Is Land Titling in Sub-Saharan Africa Cost-Effective? Evidence from Madagascar

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Formalizing land rights has been promoted as a way to encourage agricultural invest-
ment and stimulate land markets, yet little is known about the benefits of such policies
in Sub-Saharan Africa, where the preconditions for success are less favorable. The
analysis uses a large sample of plots from an intensively titled rice-growing area of
Madagascar and compares land-specific investments, land productivity, and land
values for titled and untitled plots cultivated by the same household. Having a title
has no significant effect on plot-specific investment and correspondingly little effect
on land productivity and land values. These results are broadly consistent with a
simulation of a theoretical model of investment under expropriation risk calibrated to
the same data. A cost–benefit analysis suggests that the current system of formal
titling should not be extended in rural Madagascar and that any new system of land
registration would have to be quite inexpensive to be worthwhile. JEL code: Q15.

Reducing land tenure insecurity is seen as a legitimate role for the state and
often as a cost-effective intervention. Evidence from Asia and Latin America
suggests that formalizing land ownership, through registration and titling, can
deliver large productivity gains. Formalization is particularly attractive where
indigenous tenure systems are weak or absent, where the return on investment
in land is high, and where collateralized lending has taken hold. In most of
Sub-Saharan Africa, however, none of these conditions apply, leading some to
question the wisdom of registering land and widely distributing land titles.[1]

There has been little empirical work on the effects of land rights formaliza-
tion in Sub-Saharan Africa, reflecting the small fraction of farmland there that

1. These well-known arguments are summarized in World Bank (2003), Feder and Nishio (1999),
Firmen-Sellers and Sellers (1999), Bruce and Migot-Adholla (1997), Atwood (1990), and
Migot-Adholla et al. (1991). Migot-Adholla et al. (1991) are among those who point out that
Sub-Saharan Africa lacks the infrastructure, factor market development, and other prerequisites for land
tenure reform to promote agricultural intensification and productivity growth.

is registered and titled. Evidence from Kenya, considered the African test case for tenure reform, shows little if any economic impact of land registration (Place and Migot-Adholla 1998; Carter et al. 1997). A larger literature exists on customary land rights in Africa (see, for example, Besley 1995; Gavian and Fafchamps 1996; Brasselle et al. 2002), but it is concerned mainly with the economic response to greater tenure security. This article focuses on the potential benefits of a land titling program. Land tenure reform will not necessarily succeed even if greater tenure security leads to large increases in investment and land productivity. The reform must, first of all, reduce insecurity. However, introducing or expanding a modern property rights regime alongside an indigenous tenure system is not guaranteed to reduce insecurity, or to reduce it by much, and could even have the opposite effect.

Indigenous tenure, through a set of well understood and respected rules governing land use and transfer within the community, imparts a certain degree of tenure security and could thus render land titling largely redundant. Indeed, establishing a modern property rights system without legally recognizing informal rights may expand the scope for rent-seeking, thus creating additional insecurity (Atwood 1990). Such tenure uncertainty can in turn create demand for formalization where previously none existed. According to Bruce et al. (1997, p. 259): "Much of the titling demand for smallholders in Africa can be viewed as 'preemptive'—representing an attempt to prevent the state from allocating the land to someone else, rather than the expression of a felt need for new operating rules of tenure." Land registration and titling, in other words, become privately valuable even while these institutions, in the broader sense, might be socially wasteful.

With these considerations in the background, this study estimates the private benefits of land titles in Madagascar, a country where modern and informal tenure systems coexist and overlap to a considerable extent in certain zones. Using a large data set recently collected in an intensively titled area, the Lac Alaotra Basin, the analysis compares economic performance on titled and untitled land. This focus on a long settled, irrigated, and relatively productive rice-growing area contrasts with much of the work on African customary tenure, which examines investments in tree crops. While this means that the conclusions may not generalize to tree-growing regions or to areas of recent settlement, they should be relevant to much of the continent's agriculture.

Institutionally, Madagascar also shares salient features with many other African countries. Although local communities have found ways of legitimizing land transfer and ownership, such institutions offer little safeguard against attempts at expropriation by powerful outsiders, rare though these may be.[2] To ballpark the empirical magnitudes of the titling effects that one might

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2. To be sure, there are settings with high expropriation risk in Africa. In Ethiopia, which has a history of institutionalized land redistribution, Deininger and Jin (2006) find a strong impact of land rights on investment.

expect to find in such a setting, simulations are presented from a simple model of investment subject to expropriation risk. The emphasis on potential land expropriation is further motivated by the low level of financial intermediation found in rural Madagascar, another commonality with much of Sub-Saharan Africa. While limited collateralized lending does exist in Lac Alaotra, evidence summarized later shows that formal credit is unresponsive to land titling. Credit, therefore, is unlikely to be a major channel for land titling to enhance investment.

A key empirical concern in any study of this type is endogenous take-up of land titles. Elsewhere, this problem has been dealt with by comparing areas where titles are available to those where they are not. For example, the landmark study of Feder et al. (1988) in Thailand constructs a comparison group for farmers with titled land from among farmers cultivating plots in adjacent state forest reserves, in which titles cannot be legally issued. A similar methodology is adopted here by comparing titled and untitled plots in a very restricted geographical area, within which differences in infrastructure, market development, returns to land-specific investment, and soil fertility should be minimal. In addition, the data allow comparison between titled and untitled plots cultivated by the same household, thus eliminating selection bias at the farmer level. Such selection bias may be particularly salient in the case of investment, which depends on farmer-level attributes that are difficult to observe, such as entrepreneurial ability and wealth; these attributes may also affect the decision to pursue land titling in the first place.[3]

Section I describes the setting and data used in the study, focusing on the relationship between formal and informal property rights in land. Section II presents arguments for why land titling might be beneficial and assesses their relevance in rural Madagascar. Section III develops the empirical estimates of the impacts of land titles on land-specific investment, land productivity, and land values. Section IV lays out the implications of the findings for land policy in Madagascar and Sub-Saharan Africa more broadly.

I. Setting and Background

Lac Alaotra is the principal rice-growing region of Madagascar, a country where rice is the main staple food and is cultivated by almost every rural household. The Lac Alaotra basin encompasses nearly 30,000 hectares of rice land under modern irrigation, lying within four vast irrigated perimeters along the lakeshore, and another 72,000 hectares of lowlands under traditional forms of irrigation. The large irrigated perimeters, called *mailles* (French for "mesh," evoking the crisscrossing irrigation canals), were carved out of marshland beginning in the 1950s under the French colonial administration. Dams and canals were built to control water flows, thus limiting periodic floods and allowing a reliable supply of irrigation. Rice yields have been much higher

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3. Deininger and Chamorro (2004) follow a similar household fixed-effects strategy in their study of Nicaragua, but only for land values, not for investment.

within the *mailles* than on adjacent lands. By international standards, though, rice productivity in Lac Alaotra and throughout Madagascar is low, as the green revolution has largely bypassed Sub-Saharan Africa.

Most land within the irrigated perimeters of Lac Alaotra was claimed by French settlers until Independence in 1960, when the zones of colonization were abolished and land ownership reverted to the state. Under the new law peasants occupying land could obtain formal title just as the colonists had. The old titling system, based on the Torrens model, in which the state guarantees ownership (so that the rights to the property cannot be challenged in court), lived on in the post-Independence era. However, the formal titling procedure, better suited to large tracts of highly productive farmland than to the typically small Malagasy plot, was (and is) complex and costly, involving 24 steps and taking years to complete.

When the Malagasy administration took over management of the *mailles* in 1961 through the state Development Agency for the Lac Alaotra Region (SOMALAC), it began to redistribute land among current occupants as well as newcomers. Tenants conforming to SOMALAC's by-laws were eventually to receive formal title to the reconfigured parcels. Farmers with land in the *mailles* first had to pay a "maintenance" fee entitling them to a certificate of occupation. Though only a first step toward formal title, having this document significantly lowered the barriers to a title application.[4]

Despite the attention paid to formalizing land ownership within this special zone, a large share of *maille* parcels still have no titles to this day. There are many reasons for this, not least of them lack of resources and capacity in the office of land administration. Other cases have more to do with the determination of the landowners themselves. Farmers frequently failed to pay the maintenance fee, thus blocking progress toward a title. Sometimes, the originally designated owner died during the lengthy titling process, and the heirs could not agree on a single representative to take over, or they were late in obtaining the necessary documentation for the inheritance. Often titles were abandoned after the parcel was divided or sold in a manner contrary to SOMALAC's by-laws (CIRAD 2004).

The upshot is that the Lac Alaotra Basin not only contains some of the country's most productive rice land but is also perhaps the most intensively titled area of rural Madagascar. Importantly, though, not all land within the *mailles* is titled and not all land outside the *mailles* is untitled. This makes it possible to distinguish empirically between the effects of having titles and the effects of simply having land within the *mailles*.

Data and Sampling

A specially designed survey covering more than 1,700 households in 38 communes was conducted around Lac Alaotra in April–May 2005. About 900

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4. Another advantage was that SOMALAC undertook the cartography for all *maille* parcels, work that would otherwise have had to be done by the understaffed land administration. With the dissolution of SOMALAC in 1991, its role in facilitating land titling ended abruptly.

landowning households were randomly selected from 29 communes lying wholly outside the irrigated perimeters. In order to oversample households with titled land, about 800 households were randomly selected from the nine communes encompassing the *mailles*.

The survey asked about land documentation, agricultural production, and investment for all household parcels—lowland (*riziere*), upland, and forest plots. There is a clear distinction between these types of land in Madagascar. Although rice may occasionally be cultivated on upland plots, lowland plots are used exclusively for growing rice during the main (wet) season and are virtually never converted to alternative agricultural uses. The focus here is exclusively on lowland plots, by far the most valuable type. Thus, the sample consists of 3,232 rice plots owned by 1,604 households. Descriptive statistics at the plot and the household level are shown in tables S1 and S2 of the supplemental appendix (available at http://wber.oxfordjournals.org/).

Analysis confirms the two observations made above regarding rice land within the *mailles*. First, an unusually high proportion of the land is titled (table 1). Whether the land is considered by plot or by area, farmers have formal title to about half of the land in the *mailles*, some four to six times higher than outside the *maille* where the prevalence of titled land is just above the national figure of around 7 percent of area. Second, land within the *mailles* is considerably more productive than land outside; rice yield (for the 2004 crop), revenue from rice (net of purchased input costs), and estimated plot values are all around 40 percent higher for *maille* plots.[5]

The extent to which this greater productivity is due to the higher rate of titling in the *mailles* is addressed in detail in section III. For now, a cursory answer is provided in figure 1, which illustrates the estimated densities of log plot value per hectare by *mailles* location and title status. The dominant feature is the shift of the entire distribution of land values between *mailles* and non-*mailles* plots. Within each location, however, the distributions for titled and untitled plots are virtually indistinguishable. Whether this conclusion holds up when other factors are controlled for remains to be seen, but the preliminary evidence suggests that titling effects are subtle, at best.

Informal Tenure in Madagascar

Data from the Lac Alaotra region, summarized in table 2, reveal a rich tapestry of land documents of varying degrees of formality, the so-called *petits papiers*, or "little documents." In most cases these documents appear to exist independently of the formal titling status of the plot. In the table, titles in the name of a current household member or relative are referred to as "up to date" and

5. Productivity also varies across the four large perimeters, but not nearly as much as between *maille* and non-*maille* plots. Average yield, for example, ranges between 3.1 and 3.6 tons per hectare within the four *mailles*. The coefficient of variation of yield, revenue, and plot value inside the *mailles* are all 60–70 percent as large as they are outside, probably reflecting the fact that land quality, including quality of irrigation, is more uniform within the modern irrigated perimeters.

TABLE 1. Descriptive Statistics for Rice Plots

| | Titled (%) | | Plot-specific productivity | | | | | |
| | | | Yield (metric tons per hectare) | | Net revenue per hectare (US$) | | Value per hectare (US$) | |
Plot type	Share of plots	Share of area	Median	Mean	Median	Mean	Median	Mean
Maille plot[a]	51	53	3.47	3.31(1.16)	670	655(261)	1,300	1325(527)
Non-*maille* plot	8	12	2.24	2.32(1.39)	446	466(303)	800	918(519)
All plots	27	34	3.00	2.77(1.38)	574	552(299)	1,000	1102(560)

| | Plot-specific investment | | | | | | | |
| | Irrigation /drainage canal | | Protective bunds | | Land leveling | | All investments | |
Plot type	Share of plots (%)	Mean	Share of plots (%)	Mean	Share of plots (%)	Mean	Share of plots (%)	Mean
Maille plot[a]	91	17(38)	46	12(76)	18	10(85)	94	39(188)
Non-*maille* plot	75	25(47)	40	15(41)	32	16(54)	85	56(102)
All plots	82	21(44)	43	13(60)	25	13(70)	89	48(147)

Note: Numbers in parentheses are standard deviations. Yields, revenues, and investment data are for main season rice crop and are based on about 2,800 owner-cultivated plots. The sample for the titling and plot value figures includes rented out and uncultivated plots (2 percent of total), but value excludes the 8 percent of plots with missing data, leaving a total of 2,961 plots.

[a]Plot located within a modern irrigated perimeter (45 percent of sampled rice plots).

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

FIGURE 1. Plot Value by Location and Title Status
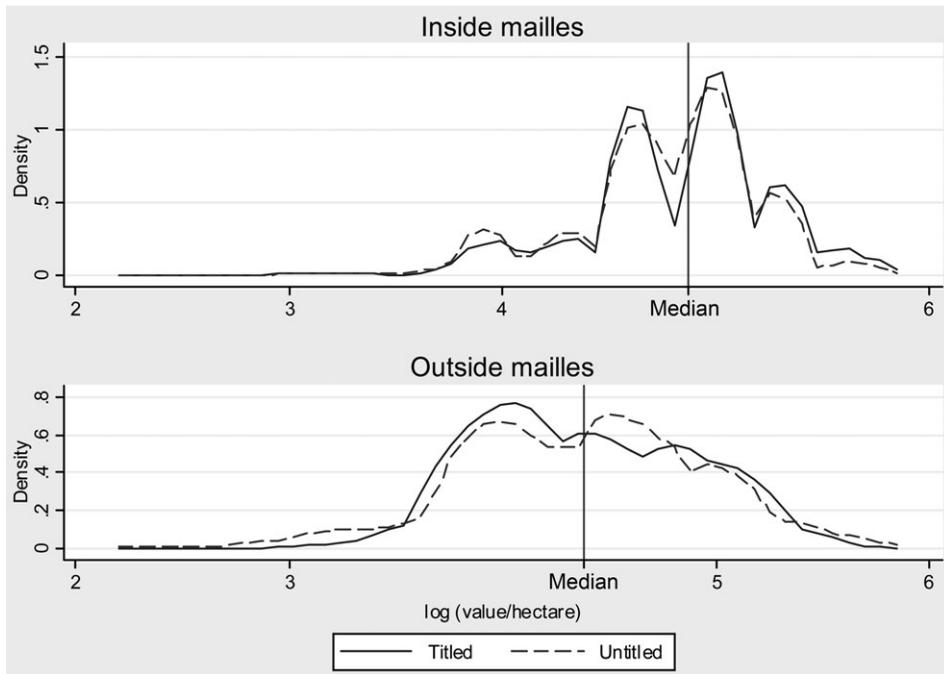
Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

those in the name of a deceased person as "out of date." Overall, 42 percent of titled plots are in the out-of-date category, reflecting both the costliness of the procedure for recording land transactions and inheritances as well as resource constraints in the land administration bureaucracy.

Regarding purchased plots, which account for more than 40 percent of the total,[6] the vast majority of land sales are accompanied by a sales receipt, usually handwritten (*acte de vente*). In most cases, this document is signed by the village (*fokontany*) head in front of the parties to the transactions and possibly other witnesses—it is thus "certified." The main purpose of such a procedure seems to be to assure the buyer that, in the eyes of the community, the plot actually belongs to the seller and, moreover, has not already been sold to someone else. It is perhaps not surprising, then, that transactions among close relative are somewhat less likely to involve these receipts and substantially less likely to be certified by the village head (see table 2). In acknowledging that a proper land transaction took place, an *acte de vente* can also subsequently

6. Lac Alaotra is notable for the extent of land market activity. Nationally, only about 13 percent of lowland plots in rural areas are purchased (according to the EPM 2001 national household survey). Also, one-quarter of cultivated plots in the sample are leased, compared with the national figures of 10 percent.

TABLE 2. Land Documentation for Rice Plots, by Mode of Acquisition (percent)

Mode of acquisition and documentation[a]	Share of plots	Share of plots with document			
		Titled[b]			
		Up-to-date	Out-of-date	Untitled	All
Purchased from close relative	11	**8**	**6**	**85**	**100**
Acte de vente		93	91	91	91
Certified *acte de vente*		74	86	74	75
Acte de donation		39	17	16	18
Purchased from distant relative, neighbor, stranger	30	**11**	**6**	**83**	**100**
Acte de vente		98	98	96	96
Certified *acte de vente*		91	87	89	89
Acte de donation		38	18	17	20
Inherited	42	**15**	**20**	**65**	**100**
Acte de patrimoine		50	70	59	60
Acte de notorité		52	71	55	58
Acte de donation		34	21	23	24
At least one of three above		57	77	60	63
Cleared by owner	7	**9**	**0**	**91**	**100**
Authorization for clearing		45	—	28	30
SOMALAC[c]	10	**44**	**5**	**51**	**100**
Acte d'attribution		—	—	85	—
All plots	100	**16**	**11**	**73**	**100**

—, is not applicable.

Note: Figures in bold are row percentages for titled status by mode of acquisition.

[a]See text for description of the documentation listed in table.

[b]"Up to date" refers to titles in the name of a current household member; "out of date" refers to titles in the name of a deceased person.

[c]Development Agency for the Lac Alaotra Region, the state land administration agency for the *mailles.*

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

serve as proof of ownership. Indeed, among the few land sales reported in the data over the past 10 years involving previously purchased plots, most mention the original *acte de vente* as the main proof of ownership.

There are several other *petits papiers* listed in table 2, depending on the mode of plot acquisition. An *acte de donation*, issued by the commune, indicates that a specific person has transferred a well-demarcated parcel of land to another person, either through purchase or inheritance; in both cases, this document is uncommon. Inherited land is generally less well documented than is purchased land, with only two-thirds of inherited rice plots having any kind of paper (most commonly an *acte de patrimoine*, itemizing the estate of the deceased, and an *acte de notorité*, certifying the heirs). For about a third of the lowland plots that were originally cleared by the current owner (virtually all

outside the *mailles*), the owner obtained advance written authorization for the exploitation. Legally, in such cases, one can apply for title based on the principle of *mise en valeur* (improvement) if one can establish occupancy for at least 10 years. Finally, 10 percent of rice plots in the sample were acquired directly from SOMALAC as part of the land redistribution in the 1960s and early 1970s. The owners of most of these plots that remain untitled report having an *acte d'attribution*, a certificate of occupation issued by SOMALAC. After so many years, however, the titling process in these cases is for all intents and purposes moribund.

Since, unlike the case of many other African countries, Madagascar land law does not recognize customary tenure, none of the aforementioned documents has the same juridical standing as a formal title. Nonetheless, they may provide farmers with a considerable sense of tenure security.

Investment in Rice Land

Land-specific investment comes in three basic varieties: initial clearing of land to make it cultivable, installation of new infrastructure, and maintenance of existing infrastructure. The scope for the first type of investment depends on the extent of unexploited lowlands. Since the region around Lac Alaotra has a long history of settlement, there is now little land left to clear for irrigated rice cultivation. Only 7 percent of rice plots were acquired through clearing by the current owner, and few of these plots were cleared recently (less than 20 percent of them after 1990; see table 2).

As for plot infrastructure, the survey collects detailed data on all investments in land over the past five years on owned plots, including cash costs and family labor inputs. There are three dominant types of investment in lowland rice plots, which are, in order of importance, the construction/maintenance of irrigation/drainage canals, the construction/maintenance of protective bunds, and land leveling (see table 1). Other investments (installation of wells, tree-planting, terracing) are virtually unheard of for rice plots in Lac Alaotra. Investments related to water management (canals) are more prevalent within the modern irrigated perimeters, whereas land leveling is more common outside the *mailles*, where plots are more prone to sedimentation.

Overall, total annualized investment expenditures (valuing family labor days at the local wage) over the past five years average only about 1 percent of plot value. Such relatively low expenditures and their high frequency suggest that investments are largely for maintenance of existing plot infrastructure. There are other indications that the vast bulk of investment in rice land is recurrent. For 92 percent of the cases of canal work, 91 percent of bund work, and 87 percent of land leveling (almost by definition a maintenance activity on existing rice plots) the investment was reported to have already existed on the plot five years before and thus was not being made for the first time only in the last five years.

II. ECONOMIC BENEFITS OF LAND TITLES IN MADAGASCAR

Land titling can increase investment in land, agricultural productivity, and land values in three ways, which Brasselle et al. (2002) term the *assurance*, *realizability*, and *collateralizability* effects. The assurance effect arises insofar as titling reduces the risk of land expropriation. As the expected length of tenure increases, improving or maintaining one's land becomes more attractive. While the assurance effect is the focus of this section, the relevance of the other titling effects in rural Madagascar is considered later.

The Assurance Effect and the Social Value of Titling

For 37 percent of untitled plots in Lac Alaotra the owner either currently has a title demand pending or intends to make one in the future, albeit not necessarily with an awareness of the full costs involved. What underlies this apparently strong latent demand for titling? The evidence suggests that a formal land title provides a virtually ironclad ownership guarantee, despite Madagascar's weak legal system. Ninety percent of farmers questioned in the survey see protection against competing claimants as the chief benefit of a title. Another 6 percent said that a title mainly facilitates bequests of land to children, which, arguably, amounts to the same thing insofar as the inheritance of a titled plot is harder to challenge.

Notwithstanding these expressions of demand for tenure security, the actual risk of land expropriation does not appear to be high. When asked whether they had heard of cases of households having lost land because they lacked proper documentation, 91 percent responded rarely or never. Most (69 percent) of those who had heard of such cases identified large landowners or powerful individuals as the instigators of the conflict. Such responses reflect an underlying perception of rent-seeking and corruption in the land administration office that often emerges in field interviews. The principal fear is that influence could be used within the land administration office to have false titles issued.

As indicated earlier, a large fraction of land titles in Madagascar are in the name of a deceased person. Do such out-of-date titles have any value? While this is ultimately an empirical question, there is good reason to believe that, with regard to expropriation of the sort just discussed, an out-of-date title still confers considerable protection. First, in most cases of inheritance, the title will bear the same family name as that of the current owner. Second, the issuance of the title, even if many years in the past, implies that the parcel is part of the title deed registry and its boundaries and title number appear in the cadastral record at the land administration office. Consequently, it would be extremely difficult to have a new title issued for land incorporating a previously titled parcel, even one subsequently subdivided among several co-inheritors. Certainly, it would be far easier to exploit the modern titling system to nullify an informal ownership claim than a formal one.

If farmer opinion is any indication, the main channel for titling to have an economic impact in the Lac Alaotra region is through the assurance effect.[7] However, even if these economic impacts turn out to be large, the fact that landowners demand titles in an area already exposed to titling does not imply that introducing a land titling program into a previously untitled area is a good idea. That depends on the extent to which the modern system of title deeds creates additional tenure insecurity on land remaining outside its umbrella. The larger the externality imposed on those with informal tenure and the more difficult it is to make titling universal, the more likely it is that a land titling initiative will entail a net social cost.

Quantifying the Impact of Expropriation Risk

If most land-specific investment in Madagascar rice land is indeed for plot maintenance, as the data suggest, then the quantitative importance of the assurance effect of land titles can be assessed a priori. Consider the simple model of recurrent investment in land subject to expropriation risk used by Jacoby et al. (2002). Let the instantaneous (annualized) probability of losing one's plot, θ, be constant over time. The private value of the plot is then $\pi/(r + \theta)$, where π is net revenue per hectare (net of recurrent investment costs) and r is the annual discount rate.[8] Recurrent investment, the stock of capital, and net revenue are all decreasing in θ. Obtaining legal title to a plot, to the extent that it lowers the threat of expropriation, raises land values both by increasing steady-state investment, thus raising land productivity, and by lowering the effective discount rate, $r + \theta$. Thus land titles are valuable to farmers even if they do not appreciably enhance investment in land.

What magnitude of expropriation risk would have to be present to obtain an empirically detectable effect of land titling on recurrent investment and on land values? Assume that output per hectare is produced according to the function $k^{1-\alpha}/(1 - \alpha)$, where k is the stock of plot infrastructure and $\alpha \in (0,1)$. Suppose further that granting a formal title reduces expropriation risk from θ to 0. Under these assumptions, the ratio of investment expenditures on titled land to that on untitled land is independent of the unit cost of investment and takes the simple form $[1 + \theta/(r + \delta)]^{1/\alpha}$, where δ is the depreciation rate on infrastructure. The analogous ratio for land values, which is

7. Atwood (1990) argues that land titles can also *create* insecurity and conflict within a community. Evidence of conflicts in the Lac Alaotra data is quite rare, involving only 3 percent of owned rice plots; this figure encompasses the entire ownership period and falls to just 1.4 percent for conflicts over the past five years. There is some evidence that conflicts are more prevalent on titled plots than on untitled plots, other things being equal, but the number of conflicts in the data set is simply too small to inspire much confidence in this finding.

8. Specifically, the farmers problem is to maximize $\int_0^\infty e^{-(r+\theta)t}\pi(k(t))dt$, subject to $\dot{k}(t) = -\delta k(t) + x(t)$, where $\pi = F(k(t)) - cx(t)$, F is the production function with unit output price, k is the capital stock, c is the unit cost of recurrent investment, x is the flow of recurrent investment, and δ is the rate of depreciation.

an overall measure of the benefits of a title, is also given by a simple formula.[9] Both of these ratios are easily calculated for different configurations of the parameters $\{r, \delta, \theta, \alpha\}$.

For the discount rate, let $r = 0.1$ throughout the simulation exercise. Since plot infrastructure, such as canals and bunds, can quickly silt up or erode without continual maintenance, both a high and low depreciation rate are considered. If three-quarters of the capital stock depreciates in five years, then δ solves $e^{-5\delta} = 0.25$, or $\delta = 0.28$. If only a quarter of the capital stock depreciates within this time, then $\delta = 0.06$. These are the two values used in the simulations in table 3.

Absent any informed guess at a value for α, the model is calibrated against the data using the ratio of annualized investment expenditures to plot value. The model delivers the expression $\delta(1 - \alpha)(r + \theta)/(r + \theta + \delta\alpha)$ for this ratio. The calibrated percentages at different parameter values are shown in the top panel of table 3, and these can be compared to the actual figure of 1.2 percent. For $\delta = 0.28$, a value of $\alpha = 0.85$ is most consistent with the investment data, whereas for $\delta = 0.06$, $\alpha = 0.75$ is more appropriate.

The percentage changes in investment expenditures due to titling under alternative choices of α and θ are reported in the middle panel of table 3. For initial expropriation risk on the order of 10 percent, as found in China under an explicit regime of village-level land reallocation (see Jacoby et al. 2002), the investment responses are always large. But the magnitudes fall roughly proportionally with θ. At $\theta = 0.001$ investment expenditures hardly respond at all to land formalization, whichever δ is chosen. The story is more or less the same for land values, although the titling effects are larger than for investment (bottom panel of table 3).

Crude as these calculations may seem, they do suggest that detecting titling assurance effects in a data set of typical size might be difficult. Even a one in a thousand chance of losing a plot in a given year is probably unrealistically large in the environment of rural Madagascar. To put this into perspective, consider that the typical village in the sample has about 300 households, each owning an average of two rice plots (along with two upland plots). A θ of 0.1 percent would imply that around one household per year in a village loses a plot. Yet in the survey, 72 percent of households report never having heard of *anyone* (ever) having lost land due to lack of proper documents, and an additional 19 percent had "rarely" heard of such cases.

The Realizability Effect

Land tenure formalization, insofar as it facilitates land transactions, can also increase land-specific investment through the so-called realizability effect (see

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9. The expression is $((r + \theta)(r + \theta + \delta)^{1/\alpha}(r + \alpha\delta))/(r(r + \delta)^{1/\alpha}(r + \theta + \alpha\delta))$. Notice that, as the depreciation rate approaches zero, the ratio of the value of titled to untitled land approaches $(1 + \theta/r)^{1/\alpha}$. Thus, in this limiting case, recurrent investment falls to zero and is unresponsive to expropriation risk, but titled land is still more valuable than untitled land, with the premium directly related to θ.

TABLE 3. Investment and Land Value Differences Due to Titling

	$\delta = 0.28$			$\delta = 0.06$		
	$\theta = 0.1$	$\theta = 0.01$	$\theta = 0.001$	$\theta = 0.1$	$\theta = 0.01$	$\theta = 0.001$
Calibration: Investment expenditure/value × 100						
$\alpha = 0.50$	8.2	6.2	5.9	2.6	2.3	2.3
$\alpha = 0.75$	3.4	2.4	2.3	1.2	1.1	1.0
$\alpha = 0.85$	1.9	1.3	1.25	0.7	0.6	0.6
Investment expenditure percentage differential of titled compared with untitled						
$\alpha = 0.75$	37	3.5	0.4	91	8.4	0.8
$\alpha = 0.85$	32	3.1	0.3	77	7.4	0.7
Land value percentage differential of titled compared with untitled						
$\alpha = 0.75$	106	10	1.0	126	12	1.1
$\alpha = 0.85$	103	10	1.0	113	11	1.1

Note: Simulated percentage differences with $r = 0.1$ assumed throughout.

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

Besley 1995). Greater transferability of land not only enhances the return on investment, but it also improves allocative efficiency, putting land in the hands of those who value it most. A title is the ultimate proof to the buyer that the land truly belongs to the seller and that no one will later challenge the original owner's right to sell. Furthermore, by relinquishing the title deed to the buyer, the seller provides assurance that the plot has not already been sold to someone else. Buyers, especially outsiders without access to village information networks and lacking familiarity or trust in village institutions, may therefore be willing to pay a premium for titled land, as a sort of transaction insurance.[10] If so, a higher proportion of titles would be expected among purchased plots than among inherited plots.

There is another side of the story, however. Under Madagascar's dysfunctional land administration, updating or transferring a title is expensive, in both money and time, especially if subdivision has occurred since the original deed was issued. Purchasing a titled plot without easily being able to update the name on the document exposes the buyer to the risk that a relative of the seller, sharing the family name, might subsequently claim the plot or challenge the transfer.

More generally, land titles under these circumstances create transaction costs. To illustrate, take the model described previously in which a plot's value is $\pi/(r + \theta)$. Assume that there are a number of potential buyers of the plot, each with a different estimate of its long-run future profitability, π'. When

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10. Farmers in Lac Alaotra were asked whether they had ever heard of cases of the same plot of land having been sold to two different people. Although the vast majority (82 percent) said that such swindles rarely or never happen, they do appear to be somewhat more common than land expropriation.

buyer and seller share the same θ (and r), a sale occurs only if a buyer can be found for whom $\pi' \geq \pi$. Now suppose that the current owner views a titled plot as completely secure, or $\theta = 0$. If titles not bearing the plot owner's family name are seen as providing inferior protection against expropriation and if it is prohibitively costly to transfer title, then potential buyers have $\theta = \theta' > 0$. Since the plot is now sold only if $\pi' \geq \frac{r+\theta'}{r}\pi > \pi$, it follows that the market is more limited for titled land than for untitled land; in particular, purchased plots should be less likely to be titled than inherited plots.

The data indicate that both of these phenomena may be important in Lac Alaotra. On the one hand, inherited plots are about twice as likely to be titled as are purchased plots (35 percent and 17 percent), suggesting that the market for titled land is indeed more limited. On the other hand, titles for purchased plots are more likely to be up-to-date (64 percent) than titles for inherited land (43 percent), a difference that is highly significant in a regression that also controls for year of plot acquisition. This finding reflects the stronger incentives to update titles for purchased plots, which, even if already titled at the time of purchase, do not necessarily bear the buyer's family name.[11]

Finally, titling may enhance the realizability of land-specific investment through leasing. Absent other effective means of property rights protection, a title could provide the landowner with the security necessary to be willing to lease when there is danger of expropriation by tenants. However, in results reported elsewhere (Jacoby and Minten, 2006), there is no evidence that having land with a title influences either the decision to lease out a plot or the duration of the lease. Despite the informality of tenure on the majority of plots, there appears to be little perceived danger of expropriation by squatting tenants. To summarize, land titling as currently practiced in Madagascar is unlikely to enhance investment or land values by facilitating land transactions.

The Collateralizability Effect

In a study of rural Thailand, Feder et al. (1988) argue that institutional lenders prefer titled land as collateral because it is easier to repossess and sell. Farmers squatting in untitled areas are unable to provide such collateral and consequently have fewer funds to buy seasonal inputs, purchase equipment, and make land improvements. In principle, then, titling can broaden access to formal credit and allow existing borrowers to obtain larger loans, resulting in higher investment. As pointed out by Feder and Feeny (1991), the market value of a titled plot should include a premium reflecting the income flow from the additional credit that can be obtained by pledging the

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11. As indicated in table 2, many land purchases are from close relatives, with whom the buyer probably shares a family name. In these cases, titles are less likely to be up-to-date than among titled plots purchased from distant relatives, friends, or strangers (56 percent compared with 66 percent), although this difference is not statistically significant.

land. In practice, however, such effects presuppose the penetration of banks into the business of agricultural lending as well as the existence of a legal framework for mortgaging land, conditions that do not generally prevail in Sub-Saharan Africa.

While institutional lenders play a miniscule role in rural Madagascar as a whole—the nationally representative 2001 household survey (EPM) showed less than 1 percent of cultivating households borrowing from formal sources—the relatively commercialized Lac Alaotra region is exceptional. Among surveyed households, oversampled as they are from the wealthier *maille* areas, 14 percent report taking out a formal sector loan in the past three years. Most of this credit came from institutions run by nongovernmental organizations, which generally demand collateral, though not necessarily in the form of land.

Analyses omitted here for brevity indicate that there is no significant advantage to owning titled land in terms of a household's access to formal credit, after controlling for the household's landholdings within the *mailles* (such land being much more likely to be titled), and titled *plots* are no more likely to be used as collateral for formal loans than are untitled plots of equivalent size, after also controlling for their position in the *mailles* (see Jacoby and Minten 2006). Thus, it does not appear that intensive land titling has opened up institutional credit opportunities for farmers in Lac Alaotra, at least not yet. For this reason, the market value of titled land in Lac Alaotra should not incorporate a significant collateral premium.

III. Impact of Titles on Investment, Productivity, and Value of Land

The empirical strategy can be described with the following regression model

$$y_{ih} = \alpha T_{ih} + \beta' x_{ih} + \eta_h + \varepsilon_{ih}, \tag{1}$$

where y_{ih} is an outcome observed on plot i belonging to household h, T_{ih} is the titling status of the plot, and x_{ih} is a set of plot attributes (and possibly farm characteristics). The error term has a component common to all plots within the same household, η_h, and an idiosyncratic component, ε_{ih}. The first of these components reflects household- or farm-level factors, such as entrepreneurial or farming ability, wealth, access to credit, local land characteristics, and infrastructure, that affect behavior (for example, investment) and its consequences (productivity, land values) on all the household's plots. The second component captures plot-specific aspects of soil fertility or infrastructure that are not included among the vector of observable characteristics, x_{ih}.

For ease of interpretation, each dependent variable is normalized by the mean of y_{ih} taken over all untitled plots (except for land value, which is estimated in logs). In this way, for continuous variables, α estimates the percentage

difference in the mean between titled and untitled plots, whereas for binary variables (investment indicators) it measures the percentage difference in proportions between titled and untitled plots.

The key estimation issue is the endogeneity of the decision to seek title for a particular plot. Titles are costly to obtain, in both time and money, but are viewed as valuable. Both the ability to bear these costs as well as the perceived benefits are likely to vary substantially across households. Holding constant the physical characteristics of the plot, one might expect more entrepreneurial or wealthier households, for instance, to be more willing and able to pursue a title.[12] Thus, T_{ih} is likely to be correlated with η_h, and ordinary least squares (OLS) estimates of α will be biased as a consequence. Under the most plausible scenarios, OLS will overestimate α; unobserved farmer characteristics that enhance the probability of obtaining a title also tend to be positively related to farm productivity and investment. To deal with this problem, household fixed effects are used, eliminating η_h from equation 1. This estimator exploits the fact that most households in the sample own more than one plot and that, in many of those cases, the titling status of the plots varies within the household.

A second endogeneity issue is that the return to titling may be higher on more fertile plots (those with a high ε_{ih}). These plots may also receive greater investment and are certainly more productive. In this case even the household fixed-effects procedure would overestimate α. There is indeed evidence that plots are selected for titling on the basis of observable characteristics, even after accounting for the strong effect of position in the *mailles*. Estimates from a household fixed-effects linear probability model (not reported here) show that larger, less remote, and more reliably irrigated plots are significantly more likely to be titled. Since there is no obvious instrument for T_{ih} (one that varies across plots within the same household), the household fixed-effects estimate of α should be viewed as an upper bound on the true titling effect.

Titles and Investment

The sample for the estimation of recurrent investment decisions consists of 2,652 owner-cultivated rice plots. Plots that are currently leased out are excluded so as not to confound titling effects with the issue of investment disincentives due to leasing (see Jacoby and Mansuri 2006). Also excluded in this and later analyses are lowland plots situated more than a two-hour walk from the respondent's house, unless all of the household's plots are exactly the same walking distance from the house. The rationale for this decision, which eliminates about 5 percent of plots, is that plots that are far away from the house (in different directions) are likely to be far away from each other and thus less

12. For example, wealthier households might have found it easier to pay SOMALAC's maintenance fee that initiated the titling process within the *mailles* before 1991. Despite this possibility, households with land in the *mailles* and with at least one titled plot are not that much wealthier, in terms of observable assets, than those with land in the *mailles* but with no titled plots (see table S2).

comparable in terms of unobservables. In the final estimation sample, 13 percent of the households own plots across which titling status varies; these plots account for 21 percent of the total sample. Given this degree of within-variation, a household fixed-effect procedure should yield reasonably precise estimates.

All of the investment regressions in table 4 include controls for the plot's position in the *mailles*, log of plot area, travel time to domicile, travel time between plot and nearest route passable by zebu cart, soil type, and irrigation (see table S1 in the supplemental appendix for descriptive statistics). A plot-specific irrigation quality index is also constructed. Farmers were asked to rank the availability of water and the frequency of floods, each on a four-point scale. The index is a sum of these rankings, with the highest value indicating that water is always available and floods never occur. It might seem problematic to condition on the nature and quality of the plot's irrigation infrastructure, as this is, after all, a consequence of past investments. The justification for including these irrigation variables is that they reflect public investment, over which the individual farmer has little control. Irrigation infrastructure should, therefore, not be correlated with the same plot-level unobservables that determine private recurrent investment.

Estimation results for binary indicators of investment, overall and by type, in the past five years using a linear probability model, as well as results for per hectare investment expenditures (cash plus imputed labor costs), are given in table 4. All estimations use household fixed effects, as a Hausman test strongly rejects random effects for each investment variable.[13] As expected, the titling coefficients estimated by random effects are uniformly larger than those based on fixed effects, indicating positive bias.[14]

There is little evidence that land titles enhance recurrent investment. None of the titling coefficients for the binary indicators and all but one coefficient for the expenditure variables differ significantly from zero. This is true even though the estimates for the binary investment indicators are, in some cases, quite precise, as indicated by the inverse power function thresholds (see Andrews 1989) reported in table 4. For example, one can be 95 percent confident that, had land titling raised the proportion of plots on which any investment occurred by more than 10.5 percent, the null hypothesis of zero effect would have been rejected. Thus, fairly small impacts can be detected in these data. On the other hand, the corresponding low power threshold indicates that the odds are merely even of detecting true titling effects below 5.3 percent.

13. Using fixed-effects logit instead would drop households without variation in investment across plots. This could reduce precision when also controlling for a number of other plot characteristics.

14. No correction is made for censoring of investment expenditures at zero. This is difficult to do in the fixed-effects model if one wants to obtain marginal effects. Note, however, that for total investment only 11 percent of the observations are censored at zero, a proportion low enough to be safely ignored in the estimation.

TABLE 4. Titles and Recurrent Investment in Land

Independent variable	Irrigation/drainage canal		Protective bunds		Land leveling		All investments	
Any investment								
Titled plot	0.022 (0.038)		0.040 (0.060)		−0.170 (0.121)		−0.030 (0.032)	
Up-to-date title		0.025 (0.042)		0.043 (0.066)		−0.140 (0.133)		−0.020 (0.036)
Out-of-date title		0.017 (0.052)		0.034 (0.082)		−0.230 (0.165)		−0.049 (0.044)
High-power threshold[a]	0.125		0.197		0.398		0.105	
Low-power threshold[b]	0.063		0.099		0.199		0.053	
Investment expenditures per hectare								
Titled plot	−0.023 (0.114)		0.249 (0.188)		0.105 (0.271)		0.090 (0.114)	
Up-to-date title		0.047 (0.125)		0.416** (0.206)		−0.079 (0.297)		0.120 (0.125)
Out-of-date title		−0.165 (0.155)		−0.093 (0.255)		0.483 (0.369)		0.027 (0.154)
High-power threshold[a]	0.375		0.619		0.892		0.375	
Low-power threshold[b]	0.188		0.309		0.446		0.188	

**Significant at the 5 percent level.

Note: Numbers in parentheses are standard errors. All regressions include household fixed effects and the plot characteristics listed in supplemental appendix table S.1 (http://wber.oxfordjournals.org/).

[a]True value of titling effect above which there is 95 percent certainty of rejecting the null hypothesis of zero effect.

[b]True value of titling effect below which there is 50 percent certainty of rejecting the null hypothesis of zero effect.

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

In contrast, power is generally poor for the investment expenditure variables. In particular, one can only be highly certain of detecting titling effects if titling actually increased overall investment expenditures by 38 percent. Despite this, when titles are disaggregated into up-to-date and out-of-date titles, up-to-date titles attract a positive and significant coefficient in the case of protective bunds. This is also the only case where the hypothesis that up-to-date and out-of-date titles have identical effects on investment can be rejected. Given the number of tests performed in table 4, however, this last result may be due to nothing more than random chance.

Titles and Land Productivity

Within the framework developed in section II, the only channel through which land titling can affect land productivity is investment. Assurance, realizability, and collateralizability effects, to the extent that they operate at all on productivity, do so through increased land-specific investment. As just discussed, however, there is no compelling evidence that recurrent investment responds to formalization of land tenure; at least the magnitude of any such response is below the threshold detectable in the data. One reason to examine productivity directly, therefore, is that the data set may fail to capture some relevant land-specific investment or, more plausibly, that investment is measured with considerable error. Productivity data, if sufficiently less noisy, might show titling effects where the investment data did not.

Two measures of land productivity are considered: main season rice yield (gross productivity) and value of main season rice yield net of purchased input costs per hectare (net productivity). Since variable input costs are generally quite small, the two productivity measures are highly correlated. A third measure that nets out annualized recurrent investment expenditures as well could also be considered; this essentially corresponds to π in the conceptual model. However, given the relative unimportance of these investment expenditures, π is almost perfectly correlated with net revenue as conventionally defined, so that only results for net revenue are reported.

The gross and net productivity estimates appear in the first six columns of table 5.[15] Random- and fixed-effects estimates are very close in this case; the titling coefficients, in particular, are statistically indistinguishable. As before, the biggest difference is the estimated precision, with the random-effects standard errors being about 60 percent the size of their fixed-effect counterparts. For this reason, there is a significant impact of titling on yields and net

15. Log of plot area has a negative and highly significant coefficient in all of the productivity regressions. There are two potential explanations for this finding. The first is that smaller rice plots are actually more productive because they are easier to keep level and hence completely submerged during irrigation. The second explanation is "division bias." Specifically, if plot area is measured with error, then there will be a spurious negative correlation between output, revenue, or value per hectare and plot area. It is difficult, though, to come up with instruments that affect plot area but do not influence productivity directly.

revenue only in the former specifications. At any rate, this impact, at about 7 percent, is not large (the *ceteris paribus* productivity effect of having a plot in the *mailles*, by comparison, is on the order of 30 percent), and as argued earlier should be viewed as an upper bound on the true effect.[16] Finally, note from table 5 that productivity impacts do not differ significantly for out-of-date titles.

Titles and Land Values

The land value differential between otherwise identical titled and untitled plots is a comprehensive measure of the private benefit of titles. The value of land incorporates any productivity effect of titling operating through increased land-specific investment, as well as the direct effect of expropriation risk operating through the risk-adjusted discount rate, $r + \theta$. Finally, market values should also reflect the extent to which titled land is easier (or more difficult) to transact.

Titles may be endogenous with respect to land values, but the argument is somewhat different than for the cases of investment and productivity. If reported plot values reflect their true market valuation and all relevant plot characteristics can be controlled for, then OLS should produce unbiased estimates of the titling effect. This may not hold, however, if the land market is segmented. To the extent that the marginal product of land cannot be fully equalized across households, land may be more productive in the hands of wealthier or better farmers, who would thus value it more highly than poorer or less able farmers. At the same time, wealthier farmers may be more willing or able to obtain titles.

The survey asks farmers to estimate the current value of their parcel in total and also on a per hectare basis (in 8 percent of cases, the respondent had no idea of the market value). Because plot values per hectare can be cross-checked against total value divided by plot area, the land value data are generally pretty accurate. Evidence of this is the fact that the standard errors for the log plot value regressions, in the last three columns of table 5, are considerably smaller than those for the corresponding coefficients in the land productivity regressions.[17] There is also much less of a difference

16. When *observed* investment variables (the three binary indicators and total expenditures per hectare) are included in the productivity regressions, there is only a minor attenuation of the titling coefficients (see Jacoby and Minten 2006). This is not surprising given the lack of relationship between investments and titling already noted.

17. The land value regression is run in logarithms because this transformation provides a better fit to the data than a linear model. Such was not the case for yields and net revenues. The set of controls is also slightly different across the two cases. Household asset variables are not included in the random-effects specification for land values since the total value of land itself is a major component of these assets. Distance of the plot to the domicile is also excluded from the land value regressions on the grounds that the market value of a plot should not depend on its distance to any particular house.

TABLE 5. Titles, Land Productivity, and Land Values

Independent variable	Yield			Net revenue per hectare			Log value per hectare		
	1	2	3	1	2	3	1	2	3
Titled plot	0.072**	0.059		0.069**	0.062		0.041**	0.056**	
	(0.025)	(0.042)		(0.027)	(0.046)		(0.020)	(0.024)	
Up-to-date titled plot			0.056			0.058			0.051
			(0.046)			(0.051)			(0.026)
Out-of-date title plot			0.065			0.070			0.066**
			(0.057)			(0.063)			(0.032)
Plot in *mailles*	0.325**	0.292**	0.291**	0.318**	0.289**	0.289**	0.371**	0.340**	0.340**
	(0.025)	(0.042)	(0.042)	(0.028)	(0.046)	(0.046)	(0.020)	(0.024)	(0.024)
Log plot area	−0.097**	−0.080**	−0.079**	−0.097**	−0.080**	−0.080**	−0.034**	−0.042**	−0.042**
	(0.012)	(0.016)	(0.016)	(0.013)	(0.018)	(0.018)	(0.008)	(0.009)	(0.009)
Log travel time to nearest zebu cart route	−0.003	−0.013	−0.013	−0.002	−0.017**	−0.017**	−0.010**	−0.011**	−0.011**
	(0.005)	(0.008)	(0.008)	(0.005)	(0.009)	(0.009)	(0.004)	(0.004)	(0.004)
Log travel time to home	−0.036**	−0.038**	−0.038**	−0.036**	−0.035**	−0.036**			
	(0.009)	(0.014)	(0.014)	(0.010)	(0.015)	(0.015)			
No irrigation (rainfed)	0.031	0.021	0.021	0.025	0.053	0.054	0.056	−0.019	−0.019
	(0.054)	(0.087)	(0.087)	(0.060)	(0.095)	(0.095)	(0.040)	(0.047)	(0.047)
Irrigated by river	0.091	0.166	0.167	0.098	0.186	0.187	0.157**	0.126**	0.126**
	(0.060)	(0.103)	(0.103)	(0.067)	(0.113)	(0.113)	(0.047)	(0.056)	(0.056)
Quality of irrigation index	0.036**	0.046**	0.046**	0.036**	0.051**	0.052**	0.042**	0.035**	0.035**
	(0.009)	(0.015)	(0.015)	(0.010)	(0.017)	(0.017)	(0.007)	(0.008)	(0.008)
Household effects	Random	Fixed	Fixed	Random	Fixed	Fixed	Random	Fixed	Fixed
Hausman test *P*-value	0.338			0.339			0.0054		
Sample size	2642	2642	2642	2633	2633	2633	2769	2769	2769

**Significant at the 5 percent level.

Note: Numbers in parentheses are standard errors. Other variables included but not reported: constant term; soil type (red, black, brown); log value of owned land, log value of farm equipment, and log value of zebus (for random-effects specifications of yield and net revenue only).

Source: Authors' analysis based on data from the 2005 Lac Alaotra survey described in the text.

between the precision of the fixed- and random-effect estimates. The random-effect specification, at any rate, is rejected in favor of fixed-effects in the present case.

Titled plots are found to be around 6 percent more valuable than untitled plots, a statistically significant difference. Again, this is an upper bound estimate, one that suggests that the productivity effect of 6–7 percent is unlikely to be entirely real, since the impact of titles on productivity is bounded from above by the impact of titles on the market value of land. The point estimate of the market premium for titled plots is even higher than the simulations in table 3 might indicate. Yet, the upper end of the 95 percent confidence interval for this estimate is only about 10 percent. To put this into context, the World Bank (2003) reports comparable land value differentials in Asia and Latin America ranging from 40 to 80 percent. The corresponding differentials for rural Madagascar clearly lie well below this range.

Plots with up-to-date and out-of-date titles do not differ significantly in value, as indicated in the last column of table 5. This finding is consistent with the earlier conjecture that the entire value of a title could lie in the mere fact of having an official record of the title in the land administration office. Once such a record exists, it becomes extremely difficult to obtain a new title for the same land under false pretenses.

Results reported in the supplemental appendix attempt to distinguish the channels by which titles influence land values (table S3). One can ask whether titles are valued more by households who view land expropriation as probable. But there is no significant interaction in the land value regression between the titling status of the plot and whether the farmer has regularly or occasionally (compared with rarely or never) heard of cases of expropriation in the community.[18] The transaction insurance benefit of a title is investigated by examining the interaction between possession of title and an *acte de vente* (sales receipt) certified by the village head. To the extent that such a document provides informal transaction insurance, it should attenuate the benefit of a title. However, a suitably augmented land value regression provides no firm evidence to this effect. Neither the titling premium nor the value of the plot itself is significantly influenced by having a certified *acte de vente*. Of course, the power of this test is predicated on there being significant transactions risk in the absence of a certified *acte de vente*. Yet, only 15 percent of purchased plots are without such a document, and for two-thirds of these transactions an uncertified *acte de vente* exists, which for all intents and purposes may be equivalent to one certified by the village head.

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18. Of course, farmers who have heard of many cases of land lost due to lack of ownership documentation do not necessarily fear that their own land is thus endangered, and conversely farmers may fear expropriation even if they have never heard of specific cases in the community.

IV. Conclusions and Policy Implications

No consensus has yet emerged on the practical importance of increasing land tenure security in most of Sub-Saharan Africa. Brasselle et al. (2002, p. 373) conclude for Burkina Faso, after failing to find significant investment effects, that "the traditional village order, where it exists, provides the basic land rights required to stimulate small-scale investment." Deininger and Jin (2006) argue that such conclusions are premature because the vast majority of studies in this literature are based on small samples, in which tenure security effects, if they exist, would be difficult to detect. The findings of this study are based on a very large sample of plots and support the notion that indigenous tenure provides adequate security for farmers to undertake the limited range of investment activities commensurate with the prevailing agricultural technology.

The results further imply that the private economic benefits from extending land titling in Madagascar would be minor and, in particular, would not exceed the cost of doing so under the current system. The median rice plot in the Lac Alaotra region is worth about $1,000 per hectare, and titling it would raise its value by no more than $60 per hectare.[19] Teyssier (2004) estimates the total cost of titling a parcel in Madagascar today at about $350, including "unofficial" costs.[20] Based on this figure, it makes economic sense only to title plots larger than about 6 hectares. Less than 3 percent of the plots in the sample (which, because of the focus on *mailles* areas, is already weighted toward larger plots) are 6 hectares or larger. Put another way, the marginal cost of a title would have to fall by a factor of six to make it economical to title the median-size plot in the sample (1 hectare). Even a comprehensive restructuring of the current land administration would be unlikely to achieve an efficiency gain of such magnitude. For Madagascar as a whole, the problem is compounded by the highly fragmented nature of landholdings: the national median plot size is only 0.20 hectare.

Looking forward, the more salient policy question is what system of land administration would be best suited to rural Madagascar and similar regions of Sub-Saharan Africa? As discussed in World Bank (2003), a menu of land registration options is available, with each option varying in degree of tenure security, precision, and unit costs. The estimates indicate that even in Lac Alaotra, where irrigation, transport, and market infrastructure are relatively well developed and plots are relatively large, the average costs of registering a parcel

19. Feder et al. (1988) argue that the private value of a title, as estimated here, exceeds its social value because society is neutral with respect to the risk induced by land expropriation, whereas individuals are risk averse. No attempt is made to account for risk aversion in the estimates, except to note that the $60 per hectare figure represents an upper bound on the social value of a title.

20. This is probably an overstatement of the true resource cost, since bribes to various officials can reflect monopoly rents in addition to the opportunity cost of the applicant's time. Raharinjanahary (2001) estimates that the cost to the applicant of all official procedures is on the order of $150, but this figure probably understates the true resource cost.

under any new system would have to be quite modest just to break even. Where conditions are less favorable, full-fledged land tenure reform may not be worthwhile compared with alternative rural development policies.

Finally, the possibility was raised earlier that land titling, as an institution, could be socially wasteful to the extent that its sole or main benefit is protection against those who would exploit the titling system itself to grab untitled land. Although it is impossible to decompose the benefits of land titles in Lac Alaotra to determine how much can be attributed to this type of protection, the social cost can be bounded from above. At most, owners of untitled land would be willing to pay 6 percent of their plot's value to eliminate this insecurity. According to the data, 47 percent of Lac Alaotra's 30,000 hectares of rice land within the irrigated perimeters and 88 percent of its 72,000 hectares outside them are untitled. This puts the social cost of the modern titling system in the Lac Alaotra Basin for rice land alone at up to $4.5 million[21]—a substantial amount when compared, say, with the value of the region's annual rice production of $28 million. Given this *potential* cost, future research should strive to determine whether such negative titling externalities are indeed empirically important.

Supplementary Material

Supplementary material is available online at http://wber.oxfordjournals.org/.

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21. Average value for *mailles* and non-*mailles* plots is taken from table 1. Tenure insecurity may also affect the value of upland and forest plots, which are largely untitled in Lac Alaotra. Estimating the titling premium on these types of land is left for future research. Finally, this calculation ignores the costs already incurred by current title-holders to obtain their titles. However, since this cost is sunk, it should not enter the decision of whether to suspend the current system.

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