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Abstract

We study the impact of loan regulation in rural India on child labor with an overlapping-generations model of formal and informal lending, human capital accumulation, adverse selection, and differentiated risk types. Specifically, we build a model economy that replicates the current outcome with a loan rate cap and no lender discrimination by risk using a survey of rural lenders. Households borrow primarily from informal moneylenders and use child labor. Removing the rate cap and allowing lender discrimination markedly increases capital use, eliminates child labor, and improves welfare of all household types.

JEL-Code: O160, O170, E260.

Keywords: child labor, India, informal lending, lending discrimination, interest rate caps.

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1 Introduction

India deregulated its loan industry in 1991 to improve its efficiency, but has kept tight control over small loans below Rs 200,000 (Indian rupees, the equivalent of US$4,000), primarily to poor rural households.[1] The goal of this reform was to improve the profitability of the banking sector by deregulating large loans while providing attractive borrowing conditions to the poorest households. For small loans, banks are required to ask for a regulated interest rate and have not been able discriminate to across households.

We show that this regulation has led to strong rationing on the small loan market. Indeed, the survey data of rural households we use show that 82% of loans are below Rs 25,000 (US$500) and only 1.5% are above the threshold of Rs 200,000.[2] In addition, we find no evidence of banks applying different conditions for different risk types, despite empirical evidence that it is possible to discriminate. To study the consequences of this rationing on the agrarian economy in rural India, we build an overlapping-generations model with formal and informal lending where farms have different risk characteristics and are loan-rationed. Households supply labor, possibly including child labor, competitively and accumulate human capital.

Others have documented that small rural farms in India are subject to loan rationing they cannot overcome with equity. Burgess and Pande (2005) document that forcing banks to open branches in rural India reduced poverty and increased wages and education. Sometimes the lack of equity is overcome with child labor. For example, Singh (2011) shows that adverse economic shocks leads to lower school enrollment in India. Similar effects have been found in South Africa (Edmonds 2004), Tanzania (Beegle, Dehejia, and Gatti 2006), and Brazil (Duryea, Lam, and Levison 2007).

After calibrating the model economy to current macroeconomic conditions and outcomes of the survey data (which include 22% of a child's time devoted to labor), we study the consequences of removing the interest rate regulation and allowing the banks to discriminate across risk types. The results of market pricing are dramatic: Informal lending and child labor both disappear and the welfare of every household improves on average by a consumption equivalent of

[1] After the initiation of financial sector reforms in the early 1990s, the Reserve Bank of India (RBI) took various steps to deregulate the lending rates of commercial banks. The slabs or credit limit size class under the RBI's revised guidelines of 1993 consisted of three categories: (i) advances up to and inclusive of Rs 25,000; (ii) advances over Rs 25,000 and up to Rs 200,000; and (iii) advances over Rs 200,000. In a major step toward deregulation of lending rates, the RBI decided in October 1994 that banks would determine their own lending rates for credit limits over Rs 200,000. This decision was reached in accordance with banks' risk-reward perception and commercial judgment. At the same time, banks were required to declare their prime lending rate (P1). In 1998, the P1 was converted as a ceiling rate on loans up to Rs 200,000. The rationale for this policy was that the P1, as the rate chargeable to the best borrower of the bank, should be the maximum rate chargeable to the small borrowers. This system continued until 2009-10 when the Base Rate system replaced it, taking effect on July 1, 2010. The Base Rate is currently the minimum rate for all loans and serves as a ceiling for small loans up to Rs 200,000 (Reserve Bank of India, 2009, 2010).

[2] See Table 1 for details.

almost 60%.

The rationing regime is characterized by high capital costs, since rural informal moneylenders charge much more than the formal banking sector, underaccumulation of physical capital, and low wages. This situation forces parents to send their children to work to meet subsistence consumption. The resulting under-accumulation of human capital exacerbates the low wages and reinforces child labor. This vicious cycle is broken by deregulation of lending, allowing the substitution of labor for capital, both physical and human.

Are parents selfish if they send their children to work? Significant research takes this a starting point—for example, in Basu and Van (1998); Baland and Robinson (2000); Ranjan (2001); Cigno, Rosati, and Tzannatos (2002); and Guarcello, Mialli, and Rosati (2003). The premise is that developing economies typically have a comparative advantage in unskilled labor-intensive goods. Under such circumstances, sending a child to school would not be the optimal choice of a household head, who could increase family income and possibly his own leisure by sending children to work. We argue that with more capital available for production, such an outcome may be avoidable and this capital can be obtained by deregulating small loans. Also, Ray (2002) shows that credit constraints can force a household to use child labor to satisfy subsistence consumption. In our case, we show that credit markets regulated in a particular way can induce child labor even with altruistic parents, also because of subsistence consumption. In addition, deregulation has a macroeconomic impact by increasing wages and thus making education more valuable.

Other financial market inefficiencies may trigger child labor. Baland and Robinson (2000) and Rajan (1999) show that because parents cannot borrow against their children's future income, they do not fully internalize the value of education. Pallage and Zimmermann (2007) show how direct transfers can (slowly) eradicate child labor.

The study is organized as follows. Section 2 discusses the model economy, which is then differentiated in Section 3 for the banking sectors between the regulated, nondiscrimating regime that leads to loan rationing and the deregulated, discriminating regime. To obtain quantitative answers, we then calibrate the economy using a survey of rural loan applicants in Section 4. We then discuss results in Section 5, including a sensitivity analysis in Section 6. The last section concludes.

2 The Baseline Model

In this section, we describe a three-period overlapping-generations model with four types of agents: households, farms, banks, and moneylenders. Households have one unit of time to devote to human capital accumulation or child labor in the first period. In the second period, labor income, including income from children, is split between present consumption and savings for the third period, retirement.

Farms are heterogeneous with respect to the riskiness of their unique projects.

They use labor only for production and need to borrow to pay for wages. If a farm's loan is rejected by a bank, it turns to the informal market for a loan from moneylenders.

We consider two banking regimes: In the first, credit rationing is prevalent as banks are tied to a government-mandated loan rate applicable to all loans. In the second, banks are free to set interest rates and discriminate.

Finally, moneylenders set interest rates freely given their cost structure. We now describe the components of the model in detail.

2.1 Households

Each member of a household lives for three periods. In the first $(t-1)$, a child can use his time allotment for education (e_{t-1}) or work $(1-e_{t-1})$, but this is a decision made by parents. If working, a child earns at the wage rate of w_{t-1}^C, which goes to the parents. Children do not consume.

In the second period, t, the child becomes an adult and uses the entire time endowment for work, paid at the efficiency rate w_t^A. Efficiency depends on the level of human capital h_t. The total income of the adult (from his own work and his child's work) is distributed between immediate consumption $(c_t^{t,A})$ and deposits at the bank (D_t).

Deposits mature in the third period $(t+1)$, and the old agent consumes deposits plus interest $(c_{t+1}^{t,O} = (1+r_{d,t})D_t)$. Agents care about their consumption in the second and third period, taking into account minimum subsistence $\underline{c}$, and they are concerned about their child through her human capital. Thus the problem of the household is

$$\begin{aligned} V_t(h_t) &= \max_{e_t, h_{t+1}, c_t} \ln\left(c_t^{t,A} + \frac{c_{t+1}^{t+1,O}}{1+r_t^d} - \underline{c}\right) + \sigma V_{t+1}(h_{t+1}), \\ \text{S. T.} \quad & c_t^{t,A} + D_t \leq w_t^A h_t + w_t^C(1-e_t), \\ & c_{t+1}^{t,O} \leq (1+r_t^d)D_t, \end{aligned}$$

where σ is an altruism parameter. We follow Pallage and Zimmermann (2007) and define the human capital accumulation as follows:

$$h_{t+1} = \xi_1 e_t^{\xi_2} h_t^{\xi_3},$$

where $0 < \xi_2, \xi_3 < 1$ and $h > 1$. Define ω as the ratio of the child wage to the adult wage, $\omega = \frac{w_t^C}{w_t^A}$. Clearly, with w^A and w^C as the efficiency wage, the value of ω will depend on the respective human capitals of the adult and children of the households. Then we can obtain from the first-order conditions the supply of child labor,

$$n_t^C = \max\left\{0, 1 - \left(\frac{\sigma\xi_1\xi_2 h_t^{\xi_3} w_{t+1}^A}{\omega w_t^A}\right)^{\frac{1}{1-\xi_2}}\right\}.$$

Thus, if the adult wage and human capital are high enough, it is possible to have no child labor in the steady state as long as the various parameter values satisfy $\frac{\sigma\xi_1\xi_2 h^{\xi_3}}{\omega} > 0$. As all parameters are positive, this is the necessary condition in our model economy to reach an equilibrium that theoretically is child labor free.

2.2 Farms

We consider agricultural farms in rural India as the major production unit in our model economy. There are two types of farms, high-risk and low-risk, and the type is private information. They are otherwise identical; in particular, they have the same output when they succeed (or fail). High-risk farms prefer to borrow less because of their higher chances of failure. Low-risk farms, on the other hand, have a lower chance of failure and hence, have higher demand for loans. They need loans to finance their only input: labor. They can use two types of labor, adult and child, that are perfectly substitutable, although the efficiency of child labor is $\frac{\omega}{h_t}$ that of adult labor.[3] Let the production function be

$$f(h_t, n_t^C) = A\left(\omega(h_t) n_t^C\right)^m.$$

Define γ_i as the probability of success of a firm depending on its risk; $i = 0$ for high-risk farms, and 1 for low-risk farms. The term l_t is the interest rate paid on loans. Then the expected profits are

$$\gamma_i A\left(\omega(h_t) n_t^C\right)^m - (1 - l_t)\left(\omega(h_t) n_t^C\right).$$

The farm maximizes these expected profits by choosing the appropriate level of child labor, as adult labor is a given. Thus, the demands for child labor and for loans are

$$\begin{aligned} n_t^C &= \max\left\{0, \left(\frac{\omega_i A m}{(1 + l_t) w_t^A}\right)^{\frac{1}{1-m}} - h_t\right\}, \\ L_t^{iD} &= \left(\frac{\omega_i A m}{(1 + l_t)(w_t^A)^m}\right)^{\frac{1}{1-m}}. \end{aligned}$$

2.3 Banks

Banks are the suppliers of loans in the formal market. They take loan applications and decide how many loans to provide and, depending on the environment, what interest rate to charge. Here, we look at two different regimes for the credit market. In the first, there is credit rationing because the interest rate is set by

[3] One could also assume that the success rate could depend on the use of child labor. This would make an analytical solution impossible but would only reinforce our results. Indeed, as we show later, changes in the success rate have an impact, but the presence of credit rationing is of first-order importance. Thus, we have neglected this feature in the model for tractability.

the government at a low level, and banks are not allowed to price discriminate. In the second, the government lifts all restrictions and thus allows banks to differentiate the interest rate by firm characteristics—in our case, riskiness—without bounds on the interest rate.

2.3.1 Credit Rationing Regime

Banks have no control over the interest rate for loans, $\bar{l}$, and cannot use information to discriminate across lenders. In our case (India), this is mandated by government policy: banks must lend at a regulated interest rate, and they cannot offer conditions that differ across lenders. This encourages more high-risk farms to apply for loans. Banks are then forced to adopt indiscriminate credit rationing as a hedging device against default risks. Under this regime, banks supply only a fraction of the market with loans even if they have suffcient resources to meet the total demand.

Thus, banks can supply only a fraction α of loans demanded, a fraction that is endogenously determined based on the administered loan rate and the success rate of the farms. Since banks cannot discriminate, low-risk farms with high demand will take the guise of high-risk farms with low demand. This adverse selection problem in the formal loan market leads the high-demand farms to reap some surplus by operating on the lower demand curve. Let ρ be the proportion of high-risk farms; then the total demand for loans is

$$L_t^D = \rho \left(\frac{\omega_0 Am}{(1+\bar{l})(w_t^A)^m} \right)^{\frac{1}{1-m}} + (1-\rho) \left(\frac{\omega_1 Am}{(1+\bar{l})(w_t^A)^m} \right)^{\frac{1}{1-m}}. \tag{1}$$

However, the total demand revealed on the formal market is

$$L_t^{FD} = \left(\frac{\omega_0 Am}{(1+\bar{l})(w_t^A)^m} \right)^{\frac{1}{1-m}},$$

as low-risk farms masquerade as high-risk ones. Finally, the total supply of loans of the formal loan market is

$$L_t^{FS} = \alpha \left(\frac{\omega_0 Am}{(1+\bar{l})(w_t^A)^m} \right)^{\frac{1}{1-m}}. \tag{2}$$

Banks maximize profits by choosing how much to ration the demand:

$$\begin{aligned} \max_{\alpha} \quad & \alpha\phi_0\bar{l}L_t^{FD} - r_t^d D_t, \\ \text{S. T.} \quad & \alpha L_t^{FD} \geq D_t. \end{aligned}$$

The optimal choice is then

$$\alpha^* = \frac{r_t^d}{\bar{l}\phi_0}. \tag{3}$$

Note that α^* is inversely related to the success rate of high-risk farms. This point is important in our analysis.

2.3.2 Self-Revelation Regime

Under this regime, banks are free to set the loan rate, in particular to discriminate among applicants. Different loans are offered at different rates, and farms self-select following the direct revelation principle of Myerson (1979).

The self-revelation of the farms operates through their demand coefficients, which depends on their risk level. High-risk farms have a lower demand coefficient γ_0 and banks try to set the loan rate so they can obtain all the surplus. Thus, given the probability of success ϕ_0, the participation constraint is binding,

$$E_t(R_t^0) = \phi_0 L_t^0(l_t^0),$$

where R_t^0 is banks' revenue from high risk farms.

Low-risk farms have a higher demand coefficient, γ_1, because of their higher success rate but have the incentive to operate on the lower demand curve of the high-risk farms. Thus, they should be bound by the incentive constraint. To determine this, first note that the surplus enjoyed by low-risks farms when they masquerade as high-risk farms is

$$Am\left(\frac{L_t^0}{w_t^A}\right)^m(\gamma_1 - \gamma_0). \tag{4}$$

This surplus is constructed in the following manner: for low-demand farms (high- and low-risk farms separately), the willingness to pay under the two contracts is defined by

$$1 + l_t^0 = \frac{\gamma_0 Am}{(w_t^A)^m (L_t^0)^{1-m}}, \tag{5}$$

$$1 + l_t^1 = \frac{\gamma_1 Am}{(w_t^A)^m (L_t^0)^{1-m}}. \tag{6}$$

Thus, for the same size loan a low-risk farm has a willingness to pay $\frac{\gamma_1-\gamma_0}{(w_t^A)^m(L_t^0)^{1-m}}$ higher, and its surplus is

$$\frac{\gamma_1 - \gamma_0}{(w_t^A)^m (L_t^0)^{1-m}} L_t^0,$$

which is the same as the surplus shown above in Equation 4. Therefore, the incentive constraint for the low-risk farm needs to be

$$E_t(R_t^1) = \phi_1 L_t^1(l^1 T_t) - Am\left(\frac{L_t^0}{w_t^A}\right)^m(\gamma_1 - \gamma_0),$$

where R_t^1 is the banks' revenue from low-risk farms and T_t is the demand for informal loans (to be determined shortly below). Then, the maximization problem of the banks with ρ as the proportion of high-risk farms, is

$$\begin{aligned}
\max_{L_t^0, L_t^1} \quad & \rho E_t(R_t^0) + (1-\rho) E_t(R_t^1) - r_t^d D_t, \\
\text{S. T.} \quad & E_t(R_t^1) = \phi_1 L_t^1 (l^1 T_t) - Am \left(\frac{L_t^0}{w_t^A} \right)^m (\gamma_1 - \gamma_0), \\
& E_t(R_t^0) = \phi_0 L_t^0 (l_t^0), \\
& D_t = \rho L_t^0 + (1-\rho) L_t^1.
\end{aligned}$$

It follows that the optimal loan rates are

$$l_t^0 = \frac{r_t^d}{\phi_0} + \frac{1-\rho}{\rho\phi_0} \frac{Am^2(\gamma_1 - \gamma_0)}{(w_t^A)^m (L_t^0)^{1-m}}, \tag{7}$$

$$l_t^1 = \frac{r_t^d}{\phi_1}. \tag{8}$$

2.4 Moneylenders

moneylenders operate on the informal loan market and try to satisfy any demand for loans that has not been satisfied on the formal market. Their operation costs are higher than those of banks; thus, moneylenders are active only in the credit rationing regime. The demand for loans they face is the revealed demand that was rationed, $L_t^D - L_t^{FS}$, and the demand that low-risk farms were hiding to masquerade as high-risk farms. The demand for informal loans that spills over from the formal market is thus

$$T_t = (1-\alpha) \left(\frac{\gamma_0 Am}{(1+\bar{l})(w_t^A)^m} \right)^{\frac{1}{1-m}} + (1-\rho) \left(\frac{Am}{(1+\bar{l})(w_t^A)^m} \right)^{\frac{1}{1-m}} \left(\gamma_1^{\frac{1}{1-m}} - \gamma_0^{\frac{1}{1-m}} \right).$$

Now suppose that η is the proportion of high-risk farms in the informal demand mix. Then the demand from the two risk types that moneylenders face can be defined as

$$M_t^0 = \eta(1-\alpha) \left(\frac{\gamma_0 Am}{(1+\bar{l})(w_t^A)^m} \right)^{\frac{1}{1-m}}, \tag{9}$$

$$M_t^1 = \left(\frac{Am}{(w_t^A)^m (1+\bar{l})} \right)^{\frac{1}{1-m}} \left((\rho + \eta\alpha - \eta - \alpha) \gamma_0^{\frac{1}{1-m}} + (1-\rho) \gamma_1^{\frac{1}{1-m}} \right) \tag{10}$$

We assume that the informal moneylenders have the ability to discriminate between the types of loan seekers, as they are not constrained by government oversight. They can set loan rates differently for high- and low-risk farms. They maximize the following profits:

$$\max_{M_t^0, M_t^1} E_t \Pi_t = \phi_0 l_t^{h,0} M_t^0 + \phi_0 l_t^{h,1} M_t^1 - (c^0 M_t^0 + c^1 M_t^1), \tag{11}$$

where c_i is a cost coefficient for raising funds and monitoring loans, and ϕ_i is the success rate of firm with type i. From the first-order conditions, we can then infer the loan rates moneylenders charge:

$$l_t^{h,0} = \frac{c^0}{(1-\alpha)\eta\phi^0}, \tag{12}$$

$$l_t^{h,1} = \frac{c^1}{(1-\eta)(1-\alpha)\phi^1}. \tag{13}$$

3 The Two Regimes

We now evaluate the steady-state equilibrium of the model economy. As there are two different regulatory environments in the formal banking sector, we need to analyze them separately. We first turn to the current situation in India, with a cap on loan rates and no loan discrimination.

3.1 Credit Rationing

From the total supply of formal loans (Equation 2) and equilibrium rationing by formal banks (Equation 3), we obtain formal loans as a function of wages,

$$L_t^F = \frac{r_t^d}{\bar{l}\phi^0}\left(\frac{\gamma^0 Am}{w_t^A(1+\bar{l})}\right).$$

From the demand for informal loans from high-risk farms (Equation 9), the equilibrium rationing by formal banks (Equation 3), and the loan rate choice of moneylenders (Equation 12), we get informal loans of high-risk farms as a function of wages,

$$M_t^0 = \eta\left(1-\frac{r_t^d}{\bar{l}\phi^0}\right)\left(\frac{\gamma^0 Am}{w_t^A(1+\frac{c^0}{(1-\alpha)\eta\phi^0})}\right).$$

Similarly for low-risk farms (Equations 3, 10, and 13), we determine the informal loans to low-risk farms,

$$M_t^1 = \left(\left(\gamma^0\right)^{\frac{1}{1-m}}\left(\rho+\frac{\eta r_t^d}{\bar{l}\phi^0}-\eta-\frac{r_t^d}{\bar{l}\phi^0}\right)+(1-\rho)\left(\gamma^1\right)^{\frac{1}{1-m}}\right).$$

Equating the sum of the three equations above to the demand for loans (Equation 1), we obtain the equilibrium adult wage, w_t^A, an equation too long to report here. Since the wages of adults and children are equal to their respective marginal products, farms are indifferent to either type of labor. It is therefore entirely up to the household to supply child labor or not. As parents are altruistic (they like to have their children educated), child labor is supplied only when minimum consumption cannot be covered with adult income. Thus,

$$
\begin{aligned}
n^C &= 0 && \text{if } w_t^A h_t > \underline{c}, \\
&= 1 - \left(\frac{\sigma \xi_1 \xi_2 h_t^{\xi_3}}{\omega(h_t)} \right)^{\frac{1}{1-\xi_2}} && \text{otherwise,}
\end{aligned}
$$

where $\omega(h_t)$ is the ratio of the child wage to the adult wage and depends on the respective human capital. There is no child labor if

$$
\begin{aligned}
\omega(h_t) &\leq \sigma \xi_1 \xi_2 h_t^{\xi_3} \\
w_t^A &\geq \frac{\underline{c}}{h_t}.
\end{aligned} \tag{14}
$$

3.2 Self-Revelation

Since banks can discriminate, they can serve the entire market and moneylenders have no role. By equating the high-risk farms' willingness to pay to the banks' willingness to accept (Equations 5 and 7), and correspondingly for low risk loans (Equations 6 and 8), we obtain the equilibrium quantity of high- and low-risk loans,

$$
\begin{aligned}
L_0^{SR} &= \left(\frac{Am(\gamma_0 \rho \phi_0 - m(1-\rho)(\gamma_1 - \gamma_0))}{(w^A)^m \rho (\phi_0 + r^{d,ss})} \right)^{\frac{1}{1-m}}, \\
L_1^{SR} &= \left(\frac{Am\phi_1 \gamma_1}{(w^A)^m (\phi_1 + r^{d,ss})} \right)^{\frac{1}{1-m}},
\end{aligned}
$$

which add up to a total loan supply of $L^{SR} = \rho L_0^{SR} + (1-\rho) L_1^{SR}$. We can then obtain the two steady-state lending rates,

$$
\begin{aligned}
l^{0,ss} &= \frac{\gamma_0 \rho r^{d,ss} + m(1-\rho)(\gamma_1 - \gamma_0)}{\gamma_0 \rho \phi_0 - m(1-\rho)(\gamma_1 - \gamma_0)}, \\
l^{1,ss} &= \frac{r^{d,ss}}{\phi_1}.
\end{aligned}
$$

Notice that the low-risk loan is inversly dependent on farms' success rate, and the higher the success rate the lower is the low-risk loan rate. The high-risk loan rate, however, has a premium attached to it (the component $m(1-\rho)(\gamma_1 - \gamma_0)$), which is mostly decided by the gap, $\gamma_1 - \gamma_0$). This suggests that when a farm type is known, banks can easily assign a differentiated price by rewarding the low-risk farms with a lower loan rate. Finally, we determine the adult equilibrium wage that satisfies the necessary condition of no child labor as follows:

$$w^A = \frac{1}{h^{1-m}} \left[\rho \left(\frac{Am(\gamma_0 \rho \phi_0 - m(1-\rho)(\gamma_1 - \gamma_0))}{\rho(\phi_0 + r^{d,ss})} \right)^{\frac{1}{1-m}} + (1-\rho) \left(\frac{Am\phi_1\gamma_1}{\phi_1 + r^{d,ss}} \right)^{\frac{1}{1-m}} \right]^{1-m}.$$

Note that this is the thresold adult wage rate necessary for a household to maintain their subsistence level of consumption, which can theoretically lead to an equilibrium without child labor. However, the sufficient condition requires that $\frac{\sigma \xi_1 \xi_2 h^{\xi_3}}{\omega} > 0$ is satisfied as derived from the household's optimization problem.

4 Calibration

A numerical solution is needed to compare the two regimes, and in particular to check whether adult wages and human capital are sufficiently high in the self-revelation regime to avoid child labor. To do so, we calibrate the model parameters to the existing evidence.

A first set of parameters is from the literature. We follow Shirai (2002) in setting the following: The inflation rate (π) is 8.7%, the real deposit rate (r_d) is 2%, the labor income share (m) is 76%, and the administered real loan rate ($\bar{l}$) is 5.3%.

A second set of parameters is estimated from micro-level survey data. We use a primary sample of 700 households from 31 Indian villages collected across the country by the Agro-economic Research Centers and Units of the Indian Ministry of Agriculture. These data document the loan history of these households along with many economic and sociodemographic characteristics. Within the dataset, we consider the 570 households that have borrowed. Among them, 121 are landless, 184 are marginal farms (up to 1 hectare), 145 small farms (1–2 hectares), and 120 are medium or large farms (over 2 hectares). Parameter values for this estimations, along with the rest of the calibration, are listed in Table 2.

We find the parameters in the human capital law of motion by running a regression of a child's human capital on her achievements in education and parents' human capital. The level of human capital is measured by taking the maximum number of years of education. We also use the information available in survey data on level of education as educational achievements (e_t) to estimate the law of motion of human capital, knowing the parents' education ($h_{A,t}$), the child's time devoted to education (e_t), and the child's education (h_{t+1}). The resulting equation is

$$\log h_{t+1} = 0.198 + 0.81 \log e_t + 0.78 \log h_{A,t}$$

The parental altruism parameter (σ) is obtained by substituting the above regression parameters into Equation 14. The supply of child labor n_c is obtained by determining the average time spent working from the data sample, which is 22%.

An analysis of the loan rates in the dataset reveals a clear separating equilibrium in the informal market, reflecting the fact that moneylenders are able to discriminate between high and low risks. Figure 1 shows separations at loan rates of 3% and 18% and modes at 0%, 15% and 27%. Clearly, a zero interest rate is not consistent with our model of moneylenders and must have some other origin (loans from relatives or loans with nonmonetary interest). We thus only consider the separation at 18%.[4]

Now that we have separated these borrowers into two groups, we use discriminant analysis to determine the characteristics of high- and low-risk borrowers. In particular, we verify that high risk ones have higher default rates, have lower diversification in their sources of income, and use more child labor (as a means to absorb shocks). Table 3 shows that the first and last are verified across the three interest rate modes. Table 4 verifies all hypotheses after classifying borrowers by risk. It is particularly interesting to see how well the characteristics of high and low risk borrowers are distinguishable and that the formal markets is clearly missing opportunities to discriminate.

From this discriminant analysis we can establish the value of a series of parameters (Table 5). The proportion of high-risk borrowers (ρ) is 54%; these borrowers have a success rate (ϕ_0) of 78%, compared with an 86% success rate for low-risk ones (ϕ_1). From this one can infer the demand coefficients for both (γ_1 and γ_0) at 1.41 and 1.56, respectively. Finally, we find the proportion of high-risk farms in the informal loan market to be 38% and 72% in the formal market. Using equilibrium conditions of the model—Equations 9, 10, 12, and 13—and the moneylender interest rates, one can then find the information cost coefficients c_1 and c_0, which are 0.038 and 0.042,respectively.

The last parameter is estimated from a different source. The ratio of the child to the adult efficient wage (ω) is from the Labour Bureau of the Government of India (2002–2003), which publishes monthly average wages for men, women, and child laborers. We convert the adult wage to an efficient wage by dividing by years of education as a proxy for human capital. For children, we assume they are all at the same efficiency, unless they finish elementary schooling. We obtain a ratio of 47%.

5 Outcomes

Now that we have determined values for all parameters in the model, where we assumed that rationing was taking place as is currently the case in India, we establish some further characteristics of this regime. Subsequently, we allow

[4] Various estimates show that zero-interest borrowers have the same characteristics as low-risk borrowers; therefore, we combine them.

formal banks to discriminate and set loan rates to observe how the equilibrium differs (Tables 6 and 7). But we first look at the rationing regime.

With the loan rate ceiling, our findings from the survey data show that 48.4% of borrowers are rejected by the formal credit sector. If they obtain a loan, high-risk borrowers manage to get a larger loan than low-risk ones. One reason could be that because of lower demand from high-risk farms, they might have been treated as small borrowers and hence were served better. Borrowers who use the informal sector pay much higher interest rates—22% more for high-risk borrowers and 10% more for low-risk ones—and the latter receive larger loans. Essentially, we see that moneylenders exercise the discrimination that formal banks cannot, but at a much higher price.

As a consequence, loans are rare and expensive, leading to a stronger reliance on the labor input, particularly on child labor, as children spend 22% of their time working. Obviously, steady-state human capital is then low, leading to low adult wages, which reinforces the need for child labor, and finally low consumption.

Note that there may be a second equilibrium in a regulated loan market, an equilibrium without child labor. We do not consider it here because the model is calibrated to the Indian economy, which exhibits child labor. Figure 3 shows that if the adult wage is high enough, an outcome without child labor is possible. It is, however, much easier to reach higher wages when more capital is available.

Now let us turn to the liberalized regime where formal banks can choose the interest rate and discriminate across borrower risk categories. Evidently, this scenario crowds out the moneylenders, since every borrower is now served. Formal loan rates are slightly higher for high risks, but massively lower for low risks compared with credit rationing. Both types obtain much larger loans, especially low risks.

The consequence is that every child can now attend school full-time. This is a consequence of several effects: First, the much higher loan mass induces a higher use of capital. Second, adult wages are now higher, and above the subsistence level (thanks to higher physical and human capital) and sufficient to allow households to rely only on adult incomes. This occurs despite the fact that in absolute terms child wages have increased but have decreased in relative terms. Finally, we observe that consumption is now 25% higher. Even better, as their child's welfare is now higher, the utility of the parents is now raised in consumption equivalence terms by 59% (Table 7).

6 Sensitivity Analysis

In this section, we seek to understand the sensitivity of our results to various changes in the parametrization, particularly those parameters that have an impact on child labor.

Figure 2 documents, for a given level of parental education, (7.14 years of education, taken from the empirical average) the child labor supply as it varies

according to the parents' altruism, σ. We note that the unconstrained supply of child labor (SSu) decreases monotically with altruism, which is expected, but it drops faster around 0.60, our calibration value of σ. It would thus appear that child labor should be easy to eradicate. However, this schedule changes markedly if one takes into account that child labor is used when needed to sustain minimum consumption (SSc). Clearly, a necessary condition for the eradication of child labor is to obtain subsistence consumption without requiring the help of children. Even with high levels of altruism, subsistence consumption remains a bottleneck. As our results indicate, an easy way to remove this bottleneck is to improve the earning capacity of the adults, which can be obtained by increasing productive capital through loans, and this can be achieved by liberalizing the credit market.

Allowing both parental education and altruism to vary reveals more interesting insights. Table 8 shows that both are important to eradicate child labor. While altruism is a given, the parents' education is endogenous in the long run and can be increased, as seen in our benchmark experiment, by increasing wages, which itself can be be obtained by removing credit rationing. This means that education can be a powerful substitute for altruism.

Credit rationing can also have some rather perverse implications. Suppose we improve the success rate of high-risk farms. On first sight, this should have positive implications for the economy. But when there is no discrimination in lending, this increases the demand for loans. Since there is an interest rate ceiling, this makes rationing more severe. As high-risk farms increase their loan share, the resulting capital and adult wages both decrease, making child labor worse (Table 9). Increasing the success rate of low-risk farms also has adverse consequences under credit rationing, through adverse selection: As farms hide their extra demand, it spills over to the informal market, increasing farms' costs and their dependence on informal lending sources.

Figure 4 for the self-revelation regime shows that both the demand for child labor (DDc) and the supply of child labor (SSc) are inelastic, with supply having a less steep slope. At the threshold adult wage (3.88), the supply of child labor reaches a corner solution with a zero child labor supply. We find that under the self-revelation regime, the adult wage rate is higher (3.97) than this thresold rate, which leads the adult labor market to clear, and the child labor market becomes suboptimal with an interior solution.

7 Conclusion

India imposes caps on lending rates in rural areas and forbids lenders from discriminating across small borrowers. We study the impact of this regulation on household outcomes, particularly the use of capital and child labor. To do so, we first build a model economy that replicates outcomes from a survey of Indian households, in particular with respect to lending rates, the use of informal moneylenders, and child labor. Then we remove the lending regulation and find that the formal sector can then fully serve the loan demand at rates

that are lower than those charged by informal moneylenders. This increases the loan mass, particularly for low-risk borrowers, and thanks to the increased use of capital, improves adult wages and human capital sufficiently to cover subsistence consumption and thus avoid child labor. Consumption is 25% larger and welfare, as measured by consumption equivalents, is improved by 59%.

Our sensitivity analysis documents that these results are affected by several factors. First, the nondiscrimination of formal lending leads to a higher-than-optimal share of high-risk borrowers to receive loans. Second, the lack of discrimination combined with the interest rate cap forces banks to ration lending considerably. Households then fulfill their capital needs at a very high cost on the informal market, which also undertakes the discrimination the formal sector cannot perform. Third, the rationing of formal lending and the high cost of informal lending lead to underuse of capital and overuse of labor, lowering wages and making child labor necessary for subsistence. Finally, child labor sustains lower human capital and thus low wages for everyone.

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Table 1: Size Distribution of Formal Loans in Rural India (in '000 Rs)

	Loan Amount					
	< 25	25–50	50–100	100-200	$200 >$	Total
Number	428	55	16	17	8	524
Low-risk	207	19	8	7	3	244
High-risk	221	36	8	10	5	280
Proportion (%)	84.7	10.5	3.1	3.2	1.5	100

Table 2: Summary of Calibration

Parameter	Description	Value
π	Inflation rate	0.087
r_d	Deposit rate	0.02
m	Labor income share	0.20
$\bar{l}$	Administered real loan rate	0.053
ϕ	Percentage gain in output when successful	0.81
A	Technology parameter	0.33
h_a	Average maximum parental education level	7.14
n_c	Percent child labor supply by labor households	0.22
ω	Ratio of child to adult efficiency wage	0.47
ξ_1	Scale factor in human capital formation	0.198
ξ_2	Share of child's education in human captial formation	0.81
ξ_3	Share of parental education in human capital formation	0.78
σ	Parental altruism	0.60

Table 3: Characteristics of Borrowers on the Informal Market

	Informal loan rate (%)		
Indicators	0	0–18	>18
Percent child labor used	16.77	21.77	47.4
		(0.16)	(0.00)
Percent default rate	22.28	26.17	29.26
		(0.29)	(0.04)

Note: Figures in parentheses indicate p-values for difference from first column.

Table 4: Mean Characteristics of High-Risk and Low-Risk Firms

Variables	High-risk (%)	Low-risk (%)
Proportion	54	46
Child labor used	38	6
Income from secondary sources	3	30
Household members engaged in agriculture	84	30
Default rate	22	15
– Formal sector	21	12
– Informal sector	29	15

Table 5: Parameter Estimates Obtained from Discriminant Analysis

Parameters	Description	Value
ϕ_1	Success rate of low-risk farms	0.86
ϕ_0	Success rate of high-risk farms	0.78
γ_1	Demand coefficient for high-risk farms	1.41
γ_0	Demand coefficient for low-risk farms	1.56
ρ	Proportion of high-risk farms	0.54
x	Proportion of high-risk farms in formal market	0.72
η	Proportion of high-risk farms in informal market	0.38
c_1	Information cost for low-risk loans	0.038
c_0	Information cost for high-risk loans	0.042

Table 6: Steady-State Equilibrium Results

		Credit rationing		Self-selection	
Variables	Description	High-risk	Low-risk	High-risk	Low-risk
α	Fraction of credit rationing	0.484	0.484	0	0
l^{ss}	Bank loan rate	0.053	0.053	0.055	0.023
$l^{h,ss}$	Informal loan rate	0.270	0.150	–	–
L^{ss}	Average bank loan	0.120	0.048	0.167	0.362
M^{ss}	Average moneylender loan	0.031	0.123	–	–

Table 7: Various Steady-State Estimates

Variables	Description	Threshold	Credit rationing	Self-selection
C	Consumption	0.291	0.291	0.363
$D+S$	Deposits	0.168	0.168	0.256
w^A	Adult wage	0.388	0.341	0.397
ω	Child/adult wage ratio	0.448	0.470	0.407
e	Time devoted to education		0.780	1.000
h	Human capital		0.750	0.916

Table 8: Parental Altruism and Proprotion of Children Attending School

	Years of education		
Altruism	4	8	10
0.1	1.00	1.00	1.00
0.2	1.00	1.00	0.99
0.3	1.00	0.97	0.92
0.4	0.99	0.86	0.66
0.5	0.97	0.56	0.00
0.6	0.93	0.00	0.00
0.7	0.85	0.00	0.00
0.8	0.69	0.00	0.00
0.9	0.44	0.00	0.00
1.0	0.03	0.00	0.00

Table 9: Impact of Rate of Success of Firms on Rationing and Adult Wage

ϕ_0	α	ω_a
1.00	0.38	0.345
0.94	0.40	0.344
0.84	0.45	0.340
0.79	0.48	0.339
0.75	0.50	0.338
0.63	0.60	0.333
0.54	0.70	0.331
0.47	0.80	0.331
0.42	0.90	0.332
0.38	1.00	0.336

Note: ϕ_0: High-risk farm success rate; α: Fraction of credit rationing; ω_a: Adult wage.

Figure 1: Frequency Distribution of Borrowers in the Informal Market by Interest Rate

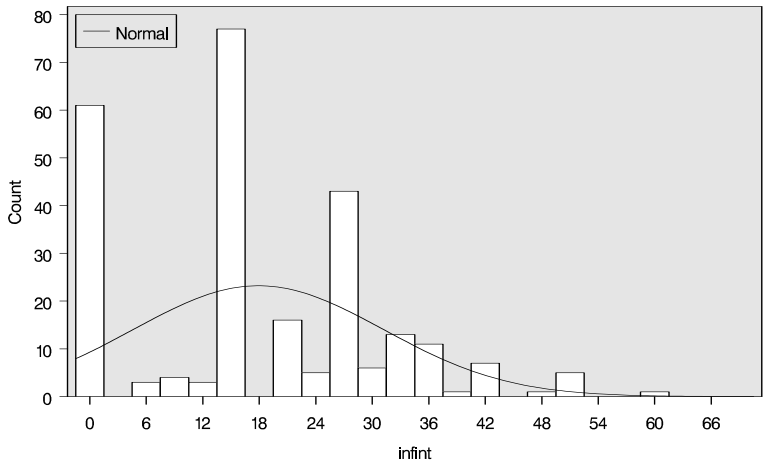
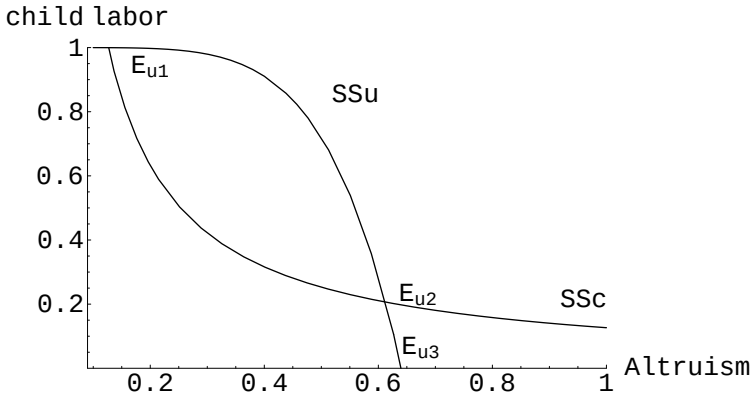
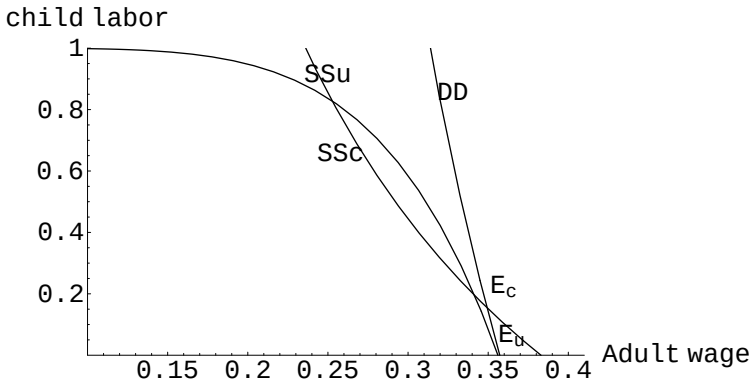


Figure 2: Actual and Required Child Labor Supply as a Function of Parental Altruism



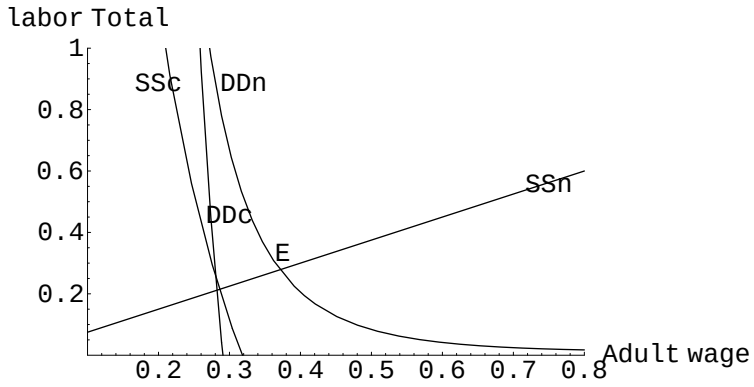
SSu: Unconstrained supply of child labor
SSc: Constraint supply of child labor
E_{u1}: Credit-rationing regime equilibrium with high child labor
E_{u2}: Credit-rationing regime equilibrium with low child labor
E_{u3}: Self-revelation regime equilibrium

Figure 3: Multiple Equilibria for Child Labor



SSu: Unconstrained supply of child labor
SSc: Constraint supply of child labor
DD: Demand for child labor
E_c: Equilibrium with child labor
E_u: Equilibrium without child labor

Figure 4: Labor Demands under Self-Revelation



SSn: Total labor supply
SSc: Constrained supply of child labor
DDn: Total labor demand
DDc: Constrained demand for child labor
E: Equilibrium