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Market imperfections and child labor

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Abstract

There is some indirect evidence that the absence of markets might cause child labor. However the existing literature is silent on whether marginal improvements of the markets functioning would reduce child labor. This paper models rural households' labor supply when the degree of imperfections on the labor market vary and the land and credit market remain absent. We highlight the heterogeneity in households' responses: some households may increase their child labor use following an improvement on the labor market, even when children are assumed not to be able to sell their workforce outside of the household. We use Malagasy data to estimate the relation between child labor and various measures of markets imperfections. We match those data with a municipality census so as to control for a large set of village characteristics. We find that on average market imperfections (labor but also land and credit) do indeed increase child labor and obtain heterogenous effects by land ownership that are consistent with the theoretical model. The results point to the fact that an improvement of markets competitiveness should decrease child labor (and even the more so for labor markets), which provides an alternative policy to fight against child labor.

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Key-words: Child labor, Market imperfections, Land, Labor, Credit, Madagascar.

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1 Introduction

According to the last estimates, child work has declined in the world with broadly 176 millions children aged 5 to 14 who were economically active in 2008. However, sub-Saharan Africa is the only area where not only the number but also the share of working children has increased between 2004 and 2008. As a result, 28.4% of African children aged 5 to 14 were economically active in 2008.[1]

This takes place despite an average growth of 6% between 2004 and 2008 and despite a decrease in poverty rates.[2] Growth is therefore unlikely to be sufficient, at least in the short run, to curtail child labor. Various policy options have been considered to fight child labor, such as bans, boycotts, and conditional (or not) cash transfers. This paper follows another avenue and discusses the effects of market imperfections on child labor. If we show that the market inefficiencies lead to an overuse of child labor, this increases the set of available leverages to reduce children's economic activity. From a policy perspective, we also would like to pinpoint which of those market inefficiencies is the strongest determinant of child labor.

A large body of the literature has already discussed the impact of credit constraints on children's time allocation, showing that the less competitive the credit market, the more children work (Baland and Robinson, 2000; Ranjan, 2001; Jafarey and Lahiri, 2002). Some empirical research has confirmed this view and displayed some evidence that households who face shocks tend to make their children work more (Beegle et al., 2004; Dumas, 2009) or that households are unable to smooth their consumption against future incomes (Edmonds, 2006). There is in comparison relatively little on the impact of imperfections prevailing on other markets such as land and labor markets.

Relevant research has shown that children's working hours may increase

[1] Source: Diallo et al. (2010).

[2] Source: World Development Indicators. Gross national income corrected for PPP was $1521 in 2004 and $1973 in 2008; poverty headcount ratio at $1.25 a day was 55% in 2002 and 50.9% in 2005.

with land ownership (Mueller, 1984; Bhalotra and Heady, 2003; Dumas, 2007; Basu et al., 2010) or with the prices of production goods (Kruger, 2004; Duryea and Arends-Kuenning, 2003; Cogneau and Jedwab, 2008). This should not happen if land and labor markets were competitive, because of the separability property (Singh et al., 1986). This is therefore some indirect evidence that markets are non competitive in developing countries and that this affects children's time allocation. However, the theoretical research on the question of market imperfections and child labor is quite rough so far. Essentially, it states that when land and labor markets are absent, children's time might be used as a substitute for non-household labor. This article endeavors to document, both from a theoretical and an empirical perspective, the effect of marginal changes in market imperfections. This is of interest for various reasons. First, it is not straightforward to infer what would be the effects of a marginal change in markets functioning on children's well-being from the two polar cases (no market vs. a perfectly competitive market). Large landowners are expected to use less child labor when they can rely on a labor market. Poor households, on the contrary, might increase child work if it is socially acceptable to make them work outside of the home. However, it is not obvious to guess the response of households owning an intermediate level of land to such changes. The model helps answering that question and its highlight is therefore on these households, namely the households in which adults combine wage work and farm work. We show that this class of households might use more child labor when they face lower market imperfections. Indeed, adults who are engaged in wage work want to take the opportunity of lower transaction costs and may transfer some farm labor to their children. It is of interest since a large share of the rural population in developing countries combine those two activities. The second contribution is therefore an empirical one: we evaluate the average effect of land, labor and credit market imperfections on child labor as well as heterogenous effects. In order to do this, we use household data from rural Madagascar. The

goal is twofold. First, we want to compare the effects of the imperfections prevailing on different markets. Second, we want to test the predictions of the theoretical model by disaggregating the effect at different land levels. The strategy we use is a control one: we match two sets of data in order to rely on a very large set of villages' characteristics as controls. We find that households who face higher market imperfections use more child labor and that this effect is unevenly distributed among households. However, no occurrence of cases in which an improvement on the markets leads to an increase in child labor is found. This suggests that policies aiming at reducing market imperfections would not have detrimental effects.

The paper is organized as follows: section 2 discusses the sources of market imperfections in rural areas of the developing countries and derives a model where the households face no land nor credit market but an imperfect labor market. Section 3 describes the data while section 4 provides the results.

2 Market imperfections and child labor

2.1 Market imperfections and their effect of child labor

Where do market imperfections come from? In developing countries, information asymmetries are the main source of market imperfections. Ray (1998) provides an excellent presentation of the various mechanisms at stake. Let us start with labor markets. Agricultural output variation due to weather shocks or pests makes it difficult for the landlord to uncover his tenant's effort. This results in higher supervision costs. Such costs are similar to transaction costs on the labor market and there might be a price-band (de Janvry et al., 1991), in which the landlord prefers not to hire any labor force. The seasonality of the activity generates an additional difficulty: if land is distributed rather equally, then all the farming households have the same tasks to undertake at the same time. This synchronicity of needs

prevents the households to exchange labor and the large landowners face a labor supply shortage.

Land markets are also recognized as imperfect. We start by the rental market. Information asymmetries about land quality can create differences between the rent a landlord can obtain and the land productivity. More importantly, renting out is associated with a risk of land deterioration and, in a context where land rights are not very well defined, with the risk of being expropriated. Sharecropping has been shown to provide some solutions to these issues but we also know that it suffers from the Marshallian inefficiency, namely a sub-optimal labor supply. Regarding the sales market, the absence of land certification makes transfers more costly, since the buyer bears the risk of not buying the land from its true owner. The scarcity of land sales might also be due to the fact that the value of land can include a non productive part (collateral, prestige).[3]

Lastly, credit markets also suffer from imperfections due to asymmetries of information between the bank and the borrower. In a world of limited liabilities, the borrower can default quite easily. For this reason, banks lend very little to poor people living in rural areas, which generates a credit shortage. Since in general banks require some collateral, this tends to worsen imperfections in land market. Microfinance has greatly improved access to credit in rural areas and generally does not require any collateral.

Market imperfections' influence on child labor When land and labor markets are competitive, production and consumption decisions are separable[4] (Singh et al., 1986): child labor decisions depend on production factors insofar as they affect households' profits. If the household owns land or labor in excess, it relies on the market to rent/sell this excess endowment. For instance, households with more land are wealthier and therefore use less child

[3]Some of this non productive part cannot be bought when the buyer needs a credit with collateral, thereby offering the land he buys as a guarantee.

[4]Production decisions are taken separately from households' preferences and consumption decisions only depend on preferences and profit generated by the activity.

labor. When only one of these two markets is imperfect, it has been shown that the separability property holds (Sadoulet and de Janvry, 1995)[5]. As a result, we will focus on the case where both markets are imperfect.

To keep it simple, we assume that no land nor credit market is available and discuss the changes induced by an improvement on the labor market functioning. A discussion on the effect of the imperfections prevailing on the other markets is postponed after the model. Bhalotra and Heady (2003); Dumas (2007), and Basu et al. (2010) have only considered the two polar cases with a perfectly competitive labor market and an absent labor market. We start by filling this gap with an analysis of the effect of a continuous change in labor market imperfections.

2.2 A model with no land market and an imperfect labor market

The model We consider rural households whose main productive asset is land. This framework has been chosen since 70% of working children in the world perform agricultural activities within their household. However, the analysis could be transposed to other types of activities. In this model, we assume that children cannot sell their labour time on the market. Their only economic activity is on the farm. This assumption is made in order to highlight how child labor might be used to compensate for shifts in adult labor supply when changes in the labor market occur. However, we will relax this assumption in the empirical part.

To model imperfections, we consider that the household faces a transaction cost on the labor market. In practice, we assume that the wage a household member would earn on the market ($\underline{w}$) is strictly lower than the wage the household would have to pay if they hired external workers on

[5]If households face some labor market imperfections but a competitive land market, they can rent out the land that they cannot farm given their labor force endowments; production and consumption decisions are separable. Conversely, a household facing only land market imperfections could compensate via the labor market if the latter is competitive: it would hire external labor force instead of renting out.

their farm ($\overline{w}$). This transaction cost is due to asymmetries of information regarding the effort made by the worker and therefore the supervision cost they induce.

The household is made of one adult and one child and maximizes its utility:

$$U(C, l_c) = \phi(C) - l_c$$

which is assumed to be additively separable. The marginal utility of consumption (C) is assumed to be independent from the level of child labor (l_c) and vice-versa.[6] Also, $\phi' > 0$ and $\phi'' < 0$. The adult is assumed to provide one unit of labor. However, he will choose how to share this unit between own farm production and wage labor.

The production depends on land (k) and labor (l). Once taken into account supervision costs, all types of labor are assumed to be perfect substitutes and

$$F(k; l) = F(k; l_a + \delta l_c + l_e)$$

where l_a is the adult working hours on the farm, l_c is child work hours, δ is the productivity ratio between adults and children, and l_e is external workers hours on the farm. We assume: $F_k > 0, F_l > 0, F_{kl} > 0$ and $F_{ll} < 0$.

The budget constraint is:

$$C = F(k; l_a + \delta l_c + l_e) + \underline{w}(1 - l_a) - \overline{w} l_e.$$

Here children are assumed to devote their working hours only to farming. As a result, we rule out the possibility that children can take the opportunity of better labor market conditions by themselves. Of course, the household faces some constraints on time endowments: $0 \leq l_a, l_c \leq 1$ and $l_e \geq 0$. These constraints give rise to different regimes. If the two wages $\underline{w}$ and $\overline{w}$ differ, no interior solution can be found: either the household sells labor or he buys it

[6] This utility is the one chosen by Basu et al. (2010). Results similar to those of Basu have been obtained with utility function that do not make such assumptions; it is therefore essentially made for the sake of simplicity.

but would not do both at the same time.[7]

The regimes Actually, we have four regimes and the regime of a given household depends on the wages $\underline{w}$ and $\overline{w}$ and the amount of land they own k (which is assumed to be given).

1. if the marginal production of labor on land is lower than $\underline{w}$: the adult sells all his time endowment on the labor market; the child might work on the farm; no external worker is employed on the farm;

2. if the marginal production of labor on land equals $\underline{w}$: the adult shares his time endowment between farming his plot and wage work; the child might work on the farm; no external worker is employed on the farm;

3. if the marginal production of labor on land is greater than $\underline{w}$ but lower than $\overline{w}$: the adult devotes all his time to the farm; the child might work on the farm; no external worker is employed on the farm;

4. if the marginal production of labor on land is equal to $\overline{w}$: the adult devotes all his time to the farm; the child might work on the farm; some external workers are hired.

Since we assume that the marginal production of labor increases with land, these four cases are ranked by land ownership. It is also important to note that cases (2) and (4) are not reduced to one value for k: when k increases, the marginal productivity of labor increases, therefore leading to a higher use of labor, keeping the marginal productivity of labor constant. Finally, we do not take into account the corner solutions induced by the limitations for the child's time endowment since they do not generate very interesting cases. We should just keep in mind that child labor might be censored between 0 and 1 in its variations.

[7] Indeed, for an interior solution, we find for the household member that $F_l = \underline{w}$ and for the external worker that $F_l = \overline{w}$, which is not compatible.

We define k_1, k_2 and k_3 as the thresholds in land area for switching from regimes 1 to 2, 2 to 3 and 3 to 4 respectively. Let us start by describing carefully how households behave in each of these regimes and then how these thresholds depend on market imperfections.

Child labor supply in each regime In regime 1, the adult worker is simply a wage earner, whose child may work. The household maximizes $U = \phi(C) - l_c$ subject to $C = F(k; \delta l_c) + \underline{w}$. As a result, they simply equate the child's marginal productivity to his marginal substitution rate between consumption and leisure:

$$\delta F_l = \frac{1}{\phi'(C)}; \tag{1}$$

this equation will hold true in each regime. We easily show that l_c decreases with the wage earned by the adult, $\underline{w}$, due to an income effect; but the effect of a variation in k is unclear. The income effect (more land generates more income for the same amount of labor) is partly or fully offset by the price effect (more land leads to a higher marginal productivity of labor, that leads to more labor) (see proof A.1). The overall effect is unknown but we should mention that very simple production functions such as the Cobb-Douglas function lead to an increasing relationship between l_c and k. To sum up, in regime 1:

$$l_c = l_c(\underset{-}{\underline{w}}, \underset{?}{k}, \underset{0}{\overline{w}}). \tag{2}$$

In regime 2, the adult worker shares his time endowment between the wage market and his farm. The household maximizes his utility subject to $C = F(k; l_a + \delta l_c) + \underline{w}(1 - l_a)$. The first-order conditions are eq. (1) and:

$$F_l = \underline{w}. \tag{3}$$

Quite interestingly, this regime is very different from the previous one. We

can show that l_c decreases with k: the effect of land area in this regime is similar to a pure income effect since the adult is able to fully compensate for a small change in the marginal productivity of labor (see proof A.2). However, a change in $\underset{?}{\underline{w}}$ leads to an income effect, as before, but also to a price effect. To take advantage of an increase in $\underset{?}{\underline{w}}$, the adult has to withdraw some of his time from the farm, needing to be taken over (see proof A.3). In regime 2:

$$l_c = l_c(\underset{?}{\underline{w}}, \underset{-}{k}, \underset{0}{\overline{w}}). \tag{4}$$

In regime 3, the adult worker would like to spend more time on his farm but is limited by his time endowment: he has now become a pure entrepreneur. The budget constraint is given by: $C = F(k; 1 + \delta l_c)$. The first-order condition is given by eq. (1) and $l_a = 1$. The household is in autarky from a labour market perspective. In this regime, l_c does not vary with $\underline{w}$ nor $\overline{w}$. A change in k generates an income effect (more land generates more income for the same labor) but also a price effect (more land leads to a higher labor marginal productivity) that cannot be accommodated by the adult since his time endowment constraint is saturated (see proof A.4). In regime (3):

$$l_c = l_c(\underset{0}{\underline{w}}, \underset{?}{k}, \underset{0}{\overline{w}}). \tag{5}$$

In regime 4, the household hire external workers and is subject to the budget constraint: $C = F(k; 1 + \delta l_c + l_e) - \overline{w} l_e$. The first-order constraints are eq. (1) and

$$F_l = \overline{w}. \tag{6}$$

We easily show that when k increases, only an income effect takes place (an increase in the labor marginal productivity leads to more non household

labor on the plot; see proof A.5). When $\overline{w}$ increases, child labor increases since profit decreases (see proof A.6). In regime 4:

$$l_c = l_c(\underset{0}{\underline{w}}, \underset{-}{k}, \underset{+}{\overline{w}}). \tag{7}$$

If, for an increase in k, the price effect does not offset the income effect in regimes 1 and 3, then l_c decreases with k over the whole range of values. This has proven wrong in different studies (Bhalotra and Heady, 2003; Mueller, 1984; Dumas, 2007; Basu et al., 2010). This is not very surprising: when income is low, we expect consumption to be much more valued than child leisure. This is also confirmed by the empirical part of this particle (section 4). Let us turn therefore to the opposite situation, namely when the price effect is larger than the income effect in regimes 1 and 3. We plot l_c against k in such a setting (graph 1): the question marks underline the fact that the decrease in regimes 1 and 3 is only putative.

This model highlights the fact that all households do not suffer equally from the market imperfections. For households in regimes 2 and 4, they behave as if they were facing competitive markets. Indeed, in those regimes, households participate in the labor market. As a result, variations in land area are fully accommodated by a change in labor market transactions and have no price effect on child labor. Households in regimes 1 and 3 however are constrained by market imperfections. For households in the first regime, it is due to the fact that we assumed that the child could not sell his labor force. The most interesting case for us is the third one: when the households would like to use more farm labor but cannot increase their own workload and are not willing to pay the price for hiring external workers. In that case, they rely on child labor and households more endowed in land may make their children work more than poorer households.

Market imperfections and regimes Now, to understand the effects of a change in market imperfections, we should not only look at the variation

of l_c in each regime with the wages but also look at the effects of these wages of the land thresholds, which determine the regime the household falls in. We therefore study the effect of changes in $\underline{w}$ and $\overline{w}$: the smaller $\overline{w} - \underline{w}$, the more competitive the market.

If $\underline{w}$ increases, then the marginal productivity of labor has to be higher to switch from regime 1 to regime 2. Therefore, the land threshold k_1 increases with $\underline{w}$. Again, if $\underline{w}$ increases, then farming one's own plot becomes less attractive and the level of land (k_2) for which the adult spends his full unit of time farming his plot has to be higher. Finally, if $\overline{w}$ is higher, then the marginal productivity of labor has to be higher for choosing to employ non household labor and k_3 increases.

$$k_1 = k_1(\underset{+}{\underline{w}}, \underset{0}{\overline{w}}) \tag{8}$$

$$k_2 = k_2(\underset{+}{\underline{w}}, \underset{0}{\overline{w}}) \tag{9}$$

$$k_3 = k_3(\underset{0}{\underline{w}}, \underset{+}{\overline{w}}) \tag{10}$$

If there is an improvement in the labor market functioning, then $\underline{w}$ increases and $\overline{w}$ decreases. This implies that the extent of regimes 1 and 4 increases and that the extent of regime 3 decreases. Only the change in the extent of regime 2 is unknown. In regime 3, child labor does not depend on wages since the household chooses to be in autarky. As a consequence, for households who remain in this regime, the level of child labor remains the same. In regime 4, a decrease in $\overline{w}$ leads to a decrease in child labor. In regime 1, an increase in $\underline{w}$ leads to a decrease in child labor. As a result, for households who remain in these regimes, the level of child labor is lower than when the labor market is characterized by stronger imperfections. However, the effect of an increase in $\underline{w}$ is unknown in regime 2. Actually, we can show by a continuity argument that there is a range in which child labor use is higher with lower labor market imperfections (see graph 2). To conclude, an

improvement in the labor market functioning should lead to a lower use of child labor for households with very little land and households with a high amount of land, should left unchanged households choosing autarky and has a mitigate effect for children from households owning some land.

2.3 Imperfect land and credit markets

The previous model assumes that land and credit markets do not exist. In this section, we discuss the effect of a marginal change in their level of imperfections.

Land market imperfections We mentioned already that if at least the land market or the labor market was competitive, then households should be able to compensate the imperfections of one of the two markets by transactions made on the other. As a result, only households who are constrained by the labor market (regimes 1 and 3) will truly benefit from an improvement on the land market. In regime 1, households are constrained by the labor market since they would like to sell some child labor. An improvement on the land market would allow these households to buy or more likely rent in some land, which is expected to result in an increase in child labor. Indeed, extremely poor households are expected to have a high marginal utility of consumption and therefore to use more child labor in order to take advantage of this new opportunity. In regime 3, households are constrained by the labor market and the marginal product of their labor is higher than the wage they can obtain on the market. An improvement on the land market would allow them to adjust the land area they farm to their labor endowments. This would allow them to obtain a higher profit with the same amount of labor. Whether this additional profit would be spent on increased consumption or child leisure is an empirical question. We expect children households belonging to regimes 2 and 4 to be moderately affected by an improvement on the land market since their household participate in the labor market.

Credit market imperfections Even if there is a credit supply in a community, it is quite unlikely that households can borrow against their children's human capital. However, if households suffer from idiosyncratic shocks, then credit availability could help them smoothen their income over periods without using child labor as a safety net, as households happen to do (Beegle et al., 2006)[8]. As a result, access to credit should reduce child labor use.

However, if credit also improves ability to invest, then it may have counter-intuitive effects on child labor. This will be the case if investments undertaken because of the credit availability improve the farm productivity and if households have to rely on their offspring to take advantage of this improvement, namely if land and labor markets are imperfect and if the household is well-endowed in land. This has to be qualified: if a household chooses to invest in a device which is a substitute for child labor (weedkiller, for instance), then this would lead to a decrease in child labor.

The global effect of an improvement on the credit market will be a decrease in child labor if the insurance mechanism predominates but is unknown if major changes in the investment choices also take place. An empirical analysis is therefore needed to assess by how much credit market imperfections are correlated with child labor.

3 Data and empirical strategy

3.1 What we do

The remainder of this article confronts the theory to the data. The idea is to assess how child labor varies with market imperfections and to evaluate the existence of heterogenous effects with respect to land size. Most of these imperfections coexist and reinforce each other. However, from a policy perspective, it is interesting to know which of these imperfections is associated with the highest levels of child labor. This calls for an estimation where all

[8]Obviously, an insurance market would be even more powerful, but given that it does not exist in rural areas, a credit market can be an imperfect substitute for it.

of them are taken into account simultaneously, which necessitates a large amount of data.

In this empirical part, we face two types of difficulties. First, we need to find measures of market imperfections. Second, we need to control for external factors that could spoil the results. For the latter, we expect some characteristics of the village to be correlated both with the market imperfections and the child time use: among others, the remoteness of the village, general level of development, agricultural practices, and distance to schools are good candidates for omitted factors. Our strategy is the following one: we will control for regions or districts fixed effects so as to pick up major differences between areas and we will also rely on a very uncommon source of information in which municipalities characteristics are extremely detailed.

3.2 Data

We combine two datasets in this paper. The first one, named "Enquête Périodique auprès des Ménages" (Epm), surveyed 11781 malagasy households spread out in 561 villages or districts.[9] The survey was stratified along the 22 regions and whether the village is located in an urban or a rural area. It is representative of the Malagasy population. In this paper, since we are particularly interested in rural households behaviour, we will not consider the major urban centers, where agriculture is unlikely to be an important source of income. We also drop 6 localities from secondary urban centers where no surveyed household owns agricultural land. This leaves us with 514 localities and 10794 households. In the Epm survey, all the household members older than 6 are interviewed and we know their activities, the number of hours they work, and their status in the job.

In addition to this, we know how much land the household owns, if it is registered in the cadaster, how they acquired the land, if they rent it, sharecrop it or farm it on their own. By averaging all this information at the

[9]The Epm survey has been designed and collected by the Malagasy national institute of statistics Instat.

level of the village (21 households are surveyed per locality), we construct the share of households who receive some land in sharecropping, who lease in, who bought their land, the share of adults (defined as between 17 and 45 years old) who engage in wage work along with the median wage for an hour of work.[10] However, the data do not include any measure for the paid wage ($\overline{w}$ in the model) and we are therefore unable to construct a measure of labor market imperfections which is akin to $\overline{w} - \underline{w}$. As detailed in the next section, we rather use the fact that a limited number of transactions on the market are a signal of imperfections. This is completely consistent with the fact that, when market imperfections prevail, there are price bands in which households prefer autarky to participation in the market. Regarding the credit market, a bank is said to be available if at least three households living in the locality said so; the same is applied to define the availability of microcredit and usurers.

We will also be able to control for a number of individual and household characteristics, such as: the household composition, father's education, age, gender, wealth[11], whether the household has some debt, and some limited information on the community such as the distance to primary and secondary school.

In addition to this, we use more detailed information on the localities obtained from the "municipality census", which was collected in 2001.[12] This survey gathers a lot of very detailed information on the infrastructures, agriculture, work opportunities, development, and so forth. However, a municipality does not match a village since several fokontany (villages) are grouped

[10] Regressions explaining children's working hours will use information on the use of markets in the village, to the exclusion of the child own household.

[11] We compute an index of wealth or permanent income, thanks to the information collected on the household's consumption of durable goods and their housing characteristics (Sahn and Stifel, 2003).

[12] The municipality census in Madagascar was organized by the Ilo program of Cornell University at the end of 2001. The survey was organized in collaboration with the National Center for Applied Research for Rural Development (FOFIFA) and the National Statistical Institute (INSTAT). A large part of the data are available at the following url: http://www.ilo.cornell.edu/ilo/data.html

into one municipality. We have to assume that the information collected at the level of the municipality are also relevant at the village level. This additional dataset allows us to control for

- the municipality's population, the extent of migration, whether the municipality is close to a lake or the sea, close to a forest, the distance between the municipality's administrative center and its most remote village, whether a farmer association exists, the duration of the lean season, the share of households who suffer from hunger during this period, and whether the municipality is classified as dangerous;
- the availability in the municipality of a health post center, a road, a bush taxi, a daily market, a phone (either a landline or a satellite coverage), and a drinkable water system;
- the rent for a hectare of ricefield, the price of a hectare of ricefield, the average price of rice and its seasonal variation;
- the main crop in the municipality, the availability of chemical fertilizers, non traditional agricultural equipments (like a plow, for instance), pesticides and weedkillers, veterinary products, and improved rice varieties;
- whether it is possible to extend rice land within the municipality, and the same for other crops;
- the number of head of cattle, the share of farmers who use draft animals, animals for stalling in ricefields and whether a common place is devoted to water the cattle.

A first limitation in this strategy comes from the discrepancy in dates between the household and the municipality survey. However, development is slow in rural Madagascar and most characteristics (and especially those related to agriculture) are expected to remain stable. A second limitation

is due to the fact some of the villages belong to a municipality that had not been surveyed in 2001, even though this was supposed to be a census. We will therefore check that the sample of villages that were surveyed in 2001 does not statistically differ from the full sample. The third issue is whether all relevant covariates are included in the estimation. We discuss this question in greater detail later on.

3.3 Markets in the data

Table 1 provides some descriptive statistics regarding the markets' functioning. Among the 10710 households used in the analysis, few of them have access to credit: 17.7% of the households have a bank and 37.3% a microcredit association operating in or near the locality. The land market is characterized by large imperfections since 44% of the land is not titled nor registered in a cadaster and 58% of the households live in a municipality where no land is rented. However, some transactions take place since only 29% of the households live in a municipality where no surveyed household bought some land. About 40% of households live in a place where sharecropping happen, which is also a sign of market imperfections. Finally, the extent of the labor market varies a lot from one municipality to another since 39% of the households face a labor market in which more than 25% of adult males participate while 45% of the households face a labor market where less than a quarter of adult males participate in; the remaining 16% rely on a very limited labor market with no wage work in the municipality.

There is some significant correlation between the measures of market imperfections. For instance, municipalities with a bank are also more likely to host a microcredit association or municipalities with a larger share of registered land also have a higher share of wage workers in the population (Table 6 in appendix). However, none of these correlations is so large that it should prevent us from identifying the effect of one imperfection conditional on the others.

4 Results

4.1 Specification

The specification is the following one: we regress the child's working hours on market imperfections measures and on the set of child, household, and community characteristics. Children under study are those aged between 6 and 13. We adopt a fairly flexible specification with both linear and quadratic effects of each measure (except for credit since the measures are dummy variables). This allows us to take into account mechanisms that have not been modeled: if the labor market is really competitive then children could take the opportunity to sell their workforce. As a result, an improvement of the labor market functioning could lead to less child labor when imperfections are strong but to more child labor if the labor market becomes truly competitive. A quadratic specification in market imperfections is flexible enough to capture such effects.

In addition to municipalities' characteristics, we also control for region or district fixed effects. There are 22 regions in Madagascar and 111 districts. Districts on average cover 5323 hectares, which is broadly four times the New York City's area. This allows to identify the effect of market imperfections on within district differences. The number of municipalities per district in the data ranges from 1 (for 3 districts) to 15. However, we cannot rule out endogenous placement (of banks, for instance) or that some unobserved heterogeneity remains at the municipality or fokontany level. This prevents us from asserting that the estimated effects are causal.

We first estimate the average "effect" of market imperfections on child labor and then look into heterogeneity of this effect, with respect to land ownership.

4.2 Average impacts

The impact of the control variables is given in appendix in Table 8, except for land area and wealth, which are of particular interest and are displayed in Table 2. We find that wealth decreases child labor and that rice land area, conditional on wealth, increases child labor. However, "tanety" land (deforested hill) does not affect child labor. A specification not included in the paper shows that children belonging to households with more riceland work more when wealth is not controlled for.[13] This average effect on the whole population suggests that the price effect overcomes the income effect when the households face an imperfect labor market, which is consistent with the assumption made in the graphs.

Table 2 gives the estimates of markets imperfections on child labor. The first column includes region fixed effects while columns 2 and 3 allow for district fixed effects. In column 3, we control for the 2001 municipalities characteristics and hence use a smaller sample. Most of the results are qualitatively similar throughout the specifications.

Among the different sources of credit, only the availability of a formal bank is associated with a lower use of child labor. This could come from a greater ability of the bank to move capital across space in case of major aggregate shocks. Regarding the "effect" of the other market imperfections measures, it is easier to look at Table 3, which provides the effect of a marginal change in the measure at the mean, the 10th and the 90th percentile of the measure. We find that an increase in the share of titled land or in the share of households who rent in land are associated with lower levels of child labor. However, no association is found on the sale market. Sharecropping, by way of contrast, is associated with higher levels of child labor, which is consistent with the fact that it has been shown to prevail when markets are imperfect (Bardhan and Srinivasan, 1971; Schultz, 1965). The labor market itself plays a role since a larger share of adult wage workers is associated

[13] Riceland is not exclusively used for farming rice, since there are some intercrops.

with lower levels of child labor. When the share is high, the marginal effect is positive but not significant. Therefore, it seems that even when the labor market gets more and more competitive, children cannot sell their laborforce. The assumptions made in the model are in line with this result.

These results point to the fact that, on average, land, labor and credit market imperfections are associated with more child labor. On the other hand, policies that reduce transaction costs on land sales would be inefficient. In order to compare the other policy options, we perform the following exercise. Imagine we take a village where none of the three markets exists and compare the effect of improving each measure by one standard deviation. In that case, an improvement by one standard deviation in the share of titled land would lead to $-1381 \cdot 0.23 = -318$ hours of child labor (per year per child), one additional standard deviation in the share in rented land would lead to $-1752 \cdot 0.11 = -193$ hours, while one standard deviation in the wage work share would lead to $-1759 \cdot 0.23 = -405$ hours. A comparison with the credit market cannot be performed since we only rely on discrete measures. Determining which option is the best would require a cost benefit analysis which is beyond the scope of this paper. However, we can notice that policies that improve the labor market competitiveness are good candidates for a reduction in the use of child labor. Such a policy could consist in building infrastructures such as roads, in order to favor temporary migration or even organizing such migration by providing cheaper and more frequent means of transportation.

4.3 Impact of market imperfections by land area

The theoretical model gives different predictions depending on how much land the household owns. However, it is very difficult to choose the right land thresholds: from a theoretical point of view, they depend on market imperfections. We therefore start by refining the first result that child labor increases with land by estimating a non parametric relationship between the

two so as to detect more local variations. Graph 3 plots the positive values of child labor against land area[14] and shows that the curve is decreasing for levels of land lower than 20 ares, increasing between 20 and 60 ares and decreases above 60 ares of rice land. This suggests that we do not observe households from the first regime (only wage work), that households who combine farm work with wage work are those who have broadly less than 20 ares of land, that households who are pure farmers have between 20 and 60 ares of land and households who hire external workers have more than 60 ares of land.[15] Given that the median household is composed of 4 persons (two adults and two children), these figures seem plausible.

Our priors are that a decrease in labor market imperfections should leave child labor unchanged for households in the third regime (between 20 and 60 ares), and decrease child labor for households who own more land than 60 ares. We also expect a decrease in land market imperfections to affect child labor mainly in households belonging to the intermediate level, since they are more constrained by the labor market imperfections than the other households. An improvement of the credit market should help first the less endowed households since they are the ones the most constrained by their lack of collateral. We therefore estimate the same equation than the ones presented before but allow for different effects of market imperfections depending on the regime. In order to do this, we split the sample in three sub-samples and run the same regressions.[16]

Table 4 provides the results of the estimations and Table 5 the marginal effects at mean. Credit market imperfections have a greater impact on households who own less land. The share of titled land impacts child labor for households who own more than 20 ares of land but there is no significant

[14]The number of observations with zero hours of child labor flattens dramatically the curve.

[15]We cannot check that directly in the data since we do not know whether a household hires some workers.

[16]The share of household who bought some land is omitted from the regressions since it is never significant.

difference between the two higher categories. However, the estimated effect of the imperfections prevailing on the land rental market, while being negative for the three categories, is greater for the intermediate category than the other two. This is consistent with the theoretical discussion. The association between sharecropping and child labor vanishes when splitting the sample. Regarding labor market imperfections, we find that a higher share of adult wage workers and therefore a more competitive labor market leads to less child labor only when the household is well-endowed in land. This does not come as a surprise since the effect for the intermediate category is predicted to be nil and the effect for the lower category is a mix of a positive and of a negative effect.

5 Conclusion

In this paper, we show both theoretically and empirically how market imperfections play a role in the use of child labor. We offer a simple model that describes how child labor varies with changes in labor market imperfections. We find that households are spread in four different categories: households with no or a very small amount of land (in which adults do not farm their land) are expected to decrease their amount of child labor following a decrease in labor market imperfections, households with a mid-lower amount of land (and in which adults combine wage work with farm work) may decrease or increase child work, depending on how far the adult is from spending all his time endowment on the farm, households with a mid-upper amount of land (in which the household is in autarky) should be left unchanged and finally households with a large amount of land (who employ wage workers) should also decrease their child labor use. The discussion on land market imperfections suggests that mainly households constrained on the labor market should take advantage of a decrease in land market imperfections and finally that availability of credit should decrease child labor use mainly for the less-endowed households. Both the model that depicts the

effects of a marginal change in market imperfections and the discussion of the heterogenous effects of such changes are new.

Most of the predictions obtained in the model are validated by the estimation of a child labor supply equation on rural areas of Madagascar, in which market imperfections are assessed by averages computed at the village level. We find no household in the first regime, which suggests that, as soon as some land is available, adults farm it. While the model predicted that, for small ranges of households, improvement on markets could lead to increases in child labor use, the estimation fails to detect such cases. This suggests that policies aiming at improving markets functioning should reduce child labor.

Madagascar already implements policies that favor land titling (by making titles easier and cheaper to obtain). By contrast, little is done to improve labor markets. The state of roads is poor and transportation remains expensive. Organizing transportation for seasonal migration around harvest time for instance could help reducing the use of child labor. From an intergenerational mobility perspective, the policy choice may matter since these two types of interventions should affect different households. Households reducing child labor following an improvement on the labor market are wealthier than households reducing child labor because of an improvement on the land market.

From a methodological point of view, it would be interesting to endogeneize market imperfections or, at the very least, to try and understand their determinants. In addition, it would also be more satisfying to take into account the fact that the land thresholds defining the regimes vary with market imperfections in the estimation. Similarly, it would be of interest to describe how households' characteristics impact their ability to access the market. All these issues are left for future research.

6 Figures and Tables

Figure 1: Child labor against land area

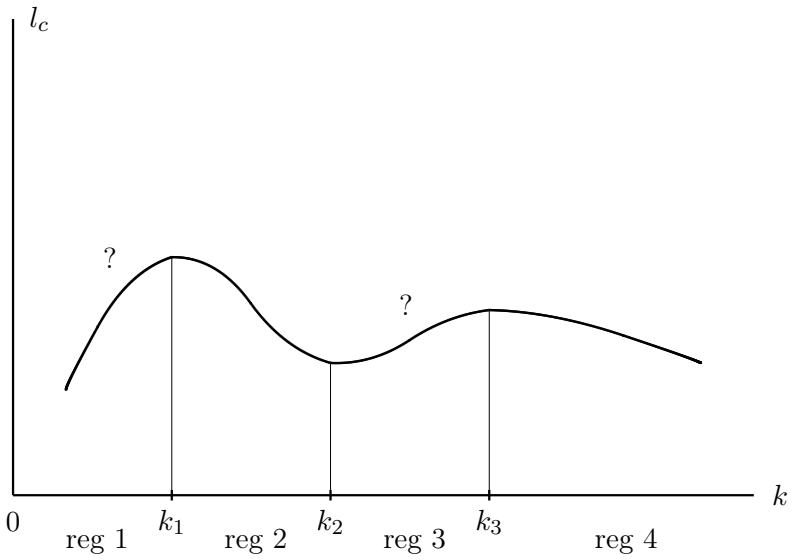

Figure 2: Child labor with less market imperfections

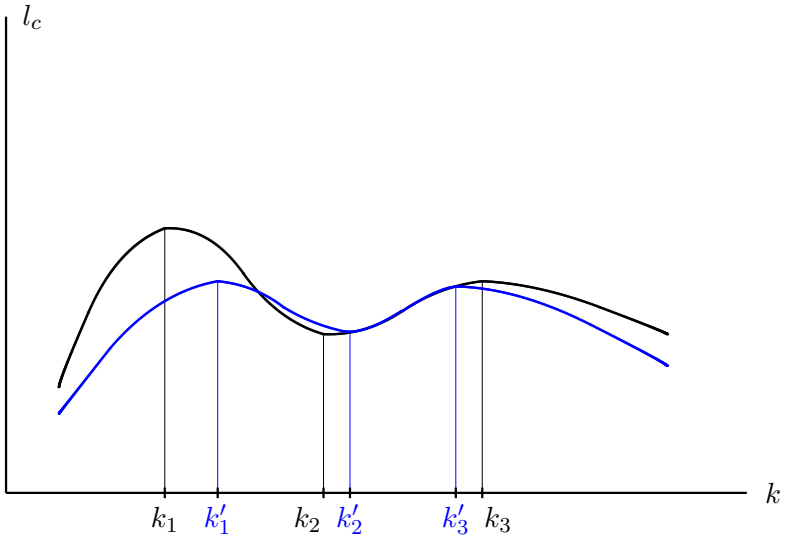

Figure 3: Child labor hours against riceland area

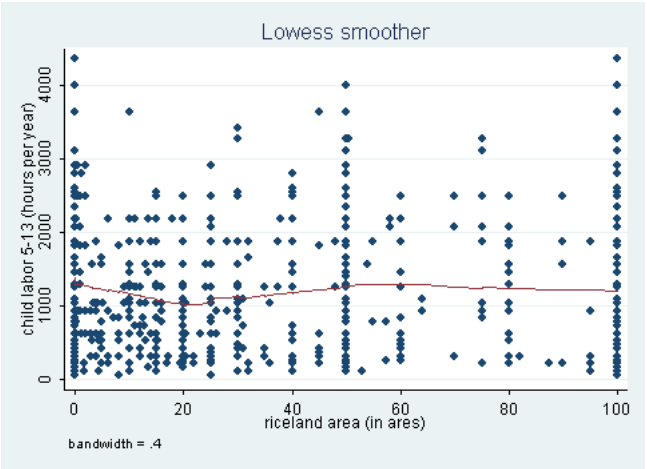

Table 1: Markets: share of households living in a village with various markets characteristics

Credit	
bank available	17.4%
microcredit available	37.4%
usurer available	15.1%
Land	
share of titled land = 0	43.7%
0 < share of titled land ≤ 25%	33.7%
25% < share of titled land ≤ 50%	11.8%
50% ≤ share of titled land	10.7%
share of hhs who rent in land = 0	57.8%
0 < share of hhs who rent in land ≤ 25%	35.9%
25% <share of hhs who rent in land	6.2%
share of households who bought their land = 0	28.1%
0 < share of households who bought their land ≤ 25%	49.3%
25% <share of households who bought their land ≤ 50%	14.4%
50% < share of households who bought their land	6.0%
Land + labor	
share of hhs who sharecrop = 0	60.4%
0 < share of hhs who sharecrop ≤ 25%	29.9%
25% <share of hhs who sharecrop	9.7%
Labor	
share of adult wage workers = 0	16.0%
0 < share of adult wage workers ≤ 25%	45.2%
25% <share of adult wage workers ≤ 50%	25.0%
50% < share of adult wage workers	13.9%

Table 2: Child labor supply and market imperfections

	Child labor 6-13 (hours per year)		
bank available	-618.2***	-369.4***	-427.6**
	(112.7)	(125.0)	(204.5)
microcredit available	25.25	-143.6	-116.2
	(78.24)	(94.87)	(111.3)
usurer available	57.16	118.5	90.27
	(99.35)	(118.9)	(149.2)
share of titled land	-1,257***	-1,849***	-1,381**
	(412.0)	(477.5)	(617.0)
share of titled land^2	161.8	1,909***	1,980**
	(576.4)	(646.8)	(940.9)
share of hhs who rent in land	-436.9	-461.4	-1,752*
	(719.9)	(874.6)	(1,012)
share of hhs who rent in land^2	102.8	72.50	1,624
	(1,667)	(2,218)	(2,496)
share of households who bought some land	-94.93	414.4	-263.8
	(417.1)	(478.6)	(582.2)
share of households who bought some land^2	200.9	226.0	815.0
	(602.7)	(673.8)	(836.0)
share of hhs who sharecrop	1,184**	1,140*	1,402*
	(584.8)	(676.6)	(818.8)
share of hhs who sharecrop^2	-1,310	-1,316	-2,486*
	(1,065)	(1,193)	(1,437)
share of adult wage workers	-2,364***	-1,206**	-1,759***
	(434.1)	(492.4)	(581.0)
share of adult wage workers^2	3,015***	1,396**	2,187***
	(545.7)	(623.8)	(709.0)
rice land area	0.618***	0.477***	0.289
	(0.168)	(0.174)	(0.213)
tanety land area	-0.137	-0.181	-0.262
	(0.137)	(0.138)	(0.160)
wealth	-169.8***	-175.2***	-165.0***
	(19.55)	(19.87)	(24.09)
# Observations	11781	11781	9428
Pseudo R^2	0.05	0.06	0.06
Children's and household characteristics	yes	yes	yes
Fixed effects	region	district	district
Community's characteristics	no	no	yes

Note: Estimation performed by maximum likelihood (tobit). Additional control variables are the full set of age dummies interacted with gender, households characteristics, ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table 3: Marginal effects of market imperfections on child labor supply

Market imperfection measure	effect at mean level	effect at 10%	effect at 90%
share of titled land	-804.1**	-1381**	580.6
share of hhs who rent in land	-1543**	-1752*	-1068*
share of households who bought some land	-9.6	-263.8	468.5
share of hhs who sharecrop	1059*	1402*	159
share of adult wage workers	-753.1**	-1759***	740.2**

Note: Computation based on column 3, Table 2 (covariates are individual's and household's characteristics, community's characteristics and district fixed effects). ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table 4: Child labor supply and market imperfections, by land ownership

	Child labor 6-13 (hours per year)		
	Rice land < 20	$20 \leq$ Rice land < 60	$60 \leq$ Rice land
bank available	-848.6**	-1,089***	-144.5
	(411.8)	(376.2)	(433.0)
share of titled land	366.1	-2,770*	-5,151***
	(1,020)	(1,505)	(1,337)
share of titled land^2	-992.2	2,719	10,714***
	(1,646)	(2,112)	(2,467)
share of hhs who rent in land	-1,955	-11,043***	1,897
	(1,687)	(2,648)	(1,781)
share of hhs who rent in land^2	3,524	21,053***	-4,737
	(4,404)	(6,281)	(4,039)
share of hhs who sharecrop	325.6	731.7	807.5
	(1,227)	(2,716)	(1,842)
share of hhs who sharecrop^2	-102.4	4,194	-2,484
	(2,045)	(5,971)	(3,929)
share of adult wage workers	-1,182	1,423	-4,443***
	(859.3)	(1,545)	(1,149)
share of adult wage workers^2	1,307	-1,725	5,178***
	(1,019)	(1,818)	(1,371)
rice land area	12.92	6.900	0.938
	(8.335)	(5.258)	(0.790)
tanety land area	-0.230	0.0174	-0.342
	(0.287)	(0.685)	(0.238)
wealth	-98.63***	-183.4***	-166.6***
	(33.31)	(62.69)	(44.69)
# Observations	4210	1758	3200
Pseudo R^2	0.08	0.10	0.08
Children's and household characteristics	yes	yes	yes
Fixed effects	district	district	district
Community's characteristics	yes	yes	yes

Note: Estimation performed by maximum likelihood (tobit). Additional control variables are the full set of age dummies interacted with gender, households characteristics, ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

Table 5: Marginal effects of market imperfections at mean on child labor supply, by land category

Market imperfection measure	Rice land < 20	$20 \leq$ Rice land < 60	$60 \leq$ Rice land
share of titled land	77.11	-1979*	-2031***
share of hhs who rent in land	-1502	-8341***	1286
share of hhs who sharecrop	311.4	1310	464.7
share of adult wage workers	-581.2	630	-2062***

Note: Computation based on Table 4 (covariates are individual's and household's characteristics, community's characteristics and district fixed effects). ***, ** and * respectively mean that the coefficient is significantly different from 0 at the 1%, 5% and 10% level.

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A Proofs

A.1 Regime 1: $\frac{\partial l_c}{\partial k}$

In regime 1, labor marginal productivity is lower than $\underline{w}$ and $l_a = l_e = 0$. Child labor is chosen such as $\frac{\partial F}{\partial l_c} = \frac{1}{\phi'(C)}$. Hence:

$$\chi = \frac{\partial F}{\partial l_c} - \frac{1}{\phi'(C)} = \frac{\partial F}{\partial l_c} - \frac{1}{\phi'(K(k, \delta l_c) + \underline{w})} = 0.$$

Since $\frac{\partial \chi}{\partial l_c} dl_c + \frac{\partial \chi}{\partial k} = 0$,

$$\begin{aligned}
\frac{\partial l_c}{\partial k} &= -\frac{\partial \chi / \partial k}{\partial \chi / \partial l_c} \\
\frac{\partial \chi}{\partial l_c} &= \frac{\partial^2 F}{\partial l_c^2} + \frac{\phi''(C)}{\phi'(C)^2} \cdot \frac{\partial C}{\partial l_c} \\
&= \delta^2 F_{ll} + \frac{\phi''(C)}{\phi'(C)^2} \cdot \delta F_l < 0 \\
\frac{\partial \chi}{\partial k} &= \delta F_{kl} + \frac{\phi''(C)}{\phi'(C)^2} F_k
\end{aligned}$$

The second term of the last expression is negative but the first is assumed to be positive. Hence the total effect, as $\frac{\partial l_c}{\partial k}$ is of unknown sign and depends on whether the substitution effect overcomes the income effect.

A.2 Regime 2: $\frac{\partial l_c}{\partial k}$

In regime 2, the FOC are such that

$$\begin{aligned}
\mu &= F_l - \underline{w} = 0 \\
\nu &= \frac{\partial F}{\partial l_c} - \frac{1}{\phi'(C)} = \delta F_l - \frac{1}{\phi'(C)} = 0
\end{aligned}$$

Total derivatives are therefore equal to zero:

$$\begin{aligned}
\frac{\partial \mu}{\partial l_a} dl_a + \frac{\partial \mu}{\partial l_c} dl_c + \frac{\partial \mu}{\partial k} dk &= 0 \\
\frac{\partial \nu}{\partial l_a} dl_a + \frac{\partial \nu}{\partial l_c} dl_c + \frac{\partial \nu}{\partial k} dk &= 0
\end{aligned}$$

Hence:

$$\left[\frac{\partial\mu}{\partial l_c}\cdot\frac{\partial\nu}{\partial l_a}-\frac{\partial\nu}{\partial l_c}\cdot\frac{\partial\mu}{\partial l_a}\right]dl_c+\left[\frac{\partial\mu}{\partial k}\cdot\frac{\partial\nu}{\partial l_a}-\frac{\partial\nu}{\partial k}\cdot\frac{\partial\mu}{\partial l_a}\right]dk=0$$

Since

$$\begin{aligned}&\frac{\partial\mu}{\partial l_c}=\delta F_{ll};\quad \frac{\partial\mu}{\partial k}=F_{kl};\quad \frac{\partial\mu}{\partial l_a}=F_{ll};\\&\frac{\partial\nu}{\partial l_c}=\delta^2F_{ll}+\frac{\phi''}{\phi'^2}\cdot\delta F_l;\quad \frac{\partial\nu}{\partial k}=\delta F_{kl}+\frac{\phi''}{\phi'^2}\cdot F_k;\quad \frac{\partial\nu}{\partial l_a}=\delta F_{ll}\end{aligned}$$

we get:

$$\begin{aligned}\frac{dl_c}{dk} &= -\frac{\delta F_{kl}F_{ll}-(\delta F_{kl}+\frac{\phi''}{\phi'^2}F_k)F_{ll}}{\delta^2F_{ll}^2-(\delta^2F_{ll}+\frac{\phi''}{\phi'^2}\delta F_l)F_{ll}}\\&= -\frac{F_k}{\delta F_l}<0\end{aligned}$$

A.3 Regime 2: $\frac{\partial l_c}{\partial \underline{w}}$

μ and ν are the same functions as in the previous section. By taking total derivatives with regard to l_a, l_c and $\underline{w}$, we show that:

$$\begin{aligned}\frac{dl_c}{d\underline{w}} &= -\frac{\frac{\partial\mu}{\partial\underline{w}}\cdot\frac{\partial\nu}{\partial l_a}-\frac{\partial\nu}{\partial\underline{w}}\cdot\frac{\partial\mu}{\partial l_a}}{\frac{\partial\mu}{\partial l_c}\cdot\frac{\partial\nu}{\partial l_a}-\frac{\partial\nu}{\partial l_c}\cdot\frac{\partial\mu}{\partial l_a}}\\&= -\frac{\delta+\frac{\phi''}{\phi'^2}(1-l_a)}{\frac{\phi''}{\phi'^2}\delta F_l}\end{aligned}$$

The last expression has the same sign as $\left[\delta+\frac{\phi''}{\phi'^2}(1-l_a)\right]$ and it is positive when l_a is close to 1.

A.4 Regime 3: $\frac{\partial l_c}{\partial k}$

In regime 3, the household maximizes its utility subject to $C=F(k,1+\delta l_c)$. The unique FOC is

$$\chi=\delta F_l-\frac{1}{\phi'(C)}.$$

As a consequence,

$$\begin{aligned}\frac{dl_c}{dk} &= -\frac{\partial\chi/\partial k}{\partial\chi/\partial l_c} \\ &= -\frac{\delta F_{kl}+\frac{\phi''}{\phi'^2}F_k}{\delta^2 F_{ll}+\frac{\phi''}{\phi'^2}\delta F_l}\end{aligned}$$

which is of the sign of $\delta F_{kl}+\frac{\phi''}{\phi'^2}F_k$.

A.5 Regime 4: $\frac{\partial l_c}{\partial k}$

In regime 4, the household maximizes $U=\phi(C)-l_c$ subject to:

$$F(k,1+\delta l_c+l_e)-\overline{w}l_e=C$$

The FOC imply that:

$$\begin{aligned}\mu &= F_l-\overline{w}=0 \\ \nu &= \delta F_l-\frac{1}{\phi'(C)}=0\end{aligned}$$

The total derivatives are therefore equal to zero:

$$\begin{aligned}\frac{\partial\mu}{\partial l_c}dl_c+\frac{\partial\mu}{\partial l_e}dl_e+\frac{\partial\mu}{\partial k}dk &= 0 \\ \frac{\partial\nu}{\partial l_c}dl_c+\frac{\partial\nu}{\partial l_e}dl_e+\frac{\partial\nu}{\partial k}dk &= 0\end{aligned}$$

Hence:

$$\frac{dl_c}{dk}=-\frac{\frac{\partial\mu}{\partial k}\cdot\frac{\partial\nu}{\partial l_e}-\frac{\partial\nu}{\partial k}\cdot\frac{\partial\mu}{\partial l_e}}{\frac{\partial\mu}{\partial l_c}\cdot\frac{\partial\nu}{\partial l_e}-\frac{\partial\nu}{\partial l_c}\cdot\frac{\partial\mu}{\partial l_e}}$$

Since

$$\begin{aligned}&\frac{\partial\mu}{\partial k}=F_{kl};\quad \frac{\partial\mu}{\partial l_c}=\delta F_{ll};\quad \frac{\partial\mu}{\partial l_e}=F_{ll}; \\ &\frac{\partial\nu}{\partial k}=\delta F_{kl}+\frac{\phi''}{\phi'^2}F_k;\quad \frac{\partial\nu}{\partial l_c}=\delta^2 F_{ll}+\frac{\phi''}{\phi'^2}\delta F_l;\quad \frac{\partial\nu}{\partial l_e}=\delta F_{ll};\end{aligned}$$

we get:

$$\begin{aligned}\frac{dl_c}{dk} &= -\frac{F_{kl}\delta F_{ll} - (\delta F_{kl} + \frac{\phi''}{\phi'^2}F_k)F_{ll}}{\delta^2 F_{ll}^2 - (\delta^2 F_{ll} + \frac{\phi''}{\phi'^2}\delta F_l)F_{ll}} \\ &= -\frac{F_k}{\delta F_l} < 0\end{aligned}$$

A.6 Regime 4: $\frac{\partial l_c}{\partial \overline{w}}$

μ and ν are defined in the same way as in the preceding section. Total derivatives give:

$$\begin{aligned}\frac{dl_c}{d\overline{w}} &= -\frac{\frac{\partial \mu}{\partial \overline{w}} \cdot \frac{\partial \nu}{\partial l_e} - \frac{\partial \nu}{\partial \overline{w}} \cdot \frac{\partial \mu}{\partial l_e}}{\frac{\partial \mu}{\partial l_c} \cdot \frac{\partial \nu}{\partial l_e} - \frac{\partial \nu}{\partial l_c} \cdot \frac{\partial \mu}{\partial l_e}} \\ &= \frac{\delta F_{ll} + \frac{\phi''}{\phi'^2}(-l_e)F_l l}{(\delta F_{ll})^2 - (\delta^2 F_{ll} + \frac{\phi''}{\phi'^2}\delta F_l)F_{ll}} \\ &= \frac{\delta - \frac{\phi''}{\phi'^2}l_e}{-\frac{\phi''}{\phi'^2}\delta F_l} > 0\end{aligned}$$

since both terms are positive.

B Additional Tables

Table 6: Correlations between market imperfections measures

	bank	microcredit	usurer	registered	sharecropping	renting	selling	wage
bank	1							
microcredit	0.51*	1						
usurer	0.16*	0.22*	1					
registered land	0.22*	0.24*	0.15*	1				
sharecropping	0.01	-0.06*	0.12*	0.04*	1			
renting	-0.02	0.11*	0.06*	-0.01	0.24*	1		
selling	0.15*	0.19*	0.13*	0.10*	0.11*	0.12*	1	
wage workers	0.39*	0.36*	0.18*	0.20*	0.02*	0.05*	0.16*	1

Table 7: Descriptive statistics for the sample

Variable	# Obs.	Mean	Min	Max
EPM 2005 variables				
gender	12116	.499	0	1
age=6	12116	.149	0	1
age=7	12116	.134	0	1
age=8	12116	.133	0	1
age=9	12116	.112	0	1
age=10	12116	.138	0	1
age=11	12116	.103	0	1
age=12	12116	.120	0	1
age=13	12116	.108	0	1
# children younger than 5	12116	1.069	0	6
# children btw 6 and 10 y.o.	12116	1.625	0	6
# children btw 11 and 15 y.o.	12116	1.195	0	7
# children btw 16 and 20 y.o.	12116	.523	0	5
# males btw 21 and 60 y.o.	12116	.918	0	5
# females btw 21 and 60 y.o.	12116	1.060	0	6
father's education	12116	2.393	1	6
father's education missing	12116	.073	0	1
has some debt	11798	.056	0	1
mean wage	12116	948.35	0	13856.81
distance to primary school	12116	731.71	0	7000
distance to lower secondary	12116	23474.7	0	70000
rice land area (in ares)	12116	70.069	0	3700
tanety land area (in ares)	12116	84.267	0	10025
wealth index	12116	-.377	-3.160778	16.519
bank available	12116	.149	0	1
microcredit available	12116	.355	0	1
usurer available	12116	.146	0	1
share of titled land	12116	.145	0	1
share of rented land	12116	.064	0	.6
share of sharecropping	12116	.068	0	.823
share of adult wage workers	12116	.229	0	.939
share of hhs who bought land	12099	.155	0	1
Continued on Next Page...				

Table 7 – Continued

Variable	# Obs.	Mean	Min	Max
2001 Municipalities census variables				
population size	9784	19434.63	1226	175250
outward migration	9798	2.022	1	4
inward migration	9798	2.253	1	4
health post available	9798	.973	0	1
road available	9784	.848	0	1
daily market available	9798	.571	0	1
phone available	9798	.206	0	1
drinkable water available	9798	.607	0	1
price of 1 ha of riceland	9778	5563167	0	1.00e+08
rent for 1 ha of riceland	9798	421613.3	0	1.30e+07
mean rice price	9798	620.563	320	1250
dangerous area	9778	.333	0	1
use of non traditional agricultural equipment	9798	2.109	1	3
use of pesticide	9798	2.273	1	3
use of veterinary products	9798	2.007	1	3
use of improved rice varieties	9798	2.527	1	3
share of hhs who use cattle as a pull force	9798	45.343	0	100
cattle can be rented	9798	.447	0	1
common place to water cattle	9798	.702	0	1
lake or sea bordering the village	9798	.518	0	1
forest bordering the village	9798	.835	0	1
peasant organization	9798	.563	0	1
length of lean season	9798	4.318	1	9
share of hhs who suffer from hunger during lean season	9798	55.072	0	99
main crop is rice (ref)	9798	0.714	0	1
main crop is coffee	9798	.060	0	1
main crop is sweet potato	9798	.024	0	1
main crop is cassava	9798	.061	0	1
main crop is corn	9798	.040	0	1
main crop is other	9798	.098	0	1

Table 8: Estimates for control variables

Variable	Child labor hours (6-13)
boy	84.01
age=6	-1,068***
boy x age=6	7.829
age=7	-716.5***
boy x age=7	-64.25
age=8	-757.8***
boy x age=8	88.02
age=9	-659.5***
boy x age=9	117.7
age=10	-279.6*
boy x age=10	181.1
age=12	-23.45
boy x age=12	505.1***
age=13	-261.5
boy x age=13	724.1***
# children younger than 5	32.58
# children btw 6 and 10 y.o.	42.83
# children btw 11 and 15 y.o.	-99.57***
# children btw 16 and 20 y.o.	-64.98*
# males btw 21 and 60 y.o.	-34.62
# females btw 21 and 60 y.o.	81.33
father's education	-223.2***
father's education missing	-257.2**
has some debt	199.7
mean wage	-0.0987**
distance to primary school	0.113***
distance to lower secondary	0.00417***
population size	-0.00230
outward migration	140.4**
inward migration	97.80*
health post available	-630.6***
road available	220.0*
daily market available	-356.6***
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Table 8 – Continued

Variable	Child labor hours (6-13)
phone available	455.3***
drinkable water available	-98.12
price of 1 ha of riceland	-5.63e-06
rent for 1 ha of riceland	-3.29e-05
mean rice price	-0.189
dangerous area	-242.3**
main crop is coffee	-292.1
main crop is sweet potato	-535.7***
main crop is cassava	-1,369***
main crop is corn	48.87
main crop is other	-492.7***
use of non traditional agricultural equipment	283.8***
use of pesticide	-110.9
use of veterinary products	-68.75
use of improved rice varieties	141.3**
share of hhs who use cattle as a pull force	4.232**
cattle can be rented	-129.9
common place to water cattle	346.3**
lake or sea bordering the village	43.65
forest bordering the village	440.4***
peasant organization	185.1**
length of lean season	15.93
share of hhs who suffer from hunger during lean season	0.557