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Taboos, agriculture and poverty

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Abstract: Although cultural practices often have important consequences for household consumption and economic performance, they are seldom studied by economists. To fill this gap we study the impact of taboos on agriculture and poverty. Madagascar is a good case study for this purpose given the prevalence of taboos in everyday life and the variation in cultural practices across the country. We examine the relationship between observance of work taboos (*fady* days) and agriculture and consumption. Using cross-sectional data from a national household survey, we find that 18% of agricultural households have two or more *fady* days per week and that an extra *fady* day is associated with 6 percent lower per capita consumption level and 5 percent lower rice productivity – controlling for human, ethnic and physical characteristics. To deal with the possible endogeneity of *fady* days, we present instrumental variable estimates as well as heterogeneous effect regressions using village fixed effects. We find that smaller households and those with less education employ less labor in villages with more *fady* days.

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Taboos, agriculture and poverty

> "Wednesday is an evil day. If one starts working in the rice fields on a Wednesday, there will be no harvest. On the other hand, Wednesday is a good day for burials… Thursday is dangerous. It might cause death in the village and it is *fady* to have burials on this day… Saturday is children's day. It is an unfortunate day for big and important work… The morning is good on Sunday but the afternoon is evil and dangerous. It is therefore *fady* to work on Sunday, especially in the afternoon."
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> (Ruud, 1960, pp. 32-35)

1. Introduction

Habits, customs and norms have had important consequences on economic behavior, welfare and wellbeing throughout world history (Landes, 1998; Diamond, 1998; Putnam et al., 1993; Kay, 2004).[1] For example, Austen (2003) examines the link between culture and labor markets. Based on cross-country evidence, he finds that cultural norms influence unemployment and the wage structure in economies in his sample. Platteau (1994) argues that the cultural endowment of a society determines its economic growth trajectory. While the link between culture and economic behavior and outcomes has received little attention in economics, it has played a prominent role in the anthropology and sociology literature. Although anthropologists and sociologists usually find large effects on people's behavior and wellbeing, they often fail to illustrate results at a large statistical representative scale due to lack of adequate tools and/or data.[2]

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[1] For examples, Landes (1998) shows that much of the increase in life expectancy in the 20th century has come from clean water, expeditious waste removal and improvements in personal cleanliness. Before the knowledge of germ theory, the great killer was gastro-intestinal diseases, transmitted from waste to hands to food. Groups that then washed their hands before eating, due to their religion, such as Jews and Muslims, had significantly lower disease and death rates.

[2] To get at the effect of norms and network effects, economists have studied the impact of ethnicity on economic performance, often finding no effect when other explanatory variables, especially education and location, are taken into consideration (Fafchamps, 2000; Van de Walle and Gunewardena, 2001; Collier and Garg, 1999). Others have addressed the effects of racial background on wellbeing and economic performance (Herrnstein and Murray, 1994; Bodenhorn, 1999; Darity et al., 1995). While some of this research may be controversial, other explanations for differences in economic performance or wellbeing are generally accepted, such as education, geography, environment and the like (Bloom and Sachs, 1998; Gallup and Sachs, 1998).

Only recently have economists started looking at explanations and effects of specific beliefs, superstition and taboos. Fudenberg and Levine (2006) and Bénabou and Tirole (2007) develop theoretical models to explain the persistence of superstition and taboos while Do and Phung (2006) look empirically at the effect of superstition on family planning in Vietnam. In this paper, we analyze empirically the relationship between taboos and agriculture and household consumption in Madagascar using a recent comprehensive nationally representative household survey. Madagascar is a good place to study this linkage as it is characterized by multiple taboos (called *fady*[3]), often associated with eating habits and burial practices.

We study the effect of a particular work taboo whereby individuals are not allowed to work on specific days (called *fady* days). Using data from the 2004 national household survey, we find that 18% of the population of agricultural households has two or more *fady* days per week and that an extra *fady* day is associated with 6 percent lower per capita consumption and 5 percent lower rice productivity, controlling for human and physical characteristics.[4] This association is statistically significant whether we use individually reported *fady* days or the village average.

What is unclear is whether the association between productivity and observance of *fady* can be given a causal interpretation. In particular, we would like to know whether the elimination of work taboos would increase consumption and productivity. This is a difficult question since we do not have truly exogenous variation in *fady* observance. We seek to address it in two ways. First, we note that *fady* observance varies systematically with the extent to which local communities have been targeted by missionary efforts. This suggests using religion as an (imperfect) instrument for *fady* observance. Using this approach, we again find a strong association between productivity and instrumented *fady* observance. We cannot, however, be certain that conversion does not proxy for

[3] The Malagasy word *fady* is of Indonesian origin (Ruud, 1960): in the Maanjab language (Borneo), the corresponding word is *padi* (taboo); in the ngaddju language (Borneo), it is *plai*. The Polynesian word *taboo* has been taken over internationally.

[4] The effect of timing on economic performance has also been studied in developed countries. For example, Thaler (1987a, 1987b) shows the impact of weekends, holidays, turn of the month and intraday effects on stock performance. Chamberlain et al. (1991) look at the effect of the thirteenth of the month on investment behavior.

something else that affects both productivity and villagers' desire to observe *fady* days, such as proximity to cities and better market opportunities.

To circumvent this difficulty, we turn to a second approach that relies on variation in labor demand across households. The logic behind this approach is as follows. Suppose there are more observed *fady* days in a village. This penalizes more those households with more land per person. Hence the negative effect of *fady* days on labor use should be stronger among land-rich households. We estimate a model where household land and proxies for work opportunities are interacted with village *fady* days. Since we include village fixed effects, factors such as proximity to cities and better market opportunities are controlled for. We find that interaction terms are statistically significant with the anticipated sign, suggesting that households with a higher land per manpower ratio are more likely to be constrained by local work taboos. We similarly find that educated households are less likely to abide by – and be constrained by – work taboos. These results provide our strongest evidence that work taboos negatively affect agricultural productivity in Madagascar.

The structure of the paper is as follows. In section 2, we discuss the meaning and importance of taboos in Madagascar. After describing the data in section 3, we map out the conceptual framework and the strategies employed to test the relationship between *fady* days and household consumption and agricultural production in section 4. In doing so, we discuss the market failures that are consistent with the observed outcomes. In section 5, we present the results of these tests. We finish with some concluding remarks.

2. Taboos in Madagascar

Madagascar is a country off the African coast that was settled relatively late. The earliest known traces of human communities date only from 800 A.D. (Wright and Raokotarisoa, 2003). The modern Malagasy people have a complex ancestry, with ancestors mainly drawn from Indonesia and eastern Africa. While all Malagasy speak one common

language, around twenty ethnic groups are still distinguished (Ramamonjisoa, 2002). The groups are identified by common traditions and group identity.

The importance of taboos cannot be understated in Madagascar (Gennep, 1904; Verin, 1990; Bloch, 1971; Ottino, 1986; Brown, 1999; Profita, 1978). This is well worded by Ruud (1960), an anthropologist who spent twenty years in Madagascar and the author of a seminal work on taboos: "…A European who lives in the country, mixes with the Natives, and speaks their language every day, will soon discover that the taboos are omnipresent. If he clashes with them, he will find himself up against a wall of difficulties. If he is ignorant of these compact and massive rules, he will meet with many unpleasant experiences…" (Ruud, 1960, p. 1). A taboo or *fady* can be translated as a prohibition, referring to what one is not allowed to do, objects which one must not come into contact, words which must not be uttered and places which must be avoided (Ruud, 1960). The transgressor becomes taboo himself to his environment and his fellows.

Fady are generally observed for two reasons. First, they are a means through which individuals display respect for their ancestors and for their elders (Brown, 1999). Taboos link individuals to their ancestors and living relatives. Sharing the same taboos allows people to identify with their clans and/or ethnic groups (Lambek, 1992). By not observing ancestral *fady*, or by observing them only selectively, individuals bring dishonor to their ancestors and can find themselves socially alienated from their community (Ruud, 1960). It is possible to draw inference regarding the social relationships that a person values most highly through *fady* observance. By passing down lineage and societal norms to their children in the form of taboos, elders use their authority to naturalize the existing order (Brown, 1999).

Second, *fady* are often adhered to out of fear. People believe that violating their *fady* invites misfortune in the form of illness, crop failure, or even death. In her case study in the Northeast of Madagascar, Brown (1999) found that most of the villagers who did not admit to violating or abandoning a *fady*, said that there was one simple reason for their

adherence – fear for leprosy. Almost everyone in her study region was convinced that this illness is the outcome of eating a particular *fady* food.

Ruud (1960) gives a comprehensive overview of the *fady* that existed in the 1960s. They include *fady* related to hospitality, habits regarding eating plants and animals, behavior towards elders, burial and child-rearing practices, agricultural activities, etc. Most of them are still largely observed and are believed to have an important influence on the behavior of Malagasy people today. For example, *fady* may be an important element affecting deforestation. Under local customs of indigenous populations all over the South, forests are treated with respect and fear as they are the place where sacred forces and spirits live (WWF, 2000; Fenn et al., 1999; Moizot, 1997). But this does not seem to affect migrants who are less bound by the social and customary *fady* of their place of residence and thus, as argued by Faroux (1999), are more destructive of forests than the local population and more than they would be themselves towards forest resources in their natal villages. The effect of *fady* can in some cases be quite dramatic. For example, in areas around Mananjara in the Southeast of the country, it is *fady* to accept twins in the household as they are associated with bad luck. Twins are therefore abandoned immediately after birth.[5]

In this paper, we will specifically address the relationship between agriculture and consumption and the observance of *fady* days. *Fady* days are among the many customs in Madagascar determined by the *vintana* (destiny) system, which is pervasive over the island. In general, the *vintana* system requires that sowing and harvesting, marriage and burial, and various kinds of important work must take place, or not take place, on certain days of the week. Any given day may be lucky or unlucky. As illustrated in the quote at the beginning of the paper, every day and every month has its *vintana* character. For many Malagasy it is impossible – even unthinkable – to oppose the *vintana* power as it is almighty (Ruud, 1960).[6]

[5] Luckily, a local NGO was formed to find suitable families/hosts for these abandoned children.
[6] Note that this statement refers to *vintana* power in general, of which *fady* day observance is a part.

According to the cosmologic conception of Malagasy society, a month has 28 days and starts with the new moon and ends with the wane of the moon. A month is generally divided in four weeks. Not only do months, weeks and days have definite destinies that must be observed, hours of the day can also have importance. By studying the *vintana*, people know what is good or bad, and what is useful or harmful. They frequently take this into account in their everyday activities. These practices are still widely observed today, especially in rural areas where most of the poor live (Brown, 1999; Bloch, 1971; Verin, 1990).

Solondraibe (1988) studied the origins of *fady* days in the Southern Highlands. He found that they mostly arise for two reasons. First, the *ombiasa* (traditional priests) impose specific days that people are not allowed to work, as part of their *vintana*. These days are part of the general taboos for larger communities, called *fadibe*. Second, some days are made *fady* by specific families or groups after some dramatic event happened and the family believes that by starting a *fady* day, it will avoid having these events repeat themselves. For example, Solondraibe (1988) mentions that death by lightning may be regarded as a sign that the family should not work on that particular day anymore.

Based on anthropological literature, there seems to exist a strong link between ethnicity and the observance of *fady* days.[7] For example, Jarosz (1994) illustrates the case for the Sihanaka ethnic group in the eastern part of Madagascar. This ethnic group is prohibited to work on days 1, 4, and 7 of a 12-day cycle. The prohibition extends to seasonal and permanently hired workers. De Bourdiec (1974) found that the Sakalava ethnic group is not allowed to work on the land on Tuesday and Thursday. On top of this, they are not allowed to work on Fridays due to their religion, which leaves them only four working days in the week. Solondraibe (1988) studied *fady* days within the Betsileo tribe. He found that the number of *fady* days within this tribe varies significantly. Brown (1999) observed *fady* days with the Betsimaraka ethnic group in the East of the country. In contrast with other researchers, she states that her studied population show some

[7] The link between ethnicity and different types of taboos has also been found in other countries. Their effects have especially been studied on health care (e.g. Addai, 1999), education (e.g. Chimombo, 2005) and nutrition (Shatenstein and Ghadirian, 1998; Aunger, 1992).

flexibility and treat *fady* days with pragmatism: "Many people, once they marry, begin to work on those days that used to be *fady* for them because, in combining their *fady* days with those of the spouse, they simply do not have enough time to get all their work done" (Brown, 1999, p. 259). Brown (1999) further shows that husband and wives respond to separate authorities. Similarly, neighbors might have separate taboo days, dictated by separate ancestral rules and passed down through separate elders. These field observations suggest that while *fady* days are largely dictated by custom, there is nevertheless an element of agency that should be kept in mind when examining the data.

3. Data

Our main source of information to study the link between *fady* days and agricultural productivity and consumption is the 2004 *Enquête Prioritaire Auprès des Ménages* (EPM), a nationally representative integrated household survey of 5,454 households. The data were collected during the months of September 2003 and January and February 2004. The sample was selected through a multi-stage sampling technique in which strata are defined by *faritany* (province) and *milieu* (rural centers, secondary urban centers, and primary urban centers), and primary sampling units (PSU) are communes. Each of the communes was selected systematically with probability proportional to size (PPS). In the analysis sampling weights, defined as the inverse probability of selection, are used to obtain accurate population estimates.

The comprehensive household questionnaire includes sections on education, health, employment, housing, agriculture, non-agricultural enterprises, and household expenditures and assets. The agriculture section is particularly detailed for a nationally representative survey as it contains plot- and crop-level information. For a measure of household well-being, in this analysis we use the estimated household-level consumption aggregate constructed by the Institut National de la Statistique (INSTAT). Because the main variable of interest in this study is the number of *fady* days, we limit our analysis to households that were asked that question – those in the agricultural section of the survey. There are 3,454 farming households in total.

4. Conceptual Framework

Just over 21% of households in our sample reported that, due to *fady*, household members were not permitted to work one day per week (see Table 1). Some 18% reported two or more *fady* days a week. At first glance, this might seem not extraordinarily high, as most employed people in developed countries typically take two days off each week. It is important to keep in mind, however, that agriculture is characterized by high seasonal demand for labor.[8] The *fady*-day constraint on household supply of labor is not likely binding during the slack periods of the agricultural calendar. But during the peak months (i.e. field preparation, planting, transplanting, and harvest), the inability to fully tap into the supply of family and hired labor is likely to have negative agricultural productivity and consumption consequences. The evidence indeed indicates that across households average rice yields are lower – and poverty rates higher – when the number of *fady* days is high (see Table 1). For example, average rice yields for households with two *fady* days are 11% lower than for those with one *fady* day, and the poverty rate is 6% higher.

While illustrative, the relationship depicted in Table 1 could be deceiving, i.e., driven by a third factor that is correlated with both *fady* days and consumption/productivity. We address this possibility using a variety of strategies. The first part of our analysis seeks to identify the average effect of *fady* days on consumption and agricultural productivity. The second examines how fady days affect different households differently.

[8] Madagascar is a rice economy par excellence as documented by different studies and datasets (e.g. Minten and Dorosh, 2006). For example, a commune census that was conducted in 2001 shows that rice is the most important crop in the majority of the communes of the country, in terms of both area and value of production (Minten et al., 2003). The only region where rice is stated to be less important than other crops is in the eastern part of the country, where cash crops are a more important source of incomes, and the south where maize and cassava are the main crops. The latter region is characterized by a drier climate that makes rice production more problematic than in the rest of the country. Rice production is little mechanized and is highly labor-intensive, with strong peaks in labor demand as rice is mostly cultivated in only one season in the year. It is estimated at the national level that almost three quarters of the Malagasy rice production happens in four months, i.e. between March and June (Minten and Dorosh, 2006). The number of lowlands where double rice harvests are possible is relatively limited, due to lack of irrigation and to water problems. The lowlands where two rice harvests are possible are mostly found in the west of the country.

In the first part of our analysis, we begin by simply regressing household consumption and agricultural production on the reported number of *fady* days and a number of household controls. This shows a strong conditional correlation between reported *fady* days and welfare.

Next we investigate is that *fady* days reported by the household are correlated with unobserved household characteristics that drive consumption income. For instance, more prosperous households may have less time to respect *fady*, and thus may report lesser *fady* obligations. To assess whether such a bias is affecting the results, we reestimate the model by replacing the household reported number of *fady* days with the village average.[9] The advantage of this approach is that the village average of *fady* days also captures how the overall village-level labor market constraints affect households. The idea is that the more *fady* days there are at the village level, the more the supply of labor is restricted in the village, affecting both farm and non-farm production of surveyed households. As noted previously, the seasonal character of labor demand among agricultural households means that labor constraints are likely to bind at least part of the year, and individual households may seek to overcome labor constraints by hiring labor.[10] Such a strategy will fail, however, if the observance of *fady* days by other households in the same village restricts the availability of hired labor. Replacing individually reported *fady* days with the village average controls for this possibility.

Replacing self-reported *fady* days by the village average does not eliminate all possible sources of endogeneity however. One particular concern is that villages that got wealthier in recent decades may be abandoning their *fady* practices. To address this concern, we re-estimate the model using an instrumental variable approach in which the excluded

[9] The household's reported *fady* days are omitted from the village average. Further, a detailed analysis of the distributions of reported *fady* days within villages indicates that there do not exist villages in which the average masks the simultaneous coexistence of concentrations of low and high *fady*-observance groups. In other words, the averages genuinely represent central tendencies.

[10] For example, as Cogneau and Robilliard (2000) write "hiring [labor] is particularly important at the time of rice transplanting in irrigated rice fields. On each field, this operation must be carried out quickly, ideally in a day, so that the seedlings grow at the same pace and appropriate water control can be assured. Typically, rice-grower households call upon paid work or mutual aid during this period."

instrument is a dummy variable that is equal to 1 if the household head follows a traditional religion. The assumptions needed for this instrument to be valid are discussed in detail in the next section.

The second part of our empirical analysis focuses on the heterogeneous effect of *fady* days on different households. To identify the relationship between *fady* days and household consumption, we have so far relied on variation across villages, thereby ruling out the use of village fixed effects. This approach is not entirely satisfactory because unobserved heterogeneity at the village level may be correlated with *fady* observance and household consumption. This could arise for instance if villages that are more backward and isolated are also poorer and more respectful of taboos.

To allow for this possibility, the second part of our analysis introduces village fixed effects. Although this means that the average effect of work taboos is no longer identified, we can still test for the *existence* of a negative effect of *fady* days by focusing on heterogeneous effects (Angrist and Krueger, 2001). The idea is that work taboos affect different households differently. Agricultural households that have a lot of manpower relative to land are less likely to be constrained by work taboos than those with a lot of land relative to their manpower. This follows because whether the *fady* constraint is binding depends on a household's demand for labor. To illustrate this, initially consider the absence of labor markets. In this case, each household has its own shadow wage which is determined by the household's internal demand for and supply of labor. On the supply side, *fady* observance reduces supply for a given household size, which consequently raises the shadow wage with other things being equal. On the demand side, the larger the land holdings relative to household size, the more demand there is for labor relative to household size. As such, *fady* is more likely to bind – that is, to push up the household shadow wage – for farmers with larger land holdings. This implies that *fady* days are more likely to bind for households with a low labor to land ratio. Introducing the existence of a labor market at the level of the village can in principle ease the constraint

for individual households.[11] But as long as *fady* days bind for a large enough proportion of households, they will adversely affect village labor supply and hence the village wage rate. *Fady* induced differences in the village wage rate will then have a larger impact on farmers who demand more labor because of a low labor to land ratio.

Whether taboos are constraining can thus be investigated by testing whether households with a high labor to land ratio are less affected by village norms regarding *fady* days than households with a low labor-land ratio. We also suspect that more educated heads of household are less likely to believe in taboos and superstition. Hence they are more likely to ignore them and hence less likely to be constrained by *fady* days.

To test for heterogeneous effects of *fady* days, we estimate a reduced-form model of demand for family labor. Because the information available in the data is limited to an indicator of whether family labor was used on the plot, we estimate a logit model of demand for family labor.[12] Since we also control for village fixed effects, we cannot estimate the effect of average number of *fady* days observed in the village.

This test is best illustrated with the following simplified equation for a reduced form plot-specific household demand for family labor (*FL*),

$$FL = \beta_0 + \beta_1(\tfrac{L}{T}) + \beta_2(\tfrac{L}{T} * \overline{fady}) + \beta_3(E) + \beta_4(E * \overline{fady}) + \beta_5(\boldsymbol{x}) + \varepsilon ,$$

where $\frac{L}{T}$, the ratio of household labor (adult equivalents) per *are* of land[13], represents the availability of family labor; $\overline{fady}$ is the village average number of *fady* days; *E* is an indicator of household educational attainment; and $\boldsymbol{x}$ represents other explanatory variables. Village *fady* days are used to test two types of heterogeneous effects β_2 and β_4.

[11] Village-level labor markets that are not nationally integrated are fair to assume given high transport costs (Stifel and Minten, 2008, and Jacoby and Minten, 2008).
[12] Note that for 25 percent of plots in the sample, households do not use any household labor and instead rely entirely on hired labor.
[13] The conversion is 100 *are* per hectare.

First, we test if *fady* norms affect households of varying sizes (relative to land holdings) differently by using the interaction between the village average *fady* days and the number of adult equivalent household members per are of cultivable land ($\frac{L}{T} * \overline{fady}$). A positive coefficient for the interaction ($\beta_2>0$) implies that *fady* norms are more constraining for households with few members relative to their land holdings.[14]

Second, the interaction between the village average *fady* days and household education ($E* \overline{fady}$) is included as a way of testing how differential degrees of respect for *fady* affect demand for household labor differently. A dummy variable for at least one member of the household with a secondary or post-secondary level of education (E) is used as a proxy for respect for *fady*. A positive coefficient ($\beta_4>0$) for the interaction term implies that those with less education (more respect for *fady*) are more constrained by the number of *fady* days observed in the village than those with more education.[15] This would arise if more educated households disregard *fady* taboos during the agricultural peak season.

5. Results

5.1. Average Effects

We begin by estimating standard OLS models (Table 2) in which the dependent variable is the log of per capita household consumption – the measure of household "expenditures" commonly used to calculate poverty. In addition to the number of *fady* days reported by the household, we include a number of household controls to correct for possible omitted variable bias. These controls include household demographics, education, and a series of ethnicity and region dummies. The default ethnic group is the biggest, the Merina. Because we suspect that respect for *fady* days is stronger in isolated

[14] Note that we expect $\beta_1 < 0$, as a lower labor/land ratio increases the marginal product of labor.
[15] More educated individuals may have less cash or credit constraints and thus may be in a better position to hire labor. This is why household education enters the regression as a separate regressor. This should not affect the interpretation of the interaction term with fady days.

communities and isolated communities are poorer, we include dummies for geographical isolation quintiles. Information on transportation costs were collected in the 2001 commune census conducted by Cornell University. The variables used here are the quintiles of the cost of transporting a 50 kilogram sack of rice to the nearest urban center to which commune members travel.

The estimated coefficient on the number of reported *fady* days indicates that a 6 percent lower household consumption is associated with each extra *fady* day. Estimated coefficients for control variables are as expected and as documented in previous poverty analysis in Madagascar (e.g. Razafindravonona et al., 2001). As such we do not comment on them here, though it is interesting to note that almost none of the ethnic variables is significant, indicating that most of the variation in consumption between ethnic groups is accounted for by the included regressors, including variation in remoteness.

As noted in section 4, a concern with these results is that *fady* days reported by the household may be correlated with unobserved household characteristics that determine household consumption. To correct for this, we reestimate the model using the village average number of *fady* days as a proxy for the village norm and for the resulting village labor market constraints. Results are shown in the second part of Table 2 (model 2). The number of village *fady* days has an even larger correlation with household consumption: one extra *fady* day is associated with 16 percent lower household consumption on average. To check whether these results are driven by migrating households, we reestimate the model without all households having migrated to their current place of residence in the last five years. Virtually identical results are obtained; they are not shown here to save space.

Next we seek to instrument *fady* days. A main source of endogeneity may be that respondents rationalize their underemployment as a result of respect for *fady*. As such, the direction of causality can go either way: *fady* appears to cause underemployment, while underemployment may cause respondents to report *fady*. To correct for this, we

need a variable that explains *fady* but does not cause underemployment. For this purpose, we use adherence to traditional religions as an instrument for the observance of *fady* days. Although this is the only reasonable instrument we could find given the available data, it is important to realize its limitations.

As shown in Table 3, conversion to Christianity satisfies the inclusion restriction: the Christian faith discourages the observance of taboos, a point that is borne out by the data. Furthermore, since conversion to Christianity started a long time ago in Madagascar, it cannot be suspected of simultaneity bias with the observance of traditional taboos – i.e., respondents did not convert last year in order *not* to follow *fady* days.

But adherence to traditional religions may nevertheless be correlated with location-specific characteristics – such as socio-economic success – that affect labor demand and therefore the shadow cost of respecting *fady*. The overall African anthropological record seems to indicate that where conversion to various Christian faiths took place, it might have been correlated with socio-economic change. Given this potential problem, we look at the historical literature to better understand Christian conversion in Madagascar.

The historical literature (Raison-Jourde, 1991; Huebsch, 1993; Brown, 2002) agrees that most early placements of missionaries in the country were driven by political objectives, i.e. first the Anglicans/London Missionary Society (LMS) tried to get hold of the Merina elite, the rulers of the country. In the late 19th and early 20th century, placements were mostly driven by growing political competition between the Anglicans/Quakers on the one hand and the Catholics on the other - in many cases they just tried to get missionaries into the villages already covered by the respective other missionary societies (the LMS also tried to get the Catholics expelled under the Merina rule and the Catholics paid back in kind when the French took over).

Although some systematic patterns have been documented, subsequent conversion efforts do not appear to have been systematically confined to a particular region or social class. Raison-Jourde (1991) argues that missionaries preferred to target villages where people

were sedentary and where the state was present. These villages may have been wealthier but there is no conclusive evidence and record on this. Within villages, poor as well as rich people were targeted as missionaries aimed at converting as many people as possible (Lupo, 1996). Brown (2002) argues that Protestants and Catholics followed different conversions paths. Protestants went mostly for the higher castes while Catholics aimed mostly at the lower castes of the population as well as the coastal areas because they were more important in numbers. For example, Lupo (1996) shows that the majority of early Catholic converts were slaves. These were attracted to Catholicism given the potential promised abolishment of slavery, as it was contrary to Christian beliefs of human equality. Conversion efforts thus appear to have been targeted at multiple ends of the social scale both across and within villages.

To summarize, missionary activity in Madagascar was largely been driven by non-economic considerations, such as political objectives and a strategy of mass conversions. No intentional relationship should therefore exist between wealth and conversion to Christian faith. Albeit not perfect, the traditional faith variable is therefore not a totally unreasonable instrument for the adherence to *fady* days.

In Table 3 we show the results of regressing *fady* days on religion dummies and the household controls. The logit model relates households with two or more *fady* days with religion dummies.[16] The same controls as Table 2 appear in the regression, namely age and gender of the household head, number of household members, ethnicity dummies, region dummies, and isolation quintiles. [17]

Results show that, as anticipated, Christian households report fewer *fady* days than those following traditional religious traditions. The effect of religion is strongly significant, indicating that the variable satisfies the inclusion restriction. Male headed households are

[16] Similar regression of reported number of *fady* days were also estimated using OLS,a Tobit and an ordered probit methods. The results were not qualitatively different from those that appear in Table 3 and are thus not reported here, though they are available from the authors upon request.

[17] Although the ethnicity estimates are not presented in the table, twelve out of the 19 ethnic groups in the data show a significant different number of *fady* days than the Merina, the main ethnic group in Madagascar. They all have more *fady* days except for the Chinese and Comoron immigrants, who have significantly fewer. As expected, these latter groups are little affected by local customs.

more likely to adhere to *fady* days than female-headed households. Higher levels of education are associated with fewer *fady* days. Household size and the age of the head of the household do not have a significant effect.

Instrumental variable regression results for household consumption are reported in Table 4. The effect of village *fady* days remains significant whether we used household responses or average village *fady* days. The magnitude of the IV model coefficient estimates suggests a large impact of 47 percent less household consumption for an extra *fady* day. While these results do not totally eliminate the possibility of endogeneity bias, they nevertheless demonstrate that the association between consumption and *fady* days is strong and not driven by household response bias. They nevertheless remain fragile to the possibility that conversion to the Christian faith is correlated with unobserved determinants of income and consumption, a possibility that we find unlikely given the historical context in Madagascar but that we cannot entirely rule out.

We have speculated that the channel through which *fady* days affect income and consumption is through labor constraints during the agricultural peak period. To investigate this idea, we examine the effect of *fady* days on agricultural production. Table 5 presents reduced-form estimates of the determinants of rice production similar to those reported in Tables 2 and 4 for consumption.[18] We focus just on rice production (log of the kilograms of paddy produced per plot) as this is the predominant crop grown in Madagascar, and as it allows for easier comparison across plots. In addition to our variables of interest (*fady* days), controls include land quality and characteristics, household demographics (to capture the quantity of household labor that can be supplied in the absence of *fady*-day constraints), and education levels (to capture the quality of labor inputs).[19] Estimated coefficients for these variables are consistent with previous estimates for Madagascar (Stifel and Minten, 2004), and we do not discuss them here.

[18] While the plot-level data used in this analysis are very detailed for a nationally representative household survey, they do not include information on quantities of labor and non-labor inputs. As such, structural estimates of production functions are not possible.
[19] Descriptive statistics appear in Appendix Table A2.

In the first model, the household *fady* day variable is negative and statistically significant. We find that an extra household *fady* day is associated with 5 percent lower rice productivity, *ceteris paribus*. The second specification is again motivated by the possibility that household-reported *fady* day are correlated with some unobserved household characteristic that also affects household rice production. A 14% fall in rice production is associated with each extra average village *fady* day. The third and fourth models are the same as the first and second, except that the *fady* variable is instrumented, as before, using the traditional religion dummy. Coefficient estimates for *fady* days remain negative and significant but are larger in magnitude.[20] These findings are subject to the same caveats as those discussed for the consumption regression, but they nevertheless suggest that agricultural production may be a channel through which *fady* days and household consumption are related.

5.2. Heterogeneous Effects

Identification of the average effect of *fady* days requires the assumption that household-reported *fady* days are exogenous or that village fixed effects can be ignored. Despite efforts to control for household level endogeneity using instrumental variables, neither assumption is entirely satisfactory. In our search for evidence of a causal effect of *fady* days on agricultural productivity, we now turn to an heterogeneous effect model and estimate the model of demand for family labor outlined in section 4. Because the information available in the data is limited to an indicator of whether family labor was used on each plot, we estimate a reduced-form logit model. We control for unobserved village heterogeneity by including village fixed-effects. Results are reported in Table 6.

The positive and significant marginal effects estimates for the two interaction terms in Table 6 indicate that smaller households and those with less education employ less family labor in villages where the average number of fady days is higher.[21,22] Two points of

[20] In addition, the z-statistics for the tests of significance of the excluded instruments are 6.7 ($p<0.001$) and 8.3 ($p<0.001$), indicating that we can have confidence in the exclusion restriction.
[21] Roughly 6 percent of the households in the sample practice sharecropping. To address the effect that this may have on land (and consequently household size relative to land), the models in Table 6 were re-

clarification are needed to understand these estimates fully. First, the interaction marginal effects that appear in the table are calculated as the average of the *partial*[23] changes in the probability of family labor use due to a one-day increase in *fady* days (holding household size/education constant). We use the term partial because it measures the effect of *fady* on family labor use only through the interaction effect.[24] For the household size-*fady* interaction, this means that we evaluate the probability change for each observation, setting the household size per *are* of land equal to one, and then take the average of the changes over the entire sample. Second, because these are *partial* changes in the probabilities, the appropriate way to interpret them is to compare the marginal effects of *fady* for the constrained households (e.g. the ones with few adults per are of land) relative to unconstrained households. The difference in marginal effects is a measure of the effect of the constraint on labor use.

Regarding the household size relative to land holdings, it makes little sense to consider households with no adults. As such, we estimate the interaction marginal effects of *fady* for various household sizes and present them in Table 7. Thus the 0.07 marginal effect for a household with one adult per *are* of land can be compared to the 0.04 for a household with one adult for two are of land (or 0.5 adults per are of land – i.e. a smaller household). This tells us that the household with more land and/or fewer adults (0.5

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estimated using various different specifications to control for sharecropping. These include using dummy variables for sharecropping, adjusting household land size by the area of land sharecropped, and estimating the model on the sample of households not practicing sharecropping. The results reported in Table 6 are robust to these different specifications of the model and are thus not reported here.

[22] We also include an interaction between village *fady* days and the household's migrant status. The rationale is that household with a migrant may be less inclined to follow local customs. As illustrated in Table 6, this interaction term is not significantly different from zero.

[23] That is we take the average of the following probabilities evaluated for each observation,

$$F(x'\beta)\,(1- F(x'\beta))\,x_{L/T}\beta_{L/T\,*\,fady},$$

where $x_{L/T}$ is the number of adults per are of land (set to one), and $\beta_{L/T*fady}$ is the estimated coefficient for the interaction. Ignoring the education interaction for simplicity, note that the change in the probability of family labor use for a one day increase in village *fady* observance is

$$F(x'\beta)\,(1- F(x'\beta))\,(\beta_{fady} + x_{L/T}\beta_{L/T*fady}).$$

The difference between the interaction marginal effect and the total change in the probability of family labor use is the direct effect of *fady* day observance ($F(x'\beta)\,(1- F(x'\beta))\,(\beta_{fady})$). This cannot be estimated because we estimate a fixed effects logit model (i.e. β_{fady} is differenced out). Thus the marginal effects reported in Table 5 for the interaction terms are *partial* changes in the probabilities.

[24] Note further that this is different from Ai and Norton (2003), who interpret the interaction in a logit model as a double-difference.

adults per are) is 3 percent less likely to use family labor for rice production than the household with less land and/or more adults (1 adult per are) in villages with one additional *fady* day. Similarly, a household with one adult per are of land is 9 percent less likely to use family labor than a household with two adults per are of land for a one day increase in the village *fady* average (0.16 – 0.07).

These estimates suggest that households with more land per adult member are affected more by the local *fady* norms, probably because they are more labor constrained. This effect of *fady* days is progressively redistributive within villages as the more prosperous (based on more land holdings) are more negatively influenced by *fady*-induced labor constraints. Although this leads to lower intra-village inequality, it does so at the expense of growth by merely pulling everyone to the bottom.

The opposite conclusion, however, follows from the interaction effect for educated households. The marginal effect in Table 6 illustrates the difference in the effect of *fady* norms between the constrained and unconstrained households and suggests that constrained household are those with a lower level of education. Households without secondary or post-secondary levels of education are 9 percent less likely than educated households to use family labor in villages with a one-day higher observance in *fady* days. This suggests that households with low levels of education are more likely to respect *fady* norms and are more negatively affected than households with higher levels of education.

6. Conclusions

Although cultural practices and customs often have important consequences for consumption and economic performance, they are seldom studied by economists. To fill this gap, we study the impact of taboos on consumption and agriculture in Madagascar. Madagascar provides a good case study because of the prevalence of taboos in everyday life and the variation in cultural practices across the country. We analyze the effects of days during which it is taboo to work (*fady* days) on agriculture and consumption. Using data from a nationally representative household survey, we find that 18% of agricultural

households report two or more *fady* days per week and that an extra *fady* day is associated with 6 percent lower per capita household consumption and 5 percent lower rice productivity.

We adopt complementary strategies to address the potential endogeneity of *fady* days. First, average effects of *fady* days are estimated using an instrumental variables approach in which traditional religion serves as instrument. In the context of Madagascar, this is a reasonable instrumentation strategy given the data constraints, albeit not a fully convincing one because there may remain village-level factors that affect both fady observance and welfare. To deal with this possibility, we introduce village fixed effects and turn our attention to the presence of heterogeneous effects across households. We find that smaller households and those with less education employ less labor in villages with high *fady* observance. These results suggest that fady norms imposes constraints on labor use that differentially affect different households.

Although we estimate the effect of one particular taboo (*fady* days), other taboos are widespread in rural areas and affect agricultural practices throughout Madagascar. Freudenberger (1999), for example, illustrates how the required slaughtering of cows for funerals, can lead to a vicious circle of deepening poverty in the case of quickly succeeding deaths of family members. She also shows that this happens despite villagers reporting a lack of manure as the main constraint on rice productivity in her study area. In some other areas, it has been found that it is taboo to transport manure, generally perceived as a major constraint to improved agricultural productivity in Africa (Barrett, Place and Aboud, 2002). Solondraibe (1988) shows widespread taboos to cultivate even fertile land in specific areas. Moser and Barrett (2003) further find economically and statistically significant social conformity effects, i.e. Malagasy smallholders choose their cultivation practices in part to conform to local behavioral norms, even if it means sacrificing gains in expected rice output. Finally, Barrett (2005) illustrates how the adoption of improved rice technologies is hindered because it departs with the "way of the ancestors" and although highland farmers say they cannot afford inorganic fertilizers,

they routinely pay extraordinary sums to exhume and re-shroud dead ancestors every 3-5 years, a ceremony known as *famandihana*.

We analyze the negative effects of taboos. Nonetheless, there could be gains from taboos that are not analyzed here. For example, food taboos have been the subject of a large body of research. Harris and Ross (1987) highlighted the benefits of some food taboos towards survival. Other taboos might reflect received wisdom for social goods, e.g. Colding and Folke (2001) synthesize information on resource and habitat taboos and find that they offer often clear benefits towards resource conservation and management. *Fady* days in particular could also contribute to social goods by requiring contribution to public goods or common property.

Taboos and other customs introduce constraints and affect the flexibility of input markets. They can contribute to poverty and low agricultural productivity. This appears to be the case in Madagascar.

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Appendix: Descriptive statistics

Table A1 shows some of the basic socio-economic descriptive statistics of the households that we study. The age of the average household is 43 years. 18% of the households are headed by females and the size of the household is 5 members. Education levels are low as 29% of the heads of households did not receive any education. About 17% of household heads went on to pursue secondary or higher education. The survey allowed for 22 ethnic groups, the most important of which are the Betsileo and Merina, mostly resident in the highlands, and the Betsimaraka located mostly on the east coast. Together, they account for 55% of our sample.

Poverty is high by any measure. The head-count ratio of poverty (P_0) is estimated to be 77.6% of individuals in our sample, which comparable to estimates from other national household surveys that have been held in the last decade. The depth of poverty (P_1) is estimated at 28%. The average annual per capita expenditures are estimated at almost 1 million Fmg in 2001 currency (about 150$ annually or 0.41$ per day). These high objective poverty measurement consistent with subjective measures in the data. About 54% of the households state that they have difficulties while 29% state that they must to pay attention.[25]

Agriculture is a main source of income for households in Madagascar. Further, rice is the primary staple crop, accounting for almost 50% of all calorie consumption in the country (Faostat, 2000). The data used in this analysis include detailed information about agricultural inputs and production, providing us with important information about people's livelihoods. As illustrated in Table A2, just over 37% of the reported plots in the sample were lowland plots where mostly only rice is grown. The average plot size is small: the mean is 38 ares and the median is 12 ares. To facilitate comparison over plots, we focus only on rice crops in this paper. Physical characteristics of rice plots are

[25] By comparing actual expenditures of the household with self-reported welfare levels in the case of Madagascar, Lokshin et al. (2003) show that this type of subjective assessment are a good alternative indication of the welfare level of households in the absence of expenditure measurements.

reported in Table A2. The low rice yields seen in Table 1 are often due to the low adoption of improved agricultural technologies. It is estimated that only 16% of the rice plots receive some type of modern inputs (defined as chemical fertilizer, pesticides or herbicides). Manure and compost was used on 31% of the plots.

Table 1: Number of weekly *fady* days

Number of *fady* days per week	Percent of Households	Poverty Rate	Rice Yields*
0	60.3	77.3	2,671
1	21.4	76.1	2,316
2	12.9	80.6	2,066
3	4.3	79.1	1,870
4	1.2	84.4	1,565
Total	100	77.6	2,484

* Kilograms per hectare

Table 2: Regression analysis on consumption expenditures
(dep. var. = log(per capita consumption expenditures))

	Model 1		Model 2	
Variable	Coef.	z-stat[a]	Coef.	z-stat
Number of *fady* days	-0.057	-4.98 ***		
Non-self village mean *fady* days			-0.157	-5.74 ***
Total land holdings (log hectares)	0.052	6.88 ***	0.052	6.97 ***
Female-headed household (dummy)	-0.099	-3.92 ***	-0.091	-3.62 ***
Age of household head	0.004	6.09 ***	0.004	5.80 ***
Number of household members (adult equivalents)	-0.147	-25.5 ***	-0.147	-25.5 ***
HH member with at least secondary educ. (dummy)	0.157	5.32 ***	0.152	5.19 ***
Remoteness Quintile[b] (omitted = Most remote)				
Q2	-0.122	-3.78 ***	-0.119	-3.71 ***
Q3	-0.112	-3.74 ***	-0.103	-3.45 ***
Q4	-0.073	-2.42 **	-0.066	-2.17 **
Least remote	0.036	0.98	0.043	1.16
Ethnicity dummies (18)	yes		yes	
Region dummies (21)	yes		yes	
Intercept	14.19	226.4 ***	14.217	227.4 ***
Number of observations	3,443		3,443	
R-squared	0.343		0.344	
F-tests for dummies included but not shown				
Ethnicities - F(17, 232)	1.5		1.4	
- p-value	0.10		0.13	
Regions - F(21, 228)	8.6		8.8	
- p-value	0.00		0.00	

[a] z-values based on robust standard errors adjusted for two-stage sampling design; [b] Remoteness defined by travel time to major urban market; * Significant at the 10-percent level; ** significant at the 5-percent level; *** significant at the 1-percent level

Table 3: Reported number of *Fady* Days
Logit Model. (dep. var. = two or more fady days)

Variable	Marg. Effect	z-stat[a]	
Religion dummies (left out = Traditional)			
Catholic	-0.052	-3.72	***
Anglican	-0.052	-4.83	***
Protestant	-0.046	-2.99	***
Lutheran	-0.042	-2.72	***
Other religion	-0.027	-1.49	
Female-headed household (dummy)	-0.031	-2.74	***
Age of household head	-0.001	-1.37	
Number of household members (adult equivalents)	-0.001	-0.44	
HH member with at least secondary educ. (dummy)	-0.035	-1.71	*
Remoteness Quintile[b] (left out = Most remote)			
Q2	0.027	1.13	
Q3	0.011	0.48	
Q4	0.005	0.18	
Least remote	0.029	1.26	
Ethnicity dummies (18)	yes		
Region dummies (21)	yes		
Number of observations	3,443		
F-test for model	9.32		
- p-value	0.00		
F-tests for dummies included but not shown			
Ethnicities - F(17, 232)	0.9		
- p-value	0.61		
Regions - F(21, 228)	5.7		
- p-value	0.00		

[a] z-values based on robust standard errors adjusted for two-stage sampling design; [b] Remoteness defined by travel time to major urban market; * Significant at the 10-percent level; ** significant at the 5-percent level; *** significant at the 1-percent level

Table 4: IV Regression on consumption expenditures
(dep. var. = log(per capita consumption expenditures))

Variable	Model 1 Coef.	Model 1 z-stat	Model 2 Coef.	Model 2 z-stat
Number of *fady* days	-0.474	-3.07 ***		
Non-self village mean *fady* days			-1.007	-3.05 ***
Total land holdings (log hectares)	0.066	7.22 ***	0.064	6.54 ***
Female-headed household (dummy)	0.134	4.39 ***	0.077	2.56 **
Age of household head	0.003	3.73 ***	0.002	1.91 *
Number of household members (adult equivalents)	-0.127	-26.0 ***	-0.128	-25.9 ***
HH member with at least secondary educ. (dummy)	0.116	3.03 ***	0.100	2.44 **
Remoteness Quintile[b] (omitted = Most remote)				
Q2	-0.106	-2.88 ***	-0.090	-2.51 **
Q3	-0.073	-2.00 **	-0.024	-0.56
Q4	-0.054	-1.50	-0.009	-0.20
Least remote	0.080	1.87 *	0.114	2.40 **
Ethnicity dummies (18)	yes		yes	
Region dummies (21)	yes		yes	
Intercept	14.203	183.4 ***	14.372	127.8 ***
Number of observations	3,443		3,443	
R-squared	0.220		0.215	
F-tests for dummies included but not shown				
Ethnicities - F(17, 232)	1.2		1.0	
- p-value	0.27		0.45	
Regions - F(21, 228)	8.0		4.7	
- p-value	0.00		0.00	
z-value for test of excluded instrument[c]	5.0		4.9	

[a] z-values based on robust standard errors adjusted for two-stage sampling design; [b] Remoteness defined by travel time to major urban market; [c] Instrument is traditional religion dummy; * Significant at the 10-percent level; ** significant at the 5-percent level; *** significant at the 1-percent level

Table 5: Regression analysis on rice production
(dep. var. = log(production of paddy in kgs))

Variable	Model 1 Coef.	Model 1 z-stat[a]	Model 2 Coef.	Model 2 z-stat	Model 3: IV[b] Coef.	Model 3: IV[b] z-stat	Model 4: IV[b] Coef.	Model 4: IV[b] z-stat
Number of *fady* days	-0.053	-2.44 **			-0.274	-2.09 **		
Non-self village mean *fady* days			-0.141	-2.59 ***			-0.520	-2.09 **
Plot size (log hectares)	0.592	36.46 ***	0.594	36.73 ***	0.589	36.49 ***	0.597	36.69 ***
Female-headed household (dummy)	-0.007	-0.20	-0.002	-0.05	0.025	0.67	-0.001	-0.03
Age of household head	0.001	1.22	0.001	1.09	0.001	1.44	0.001	0.93
Number of household members (adult equivalents)	0.018	2.7 ***	0.018	2.7 ***	0.015	2.6 **	0.015	2.6 ***
HH member with at least secondary educ. (dummy)	0.148	3.00 ***	0.142	2.84 ***	0.132	2.53 **	0.115	2.08 **
Remoteness Quintile[c] (omitted = Most remote)								
Q2	0.108	2.01 **	0.125	2.31 **	0.113	2.03 **	0.173	2.67 ***
Q3	0.006	0.11	0.026	0.46	0.012	0.20	0.084	1.15
Q4	-0.027	-0.45	-0.009	-0.15	-0.013	-0.21	0.050	0.70
Least remote	0.003	0.04	0.020	0.29	0.035	0.48	0.088	1.04
Topography, soil and slope dummies (12)	yes		yes		yes		yes	
Region dummies (21)	yes		yes		yes		yes	
Intercept	6.57	56.4 ***	6.578	56.2 ***	6.619	55.0 ***	6.655	52.7 ***
Number of observations	3,418		3,418		3,418		3,418	
R-squared	0.662		0.663		0.661		0.663	
F-tests for dummies included but not shown								
Topography, soil & slope - F(12, 137)	2.0		2.0		2.0		2.0	
- p-value	0.03		0.03		0.03		0.03	
Regions - F(21, 130)	10.4		10.8		10.9		11.1	
- p-value	0.00		0.00		0.00		0.00	
z-value for test of excluded instrument					6.7		8.3	

[a] z-values based on robust standard errors adjusted for two-stage sampling design; [b] Instrument is traditional religion dummy; [c] Remoteness defined by travel time to major urban market; * Significant at the 10-percent level; ** significant at the 5-percent level; *** significant at the 1-percent level

Table 6: Regression analysis of Family Labor Use on Rice Fields
Village Fixed Effects Logit

Variable	Marginal Effect[a]	z-stat[b]
Interaction - Village *fady* days * HH size per *are*[c] of land	0.08	1.74 *
Interaction - Village *fady* days * HH member w/ at least secondary educ	0.09	2.03 **
Interaction - Village *fady* days * Migrant household	0.04	0.70
HH size (adult equiv) per *are* of land	0.03	0.26
HH member w/ at least secondary education (dummy)	-0.10	-2.47 **
Household migrated within past 5 years (dummy)	-0.09	-1.73 *
Plot size (log hectares)	0.08	4.75 ***
Female-headed household (dummy)	0.01	0.18
Age of household head	-0.001	-1.44
Number of household members (adult equivalents)	0.02	2.65 ***
Topography, soil and slope dummies (12)	yes	
Number of observations	3,418	
LR ($chi^2(22)$)	125.5	
Chi^2 test for soil dummies included but not shown ($chi^2(12)$)	65.4	

[a] Marginal effects for interaction terms are with respect to a change in fady days; [b] z-values based on robust standard errors adjusted for two-stage sampling design; [c] The conversion is 100 *are* per hectare; * Significant at the 10-percent level; ** significant at the 5-percent level; *** significant at the 1-percent level

Table 7: Partial Change in the probability of family labor use for a one-day increase in *fady* days

Number of adult equivalents per *are* [a] of land	Average Interaction Effect	z-stat
0.25	0.02	1.68 *
0.5	0.04	1.71 *
1.0	0.07	1.69 *
1.5	0.12	1.69 *
2.0	0.16	1.71 *

[a] The conversion is 100 are per hectare

Table A1: Descriptive Statistics for Agricultural Households

Variable	unit	total	Standard deviation
Household migrated within past 5 years	% of hh	2.80	
Female-headed household	% of hh	11.9	
Age head of household	mean	43.8	12.7
Household size			
Number of adult equivalents	mean	5.5	2.3
Number of adult equivalents per *are* of land	mean	0.66	1.26
HH member w/ at least secondary education	% of hh	25.4	
Ethnic group of household head			
Antakarana	% of hh	1	
Antambahoaka	% of hh	<1	
Antandroy	% of hh	8	
Antanosy	% of hh	2	
Antefasy	% of hh	<1	
Antemoro	% of hh	4	
Antesaka	% of hh	4	
Bara	% of hh	2	
Betsileo	% of hh	16	
Betsimisaraka	% of hh	13	
Bezanozano	% of hh	<1	
Comoriana	% of hh	<1	
Mahafaly	% of hh	3	
Merina	% of hh	26	
Sakalava	% of hh	5	
Sihanaka	% of hh	3	
Sinoa	% of hh	<1	
Tanala	% of hh	3	
Tsimihety	% of hh	8	
Vezo	% of hh	<1	
Other ethnic group	% of hh	1	
Religion of household head			
Traditional	% of hh	19.2	
Catholic	% of hh	35.0	
Anglican	% of hh	1.9	
Protestant	% of hh	19.7	
Lutheran	% of hh	11.5	
Other religion	% of hh	12.8	
Number of observations		3,443	

Table A2: Descriptive statistics at the rice plot level

Variable	unit	total	Standard deviation
Family labor used on plot	% of plots	73.0	
Plot ownership			
Owned by HH	% of plots	92.3	
Sharecropped	% of plots	2.0	
Rented or gifted	% of plots	5.8	
Physical characteristics			
Plot size (hectares)	mean	0.52	1.73
	median	0.25	
Topographic situation			
Ricefields lowland	% of plots	62.1	
Ricefields at bottom of hill	% of plots	19.2	
Ricefields in terras	% of plots	8.2	
Upland at bottom of hill	% of plots	3.5	
Upland middle of the hill	% of plots	5.1	
Upland top of the hill	% of plots	1.9	
Soil type			
Sand	% of plots	11.1	
Clay	% of plots	52.6	
Mud	% of plots	22.0	
Other	% of plots	10.0	
Do not know	% of plots	4.2	
Slope			
Very flat	% of plots	59.6	
Flat	% of plots	27.5	
Sloped	% of plots	10.5	
Very sloped	% of plots	2.4	
Number of observations		3,418	