their human capital does not differ from one to the other.

vi. We used the child's level of $(h_{t+1})$, time devoted to education, $(e_t)$ and parental years of education $(h_{At})$ from our sample data set to estimate the following regression equation

$$\log h_{t+1} = \xi_1 + \xi_2 \log(e_t) + \xi_3 \log(h_{A,t})$$

to estimate the following parameters:

- $\xi_1$ = Scale parameter of the human capital development,
- $\xi_2$ = Share of education in child's human capital development, and
- $\xi_3$ = Share of parental education in child's human capital development.

vii. $\sigma$ = Level of parental altruism: Using the estimates of above parameters from the data in Equation (57) we estimate $\sigma$.

[Table 2 comes here]

### 3.2.1 Parameters Estimated using Discriminant Analysis:

The household level sample data for borrowers reveals the prevalence of separating equilibrium in the informal sector( Fig.1 ). According to Fig.1, the distribution of borrowers with respect to informal interest rates has two distinct separations (at interest rates 3 and 18 percent) with three modes in the informal loan market. The first mode is at zero percent real interest rate while the other two modes correspond to 15 and 27 percent. We assume that separation of zero percent interest rate from the other rates represents the separation of households low risk loans to their friends or family members from moneylenders loan.

[Table 3, and Figure 1 come here]

When households offer loan without charging any interest they loose basically the opportunity cost. They do it only when they know the borrower from a very close circuit like friends or family members. The other criteria required for this loan is that the borrowers must be low risk. Households provide loans iff these two criteria are fulfilled, or in other words, they know the borrowers' type very well. Therefore, considering that all borrowers who take loan from households are low risk, we can separate the entire loan market for loan consisting of formal and informal by discriminant analysis based on the characteristic variables of those borrowers.

We verify the robustness of our separation of firms across different risks type based on the following hypotheses in this regard :

- The borrowers with diversified sources of income are low risk.
- High risk borrowers use more child labor as compared to low risk borrowers as a shock absorbing device.
- High risk firms have higher probability of default.

Table 3 represents these results.

[Table 4 comes here.]

After we divided our sample firms into two groups - high risk and low risk, we find out the mean values of the following parameters.

i. $\rho$ = Proportion of high risk firms among the total borrowers = .54.

ii. $\phi_{HR}$ = Success rate of the high risk firms = .78.

iii. $\phi_{LR}$ = Success rate of the low risk firms = .86.

iv. $\gamma_{LR}$ = Demand coefficient for low risk firms = 1.56.

v. $\gamma_{HR}$ = Demand coefficient for high risk firms = 1.41.

vi. $\eta$ = The proportion of high risk firms in the informal market = .38.

vii. $x$ = Proportion of high risk firms in the formal market = .72.

## 3.3 Parameters Estimated from the model

For our computational experiment, we used the above mentioned parameters estimated from the data in our model and find out the following steady state values of the following parameters.

i. The percentage of low risk firms in the rejected pool from formal sector and getting loan from households, $\lambda$, is obtained from Equation (41) by using the available sample household level data. We estimated it by taking the percentage of low risk loan by households to the total informal low risk loans.

ii. Moneylenders' information cost coefficients for low risk and high risk loans, $c_{LR}$ and $c_{HR}$, are estimated from our model. Using the optimal moneylenders' loan rates along with Equations (29) through (31) and , (48), (49), we get the optimal cost of moneylenders per unit of loan.

iii. The equilibrium value of proportion of loan demand supplied by formal market under credit rationing regime, $\alpha$, is estimated from maximizing bank's optimization problem under credit rationing from Equation (32) through (34).

iv. The equilibrium value of high and low risk loan rate, $l_i$, is estimated from Equation (62) and (63) for revelation regime. Under credit rationing it is the average value estimated from the data for the period 1970 to 2000.

v. The equilibrium value of high and low risk loan, $L_i$, is estimated from our model using Equation (60) and (61) for the revelation regime.

vi. The equilibrium value of amount of informal moneylenders' loan, $M_i$, has been estimated from model using Equation (51)and (53).

[Table 5 comes here]

Table 5 shows that, unlike credit rationing regime, more loans can be provided with proper hedging against risk. This can be done not only by charging higher loan rate to the risky firms but also by providing lesser amount to them as compared to the low risk firms. Our results also show that due to proper risk identifying mechanism in credit rationing regime, banks land up with providing more loan to the risky firms.

[Table 6 comes here]

From Table 6, we find significant improvements in the values of some variables crucial for this study. As we find that the level of consumption under self revelation regime is much higher than the credit rationing where households consume at the subsistence level. The consumption equivalence of self revelation regime is 1.11 compared to credit rationing regime.

Another important findings of our study is the improvement in adult wage rate. It is not only higher than that under the existing credit rationing, it is also significantly higher than the minimum required adult wage to consume at the subsistence level without supplying child labor. Now, when this is necessary for no supply of child labor, the sufficient condition is supported by the value of $\omega$. The value of $\omega$ suggests that given the child labor wage and the parental altruism, the maximum threshold value that restrain households from supplying child labor is much higher than that under self revelation regime. This result gives us an unique equilibrium under self revelation regime as compared to credit rationing regime.

## 3.4 Policy Implications

In this section we analyze the child labor supply decision by households with respect to their education level, altruism and required wage rate and try to curve out the appropriate policy measures relevant for reducing the child labor supply. To do that we find out the relative importance of each of these factors and observe how their combined effect affect the child labor decision by households. Next we incorporate these findings and lay out the actions required to satisfy the conditions for eradicating child labor.

### 3.4.1 Parental Altruism and Child Labor Supply

In our study, parental altruism is endogenously determined. This part of our analysis focuses mainly on its importance in households' child labor supply decision. As depicted in Figure 3, $SS_u$ and $SS_c$ curves represent the unconstrained and constrained child labor supply decision of households at different levels of parental altruism. Constrained child labor supply is the amount required by households to maintain the subsistence level consumption. Figure 3 shows that at a lower level of parental altruism (below 40 percent), households supply much more child labor than it is required to maintain the subsistence level of consumption. Beyond this level of altruism, child labor supply plummets down drastically and reaches to zero at altruism level between 60 and 70 percent even for a non-zero requirement to maintain subsistence consumption.

One of the factors that is kept fixed at its equilibrium value is the parental education level in terms of their number of years spent in school and college. The combined effect of parental education and altruism brings out even more interesting results from our analysis.

Table 7 represents different combinations of parental altruism and average number of years of parents' schooling to explain it. Our findings suggest that with a lower level of parental education, child labor supply is very high even for a much higher level of altruism. As parental education increases the supply of child labor drops drastically. This is one of our crucial findings in regard to the mandatory schooling for children. Our results show that compulsory primary education does not have any significant impact on child labor supply. As we find that even at 90 percent altruism there will be more than 40 percent child labor–

when parental education is limited to primary level. Where as, if parental education level is extended to even middle school, child labor supply drops to a significantly lower level even for a moderate level of parental altruism. This implies that mandatory education for children up to middle school today can lead to a drastic fall in child labor supply tomorrow by the same cohort, when they grow adult and takes the households decisions. Otherwise, any form of incentive like "mid day meal" to "bring back to school" may not have significant impact on reducing child labor supply unless we go beyond the primary level.

[Table 4.a comes here]

### 3.4.2 Credit Rationing and Child Labor Supply

One of the most interesting result from our model economy is the effect of credit rationing on child labor supply. According to our results, constrained child labor supply to maintain the subsistence level consumption becomes zero for a threshold adult wage rate and any wage rate below that level gives rise to child labor supply. Interestingly, we see from Table 8, that , adult wage rate increases as credit rationing becomes more and more stringent. Based on this finding, any policy in favor of stringent credit rationing to curb child labor might lead to the wrong conclusion unless we take in to account the actual reason behind it. If we look at banks maximization problem we find that, degree of credit rationing, $\alpha$, is inversely related to the success rate of the high risk firms (Equation (34)). As success rate of the high risk firms increases, banks can achieve its long run equilibrium by catering a lower proportion of the demand for loan. On the other hand, when success rate of the high risk firms increases, their demand for loan as well as labor increases. Increase in demand for labor increases the adult wage rate but stringent credit rationing forces firms with higher demand to borrow from informal market at an exorbitantly higher rates. This higher demand for labor, coupled with stringent credit rationing and over dependence on informal sector, forces the firms to substitute adult labor by child labors and, therefore, demand for child labor increases. In a nutshell, the increase in adult wage under credit rationing rather distorts the market mechanism and aggravates the problem of child labor further. Fig. 4 corroborates this argument by showing that demand for child labor is much higher when credit rationing is

more stringent. Any policy measures in favor of stringent credit rationing to arrest child labor supply may actually be fatal. Alternatively, we find from Table 4.b, the highest achievable adult wage rate is well below the threshold value under this circumstance.

### 3.4.3 Child Labor Supply under Self Revelation

When, under the given circumstances, credit rationing fails to curb child labor- we propose self revelation as an alternative to test- whether such market failure can be overcome or not. As we see from Figure 3 that, given the demand for child labor by firms, it only exists when adult wage rate is very low. The market equilibrium, $E$ under direct revelation regime,exists at a wage rate much higher than the required adult wage represented by the $SSn$ curve. Table 6 shows the equilibrium adult wage rate and threshold required adult wage for no child labor supply. This wage rate not only stops child labor supply by wage labor households, it also gives us the unique equilibrium in the labor market. Now, as a high demand firms, since the low risk firms get higher volume of loans from banks at a cheaper rate, the higher wage will not create any distortion in the labor market.

[Table 8 comes here]

# 4 Conclusion

In this paper we address the issue of child labor in the context of developing country like India and try to link it with the credit market imperfections for production loan. We quantify two different credit regimes–the existing rationing regime with informal credit market, and, our proposed alternative to that, called direct revelation regime. The main contribution of this paper is to show quantitatively why, ceteris paribus, credit rationing in the production loan market fails to curb child labor. With the help of the necessary and sufficient conditions for eradicating child labor, we show that how our proposed alternative not only satisfy those conditions but also leads to an unique equilibrium unlike credit rationing. With the consideration of heterogenous firms with respective success rate, we conclude that–

i. Under credit rationing there is a possibility of multiple equilibria with and without

child labor, depending on households requirement to supply child labor in order to maintain the subsistence level of consumption and their degree of altruism. We find that the threshold wage rate for households not to supply child labor is much higher than the equilibrium wage rate, and as a result, child labor exist in equilibrium (Figure 2).

ii. Wage rate increases under this regime as credit rationing becomes more stringent. But, this increase in wage is due to the distortion created by the combined effect of high demand for loan by high risk firms due to their increased success rates, stringent supply of formal loan and increased dependence on informal loan. This increase in adult wage is distorting because increase in adult wage increases child labor demand instead of reducing it (Figure 5).

iii. The demand for child labor increases with increase in adult wage because, high demand and low availability of loan force the firms to depend more on informal loans at an exorbitant rates. This creates a reshuffle in the composition of labor demand and firms substitutes adult labors for child labors.

iv. Our proposed alternative to credit rationing, i.e., self revelation regime, suggests that this distortion can be overcome and an unique equilibrium is achievable. The equilibrium wage rate under this regime corroborates this fact.

v. We also find that parental altruism is one of the decisive factors in child labor supply decision by households. We allow the parental altruism to be determined endogenously and found that the crucial factors that influence the equilibrium value of parental altruism are the parental education level and the efficiency wage ratio of the child to that of the adult labor. Our result suggests that, ceteris paribus, the mandatory primary level education does not have significant impact on child labor supply. But, if education becomes mandatory up to middle school, then there is a significant drop in child labor supply even for the households with low altruism.

vi. As suggested by Table 6, the social welfare also increases significantly, if we move from

rationing regime to direct revelation regime. We compare social welfare by estimating consumption equivalence.

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**Table 1: Policy Parameters Taken from the Data in the context of India**

| Parameters | Description | Value |
|---|---|---|
| $\pi$ | Inflation rate | .087 |
| $r_d$ | Deposit rate | .020 |
| $m$ | Share of labor in production | .76 |
| $\bar{l}$ | Administered real loan rate | .053 |

Source: Shirai Sayuri. (2002): "Road from State to Market - Assessing the General Approach to Banking Sector Reform in India", Asian Development Bank Institute Research Paper, No.32.

**Table 2: Parameters Estimated from Sample Data**

| Parameters | Description | Value |
|---|---|---|
| $\psi$ | Percentage gain in output when successful | .81 |
| $A$ | Technological parameter | .33 |
| $h_a$ | Average level of Maximum Parental Education level | 7.14 |
| $n_c$ | Percent child labor supply by labor households | .22 |
| $\omega$ | Ratio of child to adult efficiency wage rate | .47 |
| $\xi_1$ | Scale factor in human capital formation | .198 |
| $\xi_2$ | Share of child's education in human capital development | .81 |
| $\xi_3$ | Share of parental education in child's human capital development | .78 |
| $\sigma$ | Parental altruism | .60 |

Note: Maximum Parental education is 4 years for education up to $4^{th}$ Grade, is 10 years for up to $10^{th}$ Grade, is 12 for up to $12^{th}$ Grade, is 15 for up to undergraduate or diploma and is 17 for up to graduate level.

We used Table 1.a in Labour Bureau, Government of India, 2002-03, for estimation of $\omega$.

**Table 3: Mean Estimated Values of Certain Indicator Variables Across High Risk and Low Risk Firms**

| Variables | High risk | Low risk |
|---|---|---|
| Percent of firms | .54 | .46 |
| percent child labor used | .38 | .06 |
| Percent income from secondary sources | .03 | .30 |
| Percent household members engaged in agriculture | .84 | .39 |
| Default rate in formal sector | .21 | .12 |
| Default rate in informal sector | .29 | .15 |
| Average default rate in both the sector | .22 | .15 |

**Source**: Dasgupta (2004)

**Table 4: Parameters Estimates Obtained from Discriminant Analysis**

| Parameters | Description | Value |
|---|---|---|
| $\phi_{LR}$ | Success rate of the low risk firms | .86 |
| $\phi_{HR}$ | Success rate of the high risk firms | .78 |
| $\gamma_{HR}$ | Demand coefficient for high risk firms | 1.41 |
| $\gamma_{LR}$ | Demand coefficient for low risk firms | 1.56 |
| $\rho$ | Proportion of high risk firms | .54 |
| $x$ | Proportion of high risk firms in the formal market | .72 |
| $\eta$ | Proportion of high risk firms in the informal market | .38 |

**Source**: Dasgupta (2004)

**Table 5: Steady State Estimates of Equilibrium Loan Rates and Optimum Amount of Loans Under Different Regimes**

| Parameter | Description | Under Credit Rationing | | Under Self Selection | |
|---|---|---|---|---|---|
| | | High risk | Low risk | High risk | Low risk |
| $\alpha$ | Fraction of credit rationing | .484 | .484 | - | - |
| $\lambda$ | Proportion of low risk households loan | - | .08 | - | - |
| $r_l^{ss}$ | Bank loan rate | .053 | .053 | .055 | .023 |
| $r_h^{ss}$ | Informal sector loan rate | .270 | .150 | - | - |
| $c_i$ | Cost coefficient for moneylenders loan | .042 | .038 | - | - |
| $L^{ss}$ | Amount of bank loan | .120 | .048 | .167 | .362 |
| $H^{ss}$ | Amount of household sector loan | - | .019 | - | - |
| $M^{ss}$ | Amount of moneylenders' loan | .031 | .123 | - | - |

**Table 6 : Steady State Estimates of Required and Optimum Consumption, Deposit and Wage Rates under Different Regimes**

| Parameters | Description | Threshold | CR | SS |
|---|---|---|---|---|
| $C$ | Consumption | .291 | .291 | .363 |
| $D+S$ | Deposit | .168 | .168 | .256 |
| $w_a$ | Adult wage rate | .388 | .341 | .397 |
| $\underline{\omega}$ | Child- adult wage ratio | .448 | .470 | .407 |
| $\delta$ | Consumption Equivalence | | 1 | 1.59 |
| $e$ | Time devoted to education | | .78 | 1 |
| $h$ | Human Capital Dev. | | .75 | .916 |

- **Note:** Threshold consumption is the subsistence level consumption ($\underline{c}$).
- Required adult wage is the minimum wage rate required to maintain subsistence consumption without child labor income ($\underline{w_a}$).
- Threshold $\omega$ is the maximum value of the child wage to adult efficiency wage ratio for no supply of child labor, ($\varpi$).

**Table 7: Interaction of Parental Altruism and Their Average Number of Years in School on Child Labor**

| Altruism | 4 Years | 8 Years | 10 Years |
|---|---|---|---|
| .1 | 1 | 1 | 1 |
| .2 | 1 | 1 | .99 |
| .3 | 1 | .97 | .92 |
| .4 | .99 | .86 | .66 |
| .5 | .97 | .56 | 0 |
| .6 | .93 | 0 | |
| .7 | .85 | | |
| .8 | .69 | | |
| .9 | .44 | | |
| 1 | .03 | | |

**Table 8: Rate of Success of the firms, Credit Rationing and their Impact on Adult Wage**

| $\phi_{HR}$ | $\alpha$ | $w_a$ |
|---|---|---|
| 1 | .375 | .345 |
| .94 | .4 | .344 |
| .84 | .45 | .340 |
| .79 | .48 | .339 |
| .75 | .5 | 338 |
| .63 | .6 | .333 |
| .54 | .7 | .331 |
| .47 | .8 | .331 |
| .42 | .9 | .332 |
| .38 | 1 | .336 |

Figure 1: **Frequency Distribution of Number of Borrowers in the Informal Market Across Different Rates of Interest**

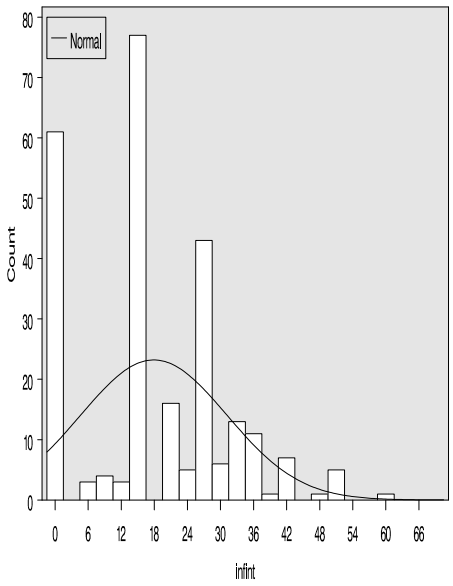
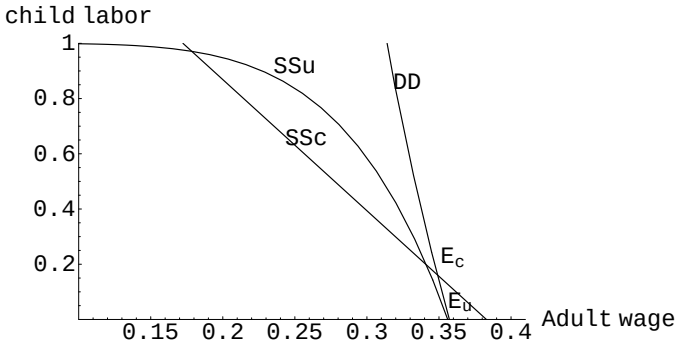
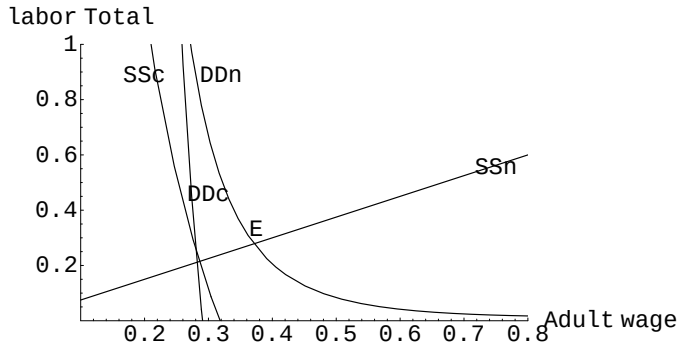



Figure 2: **Multiple Equilibria Under Credit Rationing with Different Levels of Child Labor Supply**



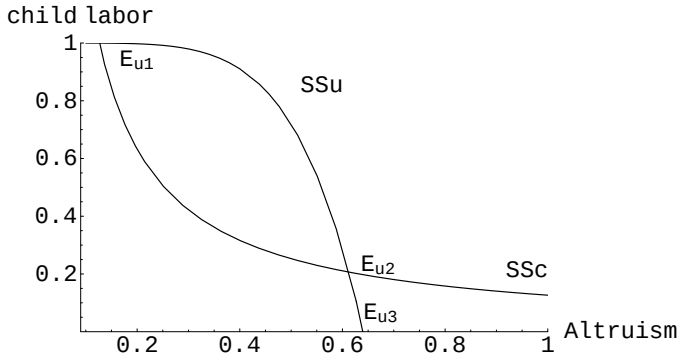

Note: $SS_u$ represents unconstrained supply of child labor. $SS_c$ represents constrained supply of child labor and $DD$ represents demand for child labor. $E_c$ and $E_u$ are the two equilibriua under credit rationing.

Figure 3: **Total and Child Labor Demand under Self-Revelation**




Note: $SS_n$ represents supply of total labor. $SS_c$ represents constrained supply of child labor and $DDn$ and $DDc$ represent demand for total and child labor. $E$ is the market equilibrium under direct revelation regime.

Figure 4: **Actual and Required Child Labor Supply Across Different Levels of Parental Altruism**




Note: $SS_u$ represents unconstrained supply of child labor. $SS_c$ represents supply of child labor required to maintain subsistence consumption. $E_1$, $E_2$ shows where these two supply decisions are identical. $E_3$ is the level of altruism for which child labor supply is zero.

Figure 5: **Child Labor Demand under Different Degrees of Credit Rationing**