The conversion of customary land in developing country cities

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Abstract

As cities in developing countries grow and expand spatially, land use changes from agricultural to residential and land tenure is converted from customary to statutory property rights. To explore these two joint processes, we propose a land-use and land-tenure conversion model where brokers purchase agricultural land from customary possesors and transform it into residential plots. Brokers may also attempt to establish a property right to reduce tenure insecurity before reselling the plot onto the residential market. This generates a mixed land-use equilibrium with statutory and non-staturory residential plots that coexist with customary agricultural parcels. In the presence of information asymmetry between customary farmers and brokers, a market failure may emerge whereby the conversion process is hindered and the city size ends up being too small. An empirical analysis using Malian data validates the key features of the model captured by the land gradients, the ranking and the variance of land prices.

Keywords: Urbanization, land markets, property rights, market failure

JEL codes: O43, R14, P14

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1 Introduction

Cities are growing at an unprecedented pace in sub-Saharan and Asian countries. In Sub-Saharan Africa alone, the urban population is expected to increase by more than 400 million residents and double within the next 25 years, causing the cities to also expand spatially at an unprecedented scale. As countries in sub-Sahara Africa and Asia are still predominantly rural, urban expansion is accompanied by a massive process of land use conversion whereby agricultural land in peri-urban areas gets transformed into urban residential land.

In these countries, new land plots are mainly available in rural and peri-urban areas that are overwhelmingly governed under a customary system of land allocation. Under most customary rules, land plots have no individualized property rights as each land plot belongs to everyone and is therefore not supposed to be purchased by individuals. This has two major implications for urban expansion. First, in cities where land is developed in a decentralized fashion, customary land needs to be sold to private investors or residents and becomes individual property. This generates an exit process from the customary system which has been designated in the literature as the "individualization of land tenure", the "commodification of land" or the "emergence of land markets".[1] Second, urbanization is therefore accompanied by a process of land-tenure conversion from customary rights to formal statutory rights (e.g., titled deeds or formal use rights), which is neither an instantaneous nor a riskless process. For instance, a land plot may be sold by illegitimate customary possessors, or multiple claimants may sell the same land plot to different buyers simultaneously. Conflicts over land following a purchase from a customary possessor are extremely frequent.[2][3] This is why buyers who can afford to pay formalization fees, convert their tenure to statutory property rights and therefore significantly reduce the risk of

[1] Under customary systems, land is allocated to users by village chiefs or other customary authorities (such as land chiefs). It is correct to say that land is allocated and not sold because it is transferred to its users in exchange of a symbolic gift to customary authorities (for instance ten cola nuts in the case of Mali). As a matter of fact, because no money is involved in the exchange, there are no land markets under customary systems. In these systems, even though land is "owned" by the allottee and can be inherited by his children, it is held under the understanding that "land cannot be sold". Although this almost never happens, in theory it can be taken back in the future by customary authorities.

[2] Durand-Lasserve et al. (2015) describe in detail the conversion process in Mali, Bamako, where purchases of customary land are very risky for the buyer due to the high prevalence of multiple sales.

[3] In fact, tribunals which are clogged by land disputes and conflicts over multiple sales of customary land represent one of the most significant number of legal cases.

loss of their asset. In practice, the customary system exists in parallel to a formal property right system which is much more prevalent in urban areas.[4] Because of such land transaction risks involved and the formalization barriers associated to poor land governance and dysfunctional land administrations, the process of urbanization / land tenure-conversion is likely to occur in very inefficient ways. Understanding these inefficiencies is thus required to design appropriate policies to accommodate the challenge of fast urbanization. This is the purpose of this paper.

To our knowledge, our paper is the first to provide a theory of land tenure conversion. Our theoretical model studies insecurity and transformation of land tenure in a monocentric-city urban economics framework. Brokers purchase land from customary owners and have the capacity to formalize tenure and reduce insecurity. Land plots are heterogeneous in the risk of a land right transformation failure in the sense that, controlling for location, local amenity and other characteristics, land plots have different customary history (previous cessions), customary right management (head of village), nexus of customary possessors, etc. In this model, brokers cannot avoid the risk of a land right transformation failure but may be able to assess it to some extent. We first analyze the case where they can acquire complete information on this risk. Then, their business is to acquire the land, pay conversion fees (bribes in some case) and take the chance of converting the land with statutory rights on which housing capital investment can safely be made. It is assumed that the brokers have higher probability of conversion than customary land holders, who usually are agricultural laypersons. We then contrast this with the case where brokers unable to acquire information on this risk. This is typically caused by the inherent difficulty of inspecting and uncovering all different stakes of the customary rights associated to a land plot. Then, we show that brokers face the additional problem of adverse selection as customary possessors uphold the least risky land plots. This causes a land market failure as transactions fail to take place at some specific distance from the city center.

The paper also provides an empirical analysis on land tenure in Sub-saharian African countries. It exploits a unique survey of unbuilt land plots in Bamako, Mali, between 2009 and 2012 (Durand-Lasserve et al. 2015). It provides several pieces of evidence corroborating the main

[4]In many African countries, formal property rights were introduced during the colonial period to serve the interests of colonizers, including the appropriation of land cities. The indigenous population usually did not participate in the colonizers' ownership system as it was tacitly implied and tacitly accepted that natives would continue to access land through customary practices and norms. After decolonization, both system continued to coexist, a situation referred to as "legal pluralism".

predictions of the theoretical model with informed brokers. In particular, it is shown that land tenure transformation from non-statutory to statutory rights decays with distance from city center. Furthermore, the land gradient (price change w.r.t. distance from city center) is smaller for the price of non-statutory land plots that were upgraded to statutory rights than for those plots that were already equipped with statutory rights. It is also shown that the variance in the price of non-statutory land plots is higher than that of statutory land plots, suggesting that the land tenure risk is larger for the former. Finally, the analysis does not give a strong support towards price patterns that would be consistent to an adverse selection issue generated by the brokers' lack of information about the risk of non-statutory land tenure.

Our paper contributes to the literature in the following way. Lanjouw and Levy (2002) study the effect of the transferability of property rights on land prices. As in this paper, their theoretical model includes a similar problem of asymmetric information between buyers and sellers. In their empirical part they find that holding a transferable title raise the value of properties by 23.5%. Both their theoretical and empirical model do not display the key uban space features that are generated by the presence of central markets for labor and farming goods. In line with this, Arruñada (2012) discusses a theory of registries and property rights and analyzes the tradeoffs between transaction cost, information. His analysis includes no mathematical modelling and no link to the urban structure in developing countries like in this paper. Closer to this paper, Selod and Tobin (2018) discuss the equilibrium choice of risk taking by individuals and show that individuals choose to certify land tenure in areas close to the city business center. Cai, Selod and Steinbuck (2018) propose a dynamic framework where city dwellers choose to purchase statutory rights to protect their urban properties against eviction risk. In contrast to this paper, they consider that land is used only for residential purpose and cannot be used for farming, information issues are absent and the urban space is condensed on a single geographical point. They rather focus on the dynamics of the city and discuss the timing of formalization and the share of informal land plots in the long run. The paper also relates to the literature on urban squats and slums as it studies the consequences of possible eviction from the lands with no statutory rights (Jimenez 1985, Brueckner 2008). The paper however strongly differs from this literature as it departs from essential features of squatting such as land invasions by squatters, land control by "community organizers", defensive expenditures throught squatters' permanent and physical presence, lobbying and bribes, political patronizing, network effects through massive

presence of squatters, under-investment in housing, etc. This literature omits the study of the problem of asymmetic information between buyers and sellers of non-certified possessions.

Section 2 presents the general architecture of the model and sections 3 and 4 develop two versions of the model depending on whether brokers are informed or not of the levels of tenure insecurity under customary tenure. Section 5 is an empirical analysis inspired by the model. Section 6 concludes.

2 Model

We consider an open city with a central business district (CBD) at $x = 0$ and perfectly mobile and risk neutral individuals. Individuals reside at various locations x from the CBD and are endowed with identical preferences over consumption of residential land and homogenous good. For simplicity, we assume a unit demand for residential land, so that utility is simply given only by the homogenous good consumption z. The price of the homogenous good is normalized to one.

Individuals can be categorized into four possible cases of economic activities and land right holdings. In the first category, individuals reside and work outside the city, hold no customary land right in the city and obtain the outside utility, u. In the second category, individuals are "customary farmers" who reside within the city extent, farm a piece of land there and sell their farming goods at the CBD. In conformity with reality, customary farmers hold "customary land rights" that allow them to avoid paying land rents. Their land plots include a unit of residential land and s additional units for their farming activities. Farms produce farming goods at productivity α per unit of land, which yields a farm production equal to αs. We normalize the price of farming goods to one so that the value of farming goods is also equal to αs. Customary farmers incur an iceberg transport cost $\tau \in (0, 1)$ per unit of distance and farming good for carrying to and trading their production at the CBD. After exchanging their production, they can get a homogenous good consumption equal to

$$z = a(x) \equiv \alpha s(1 - \tau x),$$

where the RHS is their net income from selling their farming production from their location x. Customary farmers exist only for $x < 1/\tau$. As customary land holders, farmers hold their land plots under a customary tenure right that provides some "customary right enforcement". The

enforcement level under the customary system is given by the probability q of keeping the land (given possible challenges over possession that may emerge). This probability is known by the land holder and is idiosyncratic and distributed with cdf G on the support $[\underline{q}, \overline{q}]$, $0 < \underline{q} < \overline{q} \leq 1$. With probability $1 - q$, the land is appropriated by another individual who joins the city and becomes a customary land holder at the same location. The evicted farmer leaves the city (or becomes an urban worker, see below) while the land is appropriated by another customary farmer and used for farming. Given this uncertainty, the customary farmers' expected utility is given by $qa(x) + (1 - q)\, u$, which decreases with distance x to the agricultural product market. Customary farmers are free to leave the city and get the outside utility u. They locate in the city if the expected utility is larger than u, or equivalently if $a(x) \geq u$. Hence, the last customary farmer lives at distance for CBD

$$x_a \equiv \frac{1}{\tau}\left(1 - \frac{u}{\alpha s}\right)$$

where $a(x_a) = u$.

The two other categories include "urban workers" who reside in the city and work at the CBD. Urban workers have identical work productivity and therefore identical wages w while they incur the same commuting cost t per unit of distance. Urban workers differentiate according to the statutory or non-statutory tenure of their land plots.

Urban workers with statutory land tenure reside on certified land plots with full-secure statutory rights so that they do not suffer eviction. They pay the land price $p_S(x)$ for their unit residential plot. Their budget constraint is given by $w = z + tx + p_S(x)$ so that they obtain a consumption level $z = w - tx - p_S(x)$. Urban workers are perfectly mobile and free to migrate in and out of the city. The free mobility condition $u = z$ gives the statutory residential land price

$$p_S(x) = w - u - tx.$$

Urban workers holding no staturory land tenure live on land plots with unsecure rights. They pay a price $p_{NS}(x)$ for their unit residential land with no statutory rights. Because the land is not documented they suffer the risk of eviction for the same reason as the customary farmer. Let $\theta\,(q) \in (0, 1)$ be the probability they enforce their land right. Given that such enforcement are caused by the same source of tenure conflict, this probability rises with the land security of customary hold, $\theta' > 0$.Then, with probability $\theta(q)$, those workers commute and work at the CBD for the wage w and consume $z = w - tx - p_{NS}(x)$ where x is their residential

location. With probability $1-\theta(q)$, they are evicted, lose their land, leave the city and get a utility u so that their net utility becomes $u - p_{NS}(x)$. For simplicity, we consider that the evicted residential land is sold to another worker holding no statutory right at the price p_{NS}. The expected utility of a worker with no statutory right is given by $\theta(q)(w - tx - p_{NS}(x)) + (1-\theta(q))(u - p_{NS}(x))$. Because, workers are free to migrate before purchasing their land, at the equilibrium, this expected utility must be equal to the outside utility level u. This gives the following price of non statutory residential land for workers:

$$p_{NS}(x,q) = \theta(q)(w - u - tx) = \theta(q)\, p_S(x) < p_S(x).$$

The price p_{NS} is a function of both location x and probability q of keeping the land. Non-statutory residential land sells at a discount equal to the worker's probability of eviction $\theta(q)$. Equivalently, $1/\theta(q)$ reflects the tenure security premium expressed as a multiplicative factor.

Land transformation from customary to statutory right is managed by a group of perfectly competitive risk-neutral land brokers, who acquire customary land plots, attempt to obtain formal rights and resell them to urban workers. More formally, a land broker offers a price $p(x)$ to acquire a unit of customary land and holds it under an enforcement probability $\pi(q) \in [0,1]$. This probability is higher than the farmer's customary right enforcement probability q ($\pi(q) > q$) because the sale is generally documented and brokers use their higher social status and larger social network to help enforcing their tenure right. The probability $\pi(q)$ also rises with q ($\pi' > 0$) because conflicts about land ownership carry over after land purchases. With probability $\pi(q)$, the broker keeps the plot and pays the certification cost c to obtain a "statutory property right" from the land administration, which is fully secure and transferable. In this case, the broker formally re-sells the land for a value $p_S(x)$ to urban workers and transfer the statutory property rights to them. With probability $1-\pi(q)$, the broker does not succeed in certifying the land plot and resells it as non statutory residential plot at a price $p_{NS}(x,q)$.

Before proceeding, it is interesting to briefly discuss the benchmark case of free and secure property rights. The uncertainty in land property rights can be eliminated through the setting up and enforcement of a registration system (land registry or cadastre) that unequivocally assigns statutory property rights on each land plot. Furthermore, if the registry is costless and free to access, we can impose $q = \pi(q) = \theta(q) = 1$ and $c = 0$. This implies that all land plots have statutory rights and brokers are not needed. A farmer gets a utility $a(x)$ from her farm

production and $p_S(x) + u$ from selling and leaving the city (or becoming an urban worker). A land transaction takes place if and only if

$$p_S(x) + u \geq a(x) \iff w - tx \geq \alpha s(1 - \tau x).$$

To fit reality, we assume that urban residences lie close to the CBD, which implies that the LHS falls more rapidly than the RHS. That is,

$$t > \alpha s \tau. \tag{1}$$

Commuting costs should be higher than the costs of transporting farming goods to CBD. The above condition then determines the following unique frontier between the urban workers' residential and urban farming areas:

$$\widetilde{x} = \frac{w - \alpha s}{t - \tau \alpha s} > 0.$$

The city includes urban workers' residences on the interval $[0, \widetilde{x}]$ and urban farms on $(\widetilde{x}, x_a)$. There is no mix of land uses and rights. The frontier $\widetilde{x}$ expands with higher urban wages, lower commuting cost and higher unit transportation cost of farming goods.

3 Informed brokers

We here study the city structure when brokers are perfectly informed about customary enforcement risks. Brokers get the revenue $p_S(x)$ or $p_{NS}(x)$, incur the certification cost c and pays the land price p. Under symmetric information, brokers know the customary enforcement level q and have profit

$$V(x, p, q) = (p_S(x) - c)\,\pi(q) + p_{NS}(x, q)\,(1 - \pi(q)) - p.$$

Because of land brokers' competition, customary land owners with enforcement right q are able sell their land at a price p^o that makes brokers indifferent to making a transaction ($V(x, p^o, q) = 0$). That is,

$$p^o(x, q) = p_S(x)\Pi(q) - c\pi(q). \tag{2}$$

where

$$\Pi(q) \equiv \pi(q) + \theta\,(q)\,(1 - \pi(q))$$

is the broker's *compounded* enforcement probability of land right transformation. This simply sums up to the probabilities that a land user with or without statutory rights is not evicted. This probality rises with q ($\Pi' = (1 - \theta)\,\pi' + \theta'\,(1 - \pi) > 0$).

On the one hand, customary land holders get a utility $p^o(x,q)+u$ when they sell their possession and leave the city (or become urban workers). On the other hand, customary farmers get the utility $qa(x)+(1-q)u$ $(\geq u)$ when they farm their customary land with tenure uncertainty. This means that they must at least get $u+q\left[a(x)-u\right]$ to transact. The transaction takes place if and only if

$$p^o(x,q) \geq q\left[a(x)-u\right]. \tag{3}$$

In this text, we consider that urban workers live closer to CBD, or equivalently, transactions take place closer to the CBD. Toward this aim, we assume that, for any q, the LHS of condition (3) falls more rapidly with x than its RHS, which is equivalent to impose that

$$t \geq \tau\alpha s \max_{q\in[\underline{q},\overline{q}]} \frac{q}{\Pi(q)}. \tag{4}$$

This requires that commuting costs are high enough compared to the cost of moving farming goods to the city market place. Then, there exists a unique location $\widehat{x}(q)$ such that brokers and customary farmers with enforcement level q make a transaction for all locations $x \leq \widehat{x}(q)$ and none otherwise. One computes

$$\widehat{x}(q) = \frac{(w-u)\,\Pi(q) - c\pi(q) - q\,(\alpha s - u)}{t\Pi(q) - \tau\alpha s q}. \tag{5}$$

This is a continuous function of q that accepts minimum and maximum values $(\underline{x},\overline{x})$. Then, all the land remains under customary rights and is used for farming at $x \geq \overline{x}$. For $x \leq \underline{x}$, all the land is purchased by brokers: the fraction $\pi(q)$ of land with enforcement q get certified and sold as worker residences with statutory rights and the fraction $1-\pi(q)$ is sold as residences with non statutory rights. On the interval $(\underline{x},\overline{x}]$, three types of land use and tenure exist: customary farming land and workers residences with and without statutory rights.

This is shown in the top panel of Figure 1. To understand the figure, fix q to specific value. Then, the dashed ray aa'' represents the reservation values of customary farmers with risk q while the dashed line bb'' corresponds to the reservation values of brokers with risk $\pi(q)$. The two lines intersect at $a'=b'$. Because of perfect competition, brokers' transaction prices lie on the line segment bb' when customary farmers sell their land. There is no transaction on the segment $b'b''$ because customary farmers prefer holding their possession. The same argument applies for land with higher risk security levels q, in which cases the ray aa'' and line bb'' move up. The upper and lower lines represent those loci of aa'' and bb'' for $q=\overline{q}$ and $q=\underline{q}$. Then, the

gray zone represents the prices and locations where transactions take place. The bottom panel of Figure 1 depicts the shares of land use and tenure. For $x < \overline{x}$, transactions are split according to brokers' probability $\pi(q)$ to transform the land with statutory rights.

INSERT FIGURE 1 HERE

Finally, to shorten and make more realistic our discussion we assume that $\overline{x} < x_a$. This gives the following proposition:

Proposition 1 *Suppose* $0 < \underline{x} < \overline{x} < x_a$. *The city includes three land use and tenure zones: first, a residential zone with both statutory and non-statutory rights at the proximity of the CBD,* $x \in [0, \underline{x}]$*; second, a fully agricultural zone with customary rights at its far periphery* $x \in [\overline{x}, x_a]$*; and finally, a zone mixing customary agricultural lands and statutory and non-statutory residential land,* $x \in (\underline{x}, \overline{x})$.

It can readily be seen that $\widehat{x}$ rises with larger w and τ and with smaller t. Hence, larger earnings w and smaller commuting costs t raise the urban workers' net income and their willingness to pay for residential plots. This gives more incentives to brokers to try to acquire statutory rights in inner city areas. Larger unit transport costs for farming goods τ also diminishes the customary farmers' earnings and raise their incentives to sell their land to brokers. Similarly one can show that $\mathrm{d}\widehat{x}/\mathrm{d}(\alpha s) < 0$ so that a smaller farm production raise the customary farmers' incentives to sell their possession, which pushes the city residential extent with statutory rights.[5]

We can briefly compare the land allocation with and without tenure uncertainty. One can show that $\widehat{x}(q) < \widetilde{x}$ if and only if

$$\left[\frac{\Pi(q)}{q} - 1\right]\left(\frac{x_a - x_S}{\frac{1}{s\alpha\tau} - \frac{1}{t}}\right) < \frac{\pi(q)}{q}c$$

where x_S is the location where the price $p_S(x)$ is equal to 0 (see $x_S < x_a$ in Figure 1). By (1), the ratio in this condition is positive. In conformity with reality, let us consider that the compounded enforcement probability of land right transformation $\Pi(q)$ is larger than the customary farmer's enforcement probability q so that both sides of the condition are positive ($\Pi(q)/q > 0$). Then, if

[5] Indeed, one can show that $\mathrm{d}\widehat{x}/\mathrm{d}(\alpha s) = \tau q\left[\widehat{x}(q) - 1/\tau\right] / \left[t\Pi(q) - \tau\alpha s q\right]$, which is positive by (4), $\widehat{x}(q) < \overline{x}$ and $\overline{x} < x_a < 1/\tau$.

the certification cost is high enough, the condition holds true so that tenure risk reduces the city extent at any enforcement probability q. This is because too a high certification cost reduces the brokers' incentives to transform the land. The opposite may however occur. For instance the above condition does not hold if the certification cost tends to zero. In this case, by securizing the land plots, brokers increase the land value so much that customary farmers prefer to sell their unsecured land plots, even though they would have held the latter with full-secured rights. Hence, *the city extent may be larger with tenure uncertainty than without it.*

Comparative statics are difficult to obtain on other parameters. In general, the impact of the enforcement probability q on $\widehat{x}$ is neither linear nor monotone. To illustrate this impact, we explore the following example where $\pi(q) = \pi_0 q$, $\theta(q) = \theta_0 q$, $q \in [0, \overline{q}]$, $\pi_0 < 1/\overline{q}$, $\theta_0 \in [1, \pi_0]$. The parameter π_0 measures risk transformation faced by brokers. The higher this parameter the better, the brokers are able to ensure the land transformation from customary to statutory rights. The parameter θ_0 measures the discount brokers accept when they resell non-statutory land to residents. We compute

$$\widehat{x}(q) = \frac{(w-u) - \frac{c\pi_0 + (\alpha s - u)}{\pi_0 + \theta_0(1-\pi_0 q)}}{t - \alpha\tau s \frac{1}{\pi_0 + \theta_0(1-\pi_0 q)}},$$

which is a monotone function of q. It increases in q if and only if

$$t(\alpha s + \pi_0 c - u) < \alpha s \tau (w - u). \tag{6}$$

That is, for low enough risk transformation parameter π_0. When the schedule $\widehat{x}(q)$ is monotonically increasing (as in the top panel of figure 1), brokers prefers to buy the more secure land plots; in other words, the plots with higher customary security q transact more and to a larger geographical extent. To see this note that the location $\overline{x}$ has transactions with the highest customary security level $\overline{q}$ and therefore the highest probability of transformation $\pi(\overline{q})$. Conversely, the inner location $\underline{x}$ has transactions with the least secure land $\underline{q}$ and the lowest probability of transformation $\pi(\underline{q})$. According to Condition (6), this takes place for low enough risk transformation parameter π_0. Interestingly, the opposite argument obtains for high enough risk transformation parameter π_0 and therefore decreasing profiles $\widehat{x}(q)$. In this case, brokers attract the customary possessors with the lower security q and transform the latter to statutory residential plots with a high probability of success. These contrasting results reflect the trade-off for the brokers between buying cheaper unsecure plots and the ease at which they can formalize those

plots. In what follows, we do not make any assumption regarding whether $\widehat{x}$ is an increasing or decreasing function of q.

We now study the city structure when brokers are not informed about the customary enforcement levels of land plots.

4 Uninformed brokers

In this section we study land market allocations when brokers are unable to observe the risk in their land transactions with customary land holders. Typically, brokers are not informed about the seller's customary right enforcement q and do therefore not know their own enforcement probability $\pi(q)$ at the time they commit to purchase a unit of customary land at price p. This gives rise to an adverse selection problem where brokers are offered the land with the worst tenure risks.

On the supply side of the land market, a customary land holder chooses his best option between (1) farming her unsecured land, which yields a utility level $qa(x) + (1-q)u$, and (2) selling her possession and leaving the city (or becoming an urban worker), which yields a utility level $p + u$. The customary enforcement levels of land plots offered for sale at x are therefore given by the set

$$Q(x,p) = \{q : qa(x) + (1-q)u < p + u\},$$

which expands with the offered price p. Land supply depends negatively on the farming productivity $a(x)$, which increases with proximity to the city center. Because $a(x) > u$ on the whole urban area, land supply also depends negatively on customary farmers' enforcement probability q. Only customary farmers with sufficiently low want to offer their land slots for sale. As those slots also have higher uncertainty for brokers, this creates an adverse selection issue between sellers and brokers. In this paper, the seller's value stems from the sales of her farming production in the city center $a(x)$. The idea readily extends to any value created by city center proximity for customary possessors such as access to shopping, public administration, informal work.

On the demand side of the market, brokers pay the land price with certainty but obtain a revenue $p_S(x) - c$ with probability $\pi(q)$ when they are able certify the land rights and $p_{NS}(x)$

otherwise. Given the set of customary enforcement levels Q, they make the expected profit

$$V(x,p,Q)=\int_{Q}\left\{\left(p_{S}(x)-c\right)\pi(q)+p_{NS}(x,q)\left[1-\pi(q)\right]\right\}\mathrm{d}G(q)-p.$$

We can write this as

$$V(x,p,Q)=\int_{Q}\left[p_{S}(x)\Pi(q)-c\pi(q)\right]\mathrm{d}G(q)-p,$$

where we substituted for the compounded probability $\Pi(q)$. The expected profit therefore balances the expected values of urban workers' residential land price, their compounded probability of not being evicted and the broker's certification cost as well as the price paid for the land. A further substitution yields

$$V(x,p,Q)=\int_{Q}p^{o}(x,q)\mathrm{d}G(q)-p,$$

so that the expected profit is the difference between the expected value of the *informed* broker's bid $p^{o}(x,q)$ and the price paid under asymmetric information p.

In the market for customary land, there are two sets of endogenous variables at location x: the land price of $p(x)$ and the support of security levels of plots offered for sale, $Q(x,p(x))$. A *competitive land equilibrium at location* x is then defined as the customary land price $p^{*}(x)$ and the set of security levels $Q^{*}(x)$ such that the supply of land is given by $Q^{*}(x)=Q(x,p^{*}(x))$ and brokers enter the market and make no excess profit, $V(x,p^{*}(x),Q^{*}(x))=0$. For the sake of comparison and exposition, we consider the economic parameters that satisfy $0<\underline{x}<\overline{x}<x_{a}$. We also focus on the land within the city extent $[0,x_{a}]$ because the customary land beyond x_{a} is not of interest for brokers if $x_{a}>\overline{x}$.[6] For the sake of conciseness, we dispense with reference to x on the variables $a(x)$, $v(x)$, $p(x)$, $Q^{*}(x)$ and $V(x,\cdot,\cdot)$ in the next two paragraphs.

Customary land holders are willing to sell their unit of land plot if the offered price p lies above their reservation utility $q\left(a-u\right)$. The set of customary enforcement levels is therefore given by $Q^{*}(p)=[\underline{q},p/(a-u)]$ if $p/(a-u)<\overline{q}$ and $[\underline{q},\overline{q}]$ otherwise. It is convenient to denote by $\underline{p}=\underline{q}\left(a-u\right)>0$ and $\overline{p}=\overline{q}\left(a-u\right)>0$ $(0<\underline{p}<\overline{p})$ the land prices enticing supply by none or all customary land holders. Then, the broker's expected profit writes as

$$\widehat{V}(p)\equiv V(p,Q^{*}(p))=\int_{\underline{p}/(a-u)}^{\min\{p,\overline{p}\}/(a-u)}p^{o}(x,q)\mathrm{d}G(q)-p. \tag{7}$$

[6]Indeed, for any $x>x_{a}$, the farming production yield a utility lower than the outside utility: $a(x)-u<0$. For any $x>\overline{x}$, condition (3) fails so that $p^{o}(x,q)\leq q\left[a(x)-u\right]$ for all $q\in[\underline{q},\overline{q}]$. Hence, for $x>x_{a}>\overline{x}$, $p^{o}(x,q)<0$ and $V(x,p,Q)<0$ for any set Q.

The equilibrium is found where brokers make zero expected profit: $\widehat{V}(p) = 0$. It is easy to see that the function $\widehat{V}(p)$ is zero at $p = 0$ and it is negative and decreasing for $p \in (0, \underline{p}]$. It is also decreasing for $p > \min\{p, \overline{p}\}/(a - u)$. In this paper we simplify the discussion of equilibria by assuming that $\widehat{V}(p)$ crosses the zero axis at most once from below for $p \in [\underline{p}\ \overline{p}]$. A sufficient condition is

$$\int_{\underline{q}}^{q} p^o(x, q')\mathrm{d}G(q') \text{ is a convex function of } q. \tag{8}$$

This is equivalent to say that $p^o(x, q)g(q)$ is increasing in q. For instance, when $\theta(q)$ is small enough, one just needs to have $\pi(q)g(q)$ a monotone increasing function of q. Under this assumption, the expected profit linearly falls from and below zero on $[0, \underline{p}]$, increases on $(\underline{p}, \overline{p}]$, reaches a maximum at $p = \overline{p}$ and, again, linearly falls on $(\overline{p}, \infty)$. This is shown in Figure 2. A first solution for $V(p) = 0$ is the trivial equilibrium solution $p = 0$ for which no customary land holder supplies land and the land market is inactive (i.e. $Q^*(0) = \emptyset$). This is the unique solution if $\widehat{V}(\overline{p}) < 0$. Otherwise if $\widehat{V}(\overline{p}) > 0$, the function $\widehat{V}(p)$ has three roots $p \in \{0, p^{**}, p^*\}$ $(0 < p^{**} < \overline{p} < p^*)$ and is positive on the interval $[p^{**}, p^*]$. However, only the highest price p^* is robust to overbidding by brokers. Indeed, if all brokers set a price $p < p^* - \varepsilon$ with small enough $\varepsilon > 0$, some brokers can reap the land market by setting the price $p^* - \varepsilon$ and make a positive profit $\widehat{V}(p^* - \varepsilon)$. Hence, under asymmetric information, the land market yields the equilibrium price p^* for all transactions with all types of land holders. We now reintroduce the reference to CBD x.

INSERT FIGURE 2 HERE

Importantly, because $p^* > \overline{p}$, the larger root is given by

$$p^*(x) = \int_{\underline{q}}^{\overline{q}} p^o(x, q)\mathrm{d}G(q),$$

which expresses the broker's expected value of residential projects. Like the price $p^o(x, q)$, $p^*(x)$ increases with higher value of certified land p_S and lower certification cost c. It also increases with higher probability $\pi(q)$ if $p_S(1 - \theta(q)) > c$. Because p_S falls with distance from CBD, this price also falls with distance to CBD. Finally the condition for an equilibrium with price p^* is given by

$$\widehat{V}(x, \overline{p}(x)) \geq 0 \iff \int_{\underline{q}}^{\overline{q}} p^o(x, q)\mathrm{d}G(q) \geq \overline{q}\,[a(x) - u].$$

The main difference with land markets with informed brokers lies in the concentration of land prices on its expected value p^*.

Proposition 2 *Suppose* $0 < \underline{x} < \overline{x} < x_a$ *and that condition (8) holds. Then, customary land beyond* x_a *is neither farmed for the city nor transformed with statutory property rights. Customary land beneath* x_a *is acquired by brokers if* $\widehat{V}(x, \overline{p}(x)) \geq 0$. *In other locations, the customary land market is inactive: land is is farmed but there is no attempt to transform it with statutory property rights.*

For the land beneath x_a, the land market activity and prices differ compared to markets with fully informed brokers. First, the equilibrium price $p^*(x)$ is the brokers' expected value of the informed brokers' equilibrium prices $p^o(x, q)$. Second, land market is active for the set of locations $X^* \equiv \{x : \widehat{V}(x, \overline{p}(x)) \geq 0\}$. It can be checked that, if $p_S(x)(1 - \theta(q)) > c$ for all q, an upper shift in the broker's enforcement probability $\pi(q)$ raises the expected profit $\widehat{V}(x, \overline{p}(x))$ and therefore enlarges the set X^*. Under the opposite condition, the same conclusion may hold or not depending on the balance of land for which the condition holds and does not hold.

To understand the effect of adverse selection, we must compare the sets of locations X^* and $[0, \overline{x}]$ where the land market is active under asymmetric and full information. On the one hand, it is easy to show that, under asymmetric information, there is no land transaction beyond $\overline{x}$: $[\overline{x}, x_a] \cap X^* = \emptyset$. Indeed, under complete information there is no transaction at $x \in [\overline{x}, x_a]$ where, by (3),

$$p^o(\overline{x}, q) - q\left[a(\overline{x}) - u\right] \leq 0, \tag{9}$$

for all q. The above proposition states that the market is inactive under incomplete information if

$$\widehat{V}(x, \overline{p}(x)) = \int_{\underline{q}}^{\overline{q}} p^o(x, q) \mathrm{d}G(q) - \overline{q}\left[a(x) - u\right] < 0.$$

This can however be written as

$$\widehat{V}(x, \overline{p}(x)) = \int_{\underline{q}}^{\overline{q}} \left\{p^o(x, q) - q\left(a\left(x\right) - u\right)\right\} \mathrm{d}G(q) - \left(\overline{q} - \int_{\underline{q}}^{\overline{q}} q \mathrm{d}G(q)\right)\left(a\left(x\right) - u\right) < 0.$$

The second term is strictly negative since $\overline{q} > \int_{\underline{q}}^{\overline{q}} q \mathrm{d}G(q)$. The first term is negative for any $x \in [\overline{x}, x_a]$ since its integrand is negative by (9). Hence, $\widehat{V}(x, \overline{p}(x)) < 0$ for any $x \in [\overline{x}, x_a]$. On the other hand, by a continuity argument the same conclusion applies for locations closer to CBD. Indeed, one may take $x = \overline{x} - \varepsilon$, for all (small enough) ε so that the absolute value of the

first term is smaller than that of the second term. So, $[\overline{x}-\varepsilon, x_a] \cap X^* = \emptyset$. Land transformation does not take place at locations $[\overline{x}-\varepsilon, \overline{x}]$ under asymmetric information although it occurs there under symmetric information. We summarize this result in the following proposition:

Proposition 3 *Asymmetric information reduces the geographical extent of urban land transformation and residential areas.*

Although asymmetric information reduces residential geographical extent (with statutory and non-statutory rights), it is not clear whether it diminishes the total residential surface and therefore the number of urban workers. Indeed, in this model, all land plots get transformed under asymmetric information in X^* whereas only part of this land is transformed under symmetric information in $[\underline{x}, \overline{x}]$.

To fix ideas on those sets, we focus on a slightly more restrictive setting than the one presented in the previous section.

4.1 Example

Suppose that the brokers' enforcement probability $\pi(q)$ is linear in the customary right enforcement probability q and the residential plots without statutory rights are given no tenure security. More specifically, $\pi(q) = \pi_0 q$, $\theta(q) = \theta_0 q = 0$, $q \in [0, \overline{q}]$ and $\overline{q} < 1/\pi_0$. Non-statutory residential land are then exchanged at a zero price $p_{NS}(x) = 0$. Under full information, we get the price $p^o(x,q) = [p_S(x) - c]\,\pi_0 q$ and condition (3) becomes

$$(p_S(x) - c)\,\pi_0 \geq a(x) - u, \tag{10}$$

which is independent of q. Assuming that the LHS falls more rapidly than the RHS, the binding condition (10) yields a constant threshold location $\widehat{x}$ that divides the city in two districts: statutory and non-statutory residential for $x \leq \widehat{x}$ and customary agricultural otherwise. Under asymmetric information, the broker's expected value of a residential project simplifies to

$$p^*(x) \equiv (p_S(x) - c)\,\pi_0 \mathrm{E}(q)$$

where $\mathrm{E}(q) = \int_{\underline{q}}^{\overline{q}} q \mathrm{d}G(q)$, and her maximal expected profit is given by $\widehat{V}(x, \overline{p}(x)) = p^*(x) - \overline{q}\,[a(x) - u]$. Hence, brokers enter if and only if

$$(p_S(x) - c)\,\pi_0 \frac{\mathrm{E}(q)}{\overline{q}} \geq a(x) - u. \tag{11}$$

Because $\mathrm{E}(q) < \overline{q}$, the LHS of (11) is smaller than that of (10), so that the solution x^* of the binding condition (11) is smaller than $\widehat{x}$. As a result, the city divides in the same districts as under symmetric information: statutory and non-statutory residential for $x \leq x^*$ and customary agricultural otherwise. However, the residential district is smaller due to adverse selection. Brokers' information asymmetry leads to a land market failure takes place at locations $x \in (x^*, \overline{x})$. Here, asymmetric information reduces both residential geographical extent and surface and therefore the number of urban workers since land in $(x^*, \overline{x})$ is not used for residences.

Corollary 1 *When brokers' enforcement function $\pi(q)$ is linear and residential plots without statutory rights are given no tenure security, a land market failure exists at the edge of the urban workers' residential place for $x \in (x^*, \overline{x})$. The city includes fewer workers because of asymmetric information.*

5 Model predictions

The model leads to four possible empirical predictions on the price schedules of sales to urban workers and brokers.

First, urban workers buy residential properties with statutory rights at price $p_S(x)$ while, by condition (2), informed brokers purchase customary land at price $p^o(x) = p_S(x)\Pi(q) - c\pi(q)$, where we define

$$\Pi(q) \equiv \pi(q) + \theta(q)(1 - \pi(q))$$

as the broker's *compounded* probability of land right transformation. The expected price conditional on distance from city center is given by $\mathrm{E}[p^o(x)] = \mathrm{E}[p_S(x)\Pi(q) - c\pi(q) \mid x < \widehat{x}(q)]$, where E is the expectation operator over the distribution of enforcement levels q. Hence, the observed ratio of the slopes of price lines satisfies

$$\frac{\frac{\mathrm{d}}{\mathrm{d}x}\mathrm{E}[p^o(x)]}{\frac{\mathrm{d}}{\mathrm{d}x}p_S(x)} = \mathrm{E}[\Pi(q) \mid x < \widehat{x}(q)]. \tag{12}$$

Since $\pi(q)$ and $\theta(q)$ are smaller than one, a first prediction is that this ratio of slopes be lower than one. If one considers only locations $x < \underline{x}$, this ratio simplifies to $\mathrm{E}[\Pi(q)]$.

Second, in the model of informed brokers, the price for statutory land $p_S(x)$ has zero variance whereas $p^o(x)$ has a positive variance

$$\mathrm{var}[p^o(x)] = p_S(x)^2\mathrm{var}[\Pi(q) \mid x < \widehat{x}(q)] + c^2\mathrm{var}[\pi(q) \mid x < \widehat{x}(q)].$$

In the data, prices are subject to measurement errors and unobserved characteristics other than transformation risks. As a result, land price with statutory rights shall be observed with positive variance $\text{var}\left[p_S\left(x\right)\right] > 0$. A second model prediction is the average of $\text{var}\left[p^o\left(x\right)\right] \text{d}x$ is larger than the average of $\text{var}\left[p_S\left(x\right)\right]$.

Third, informed brokers set different prices $p^o(x)$ at a same distance from the city center whereas uninformed broker can only propose a single price $p^*(x)$ reflecting the expected value of heterogenous tenure risks. Hence, whereas the informed broker model predicts a positive price variance $\text{var}\left[p^o\left(x\right)\right] > 0$, controlling for observed location and other characteristics, the uninformed broker model predicts a zero variance: $\text{var}\left[p^*\left(x\right)\right] = 0$. Remember that in the model, staturory land plots bear no risk and thus have zero price variance: $\text{var}\left[p_S\left(x\right)\right] = 0$. Considering measurement errors and unobserved characteristics other than transformation risks, a prediction is that a same price variance for non-statutory and statutory plots reveals the existence of information asymmetry.

Finally, the spatial pattern of right transformation is different according to whether brokers are informed or not. In general, informed brokers progressively attempt to transform the land rights across the urban space in the interval $[\underline{x}, \overline{x}]$ while uninformed brokers attempt to transform the whole urban space beneath some distance from the city center x^*. This highlights a spatial difference in terms of transaction frequency between the two versions of the model: in the uninformed case, property right transformations abruplty cease beyond the critical location x^*, whereas in the informed case, there can be a smooth phasing out of property right transformation over $[\underline{x}, \overline{x}]$.

6 Empirical analysis

6.1 Data

We use the data of a unique database on a survey on $1,655$ land plots that were transferred as unbuilt land plots in Bamako, Mali, between 2009 and 2012 (Durand-Lasserve et al. 2015). Current information was obtained at the year of the survey (2012) and retroactive questions were asked regarding the situation at the time of the transaction (between 2009 and 2012). The database reports characteristics such as price, tenure status, location (GPS coordinates), land use, surface area, infrastructure and services, municipality, distance to paved main road

and river, as well as details on buyers and sellers.[7] The sampling ensures extensive coverage of the Bamako greater area, at regular intervals along paved main roads extending outward from Bamako. The coverage of the survey area makes it possible to draw conclusions regarding the characteristics of the transfers and provides the best possible sample that could be constructed in the Malian context for an empirical analysis. Figure 2 displays the land plots on the Bamako map.

INSERT FIGURE 3 HERE

We drop the observations located farther than 40 km from the city center, those without residential or agricultural use and those without some missing data, which leaves $1,259$ observations. We code observations into two land right categories: non-statutory rights for customary land or land with formal property right that is not established; statutory rights include for lands with permits to occupy and title deeds. In this text, we focus on three land use and tenure categories: statutory residential, non-statutory residential and non-statutory agricultural. (We eliminate the plots that have statutory rights but are destined to agriculture since they are not explained by our model.) This reduces our sample to $1,150$ land plots.

Table 1 presents the summary statistics by tenure transitions between the time of transaction (2009-2012) and the time of the survey (2012). "NS to S" indicates plots with transition from non-statutory to statutory right. "S to S" and "NS to NS" represents plots that remained statutory and non-statutory respectively. One can observe that average land prices falls as one moves from the residential statutory plots to the residential plots recently granted with statutory rights, then to those without such rights and finally to non-statutory agricultural lands. This suggests that statutes and uses are important determinants of land prices. However, in the same move, it can be seen that the distance to the CBD and the access to water and electricity decrease while the plot area and distance to main road increase. As those factors are determinants of the price, they may confound the effect of statutes on prices.

INSERT TABLE 1

We first present basic facts about the tenure and use of land plots.

[7]Information on each plot was collected by a team of investigators through a variety of local informants (neighbors, informal brokers, customary chiefs, buyers, users, sellers, and elected local officials).

6.2 Land use and tenure mix

Figure 3 presents the share of property rights by distance to the city center at the time of the survey. The black color represents the share of residential plots that have statutory rights at the time of the survey. The blue color represents the share of residential plots that were transformed to statutory rights. The grey color represents the residential plots that were not transformed. The green color displays the non-statutory agricultural plots. The figure first confirms that the share of agricultural plots is larger away from the center. In line with the model, the figure also confirms that the share of plots with statutory rights are larger at locations closer to the CBD. Note that the share of transitions of residential plots from non-statutory to statutory rights peaks at approximately 16 km from the CBD.

INSERT FIGURE 4 HERE

Table 1 shows that within less than 3 years (and in some cases within just a few weeks), more than 13 percent of plots ($= 102/(102 + 675)$) that were initially non-statutory at the time of the transaction became statutory. Within 20 km from the city center, we see that 20 percent of initially non-statutory plots have become statutory. Beyond 20km, the percentage of non-statutory plots converted to statutory plots drops to less than 6 percent. In line with the model, this confirms that the conversion process tends to be more intense closer to the city center.

Table 2 confirms this trend by showing a probit regression of the transition to statutory status among initially non-statutory plots. The first column shows a negative and significant coefficient on distance to CBD in the absence of controls. In the reality, workers' trips to CBD are not only affected by the geographical distance to CBD but also by their access to a road. The second column adds the effect of the second spatial variable, namely the distance to the main road. As it can be seen, this variable also has a strong and significant effect on residential plot transitions to statutory rights. On the other hand, the tenure transitions are more likely for higher value of transacted land plots: higher land prices and larger plot surfaces indeed entice brokers to secure their assets by obtaining statutory rights. This is confirmed in the fourth column, which displays significant effects of those two factors. However land price is an endogenous variable determined by exogenous factors such as distance to CBD and main road, access to electricity and water and location characteristics. The third column shows that controlling for those exogenous factors

eliminates the impact of price on land statutory transitions, but does not affect the impact of the distance to CBD.

INSERT TABLE 2

6.3 Prices

Next, we estimate the differential land price gradients for residential plots with statutory and non-statutory rights. We restrict our attention to the land plots that have statutory rights at both dates of transaction and survey and those that are transformed from non-statutory to statutory rights between transaction and survey dates. This restriction allows us to separately identify the land purchases by urban workers and brokers as described in our model.

Table 3 displays OLS regressions of the log of the transaction sales price on various sets of price determinants. The first column excludes the determinants associated to distance to CBD and tenure. Controls include plot area, distance to paved main road, dummies for water connection, electricity connection and South bank location, and year dummies to control for land price inflation. Except for electricity access, all coefficients have the expected sign and are significant at 1 percent level. The second column adds the effect of distance to CBD. As in the theoretical model, this effect has negative and significant coefficient. The third column adds the impact of a plot purchase without statutory right (coefficient of NS purchase). As in the theory, the absence of statutory rights decreases the value of the purchased land plot. The last column adds the combined effect of absence of tenure rights and distance of the CBD. This strenghtens the negative impact of purchasing a plot without statutory right (coefficient of NS purchase), but this impact attenuates with distance to the CBD (coefficient of NS purchase*distance). Accordingly, this negative effect vanishes at about 36 km (1.77/0.049). This empirical result finally confirms our first model predictions: the land price gradient is steeper for statutory than for non-statutory plots. The land gradients are respectively -0.13 and -0.08 ($=-0.13+0.049$) for the former and latter.[8] Applying (12), the brokers' average of compounded probability $\mathrm{E}\left[\Pi(q) \mid x < \widehat{x}(q)\right]$ over the city is estimated to be 0.62 (=0.08/0.13).

[8] See also Selod and Tobin (2018) for a similar regression with a more detailed land tenure typology.

INSERT TABLE 3

Figure 4 depicts our observations after controlling for plot area, distance to paved main road, dummies for water connection, electricity connection, South bank location and land price inflation. In particular, it depicts the land price residuals of the regression in the first column of Table 2 as function of the distance to CBD. The small black triangles denote the residential land plots that remained statutory and the small blue squares the residential land plots that were transformed from non-statutory to statutory rights. The black and blue lines depict the linear fit on each set of points. The figure confirms our first model predictions according to which the land price gradient is steeper for statutory than for non-statutory plots.

INSERT FIGURE 5

Figure 4 also suggests a smaller variance for the observations of plots that already were statutory than those that became statutory. We can formally calculate that, over the whole sample, the average of the squares of residuals is equal to .75 for the former and to 1.10 for the latter. The discrepancy between those numbers rises when we restrict to observations beneath 18 km from the CBD: the averages of the squares of residuals become 0.36 and 1.38 respectively. Those numbers therefore confirm our second prediction: land prices have larger variance for plots that experience a tenure transtition to statutory rights.

By the same token, the last finding runs against the hypothesis that brokers are uninformed. According to the third prediction of our theoretical analysis, at a same distance from the city center, informed brokers set different prices whereas uninformed broker propose a single price reflecting the expected value of their heterogenous tenure risks. A discrepancy in the price variance for non-statutory and statutory plots therefore provides evidence about the absence of information asymmetry.

We can further check the existence of information asymmetry using our fourth model prediction: property right transformations abruplty cease beyond a critical distance from CBD under asymmetric information whereas they smoothly phase out under symmetric information. Towards this aim, we compare in Figure 5 the cumulative shares of observations across the geographical space of the residential plots that held statutory rights at the purchase time and

those that did not but acquired them. The figure shows that the sales of statutory residential plots (blue curve) are mostly uniformly distributed across the urban space between 10km and 28km whereas the sales of non-statutory lands (brown curve) that get transformed into statutory residential land are more concentrated about 18km from city center. In the uninformed broker model, there is no right transformation beyond the critical location, so that the cumulative frequency distribution is expected to be vertical at that location. The data reveals this patterns only partly as the right transformation peaks at about 18km. However, the absence of vertical edge makes it difficult to conclude for a model with only uninformed brokers. Overall, the evidence of existence of asymmetric information seems weak and the market failure seems unlikely.

INSERT FIGURE 6 HERE

Conclusion

As cities in developing countries grow and expand spatially, land use changes from agricultural to residential purposes while land tenure is converted from customary to formal/statutory property rights. Although this land conversion phenomenon is currently happening at a massive scale, especially in the rapidly expanding sub-Saharan African cities, the phenomenon remains largely understudied by economists. To fill this gap, we combine a monocentric-city urban economics framework with a theoretical model of land-tenure conversion from customary to statutory property rights. A key feature of the model is that land tenure is risky and brokers who purchase land from customary owners have the capacity to formalize tenure and reduce insecurity. Information on the risk of tenure transformation may be symmetric or asymmetric across customary land sellers and brokers. Under symmetric information, brokers perfectly evaluate the idiosyncratic transformation risk of each land plot. As a result, it is shown that the share of customary land smoothly decreases with the distance from the city center. Under asymmetric information, brokers are unable to evaluate this risk. As a result, there may be a failure in the land transformation market so that land transformation abruptly ceases at some distance from the city center. The paper then checks the predictions about tenure conversions using a geo-referenced

survey of land plots in Bamako, Mali and its peri-urban area. The empirical analysis confirms the main features of the model.

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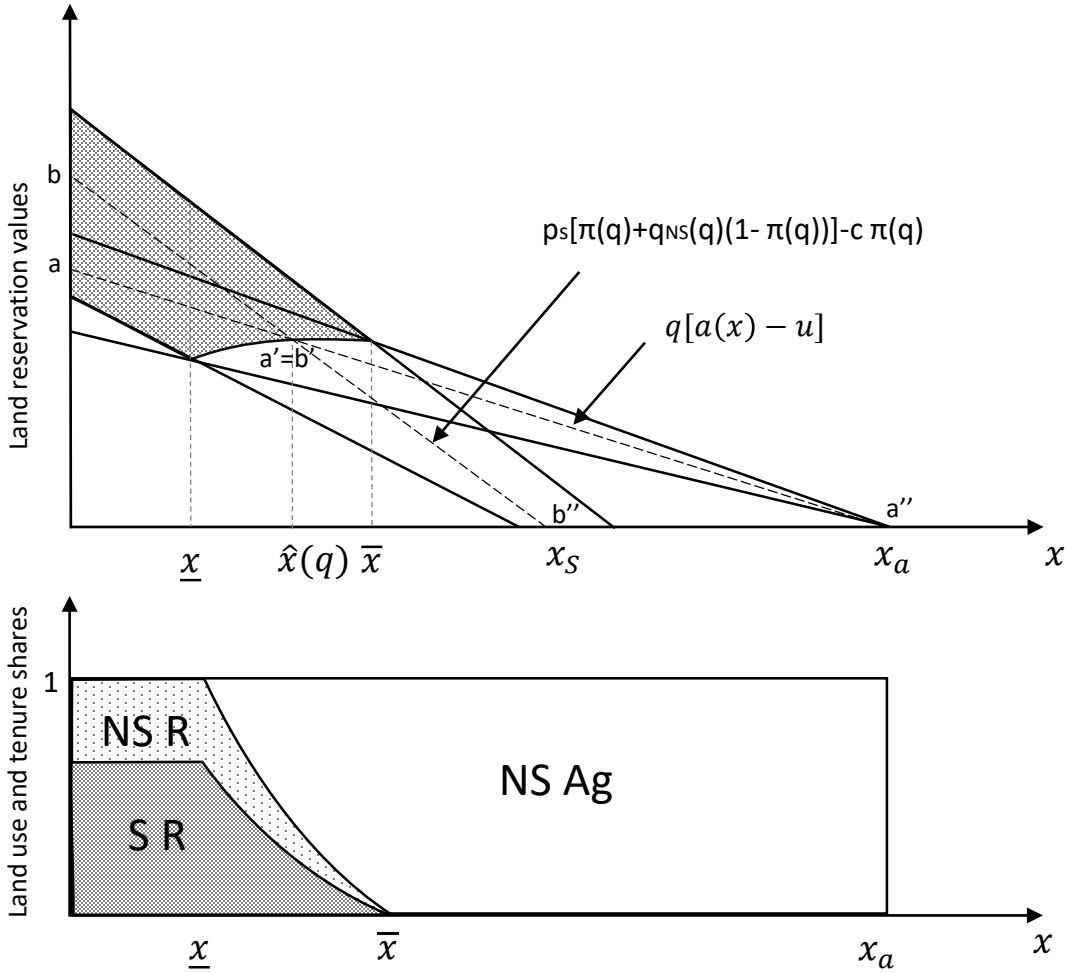


Figure 1: Land transactions and formalization under full information

Note: The top panel displays the land reservation values of customary farmers and brokers. The shaded area represents the set of values for the realized transactions between customary farmers and brokers in each location. The bottom panel shows land use and tenure status after the brokers' attempt to formalization. SR, NSR and NSAg stand for "Statutory Residential", "Non-Statutory Residential" and "Non-Statutory Agricultural" land.

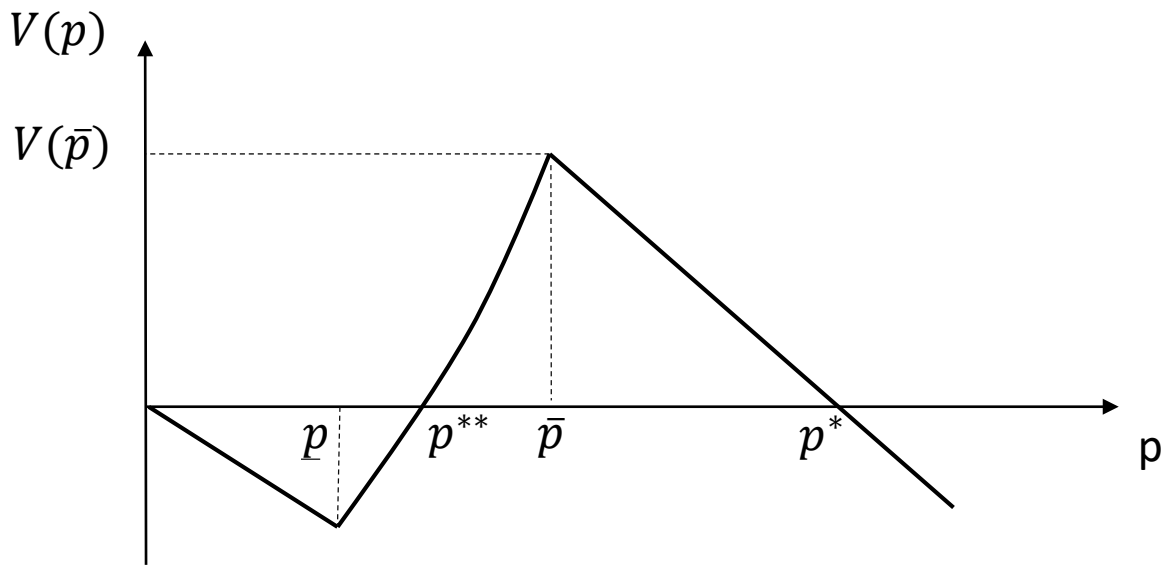


Figure 2: Broker's expected profit under asymmetric information.

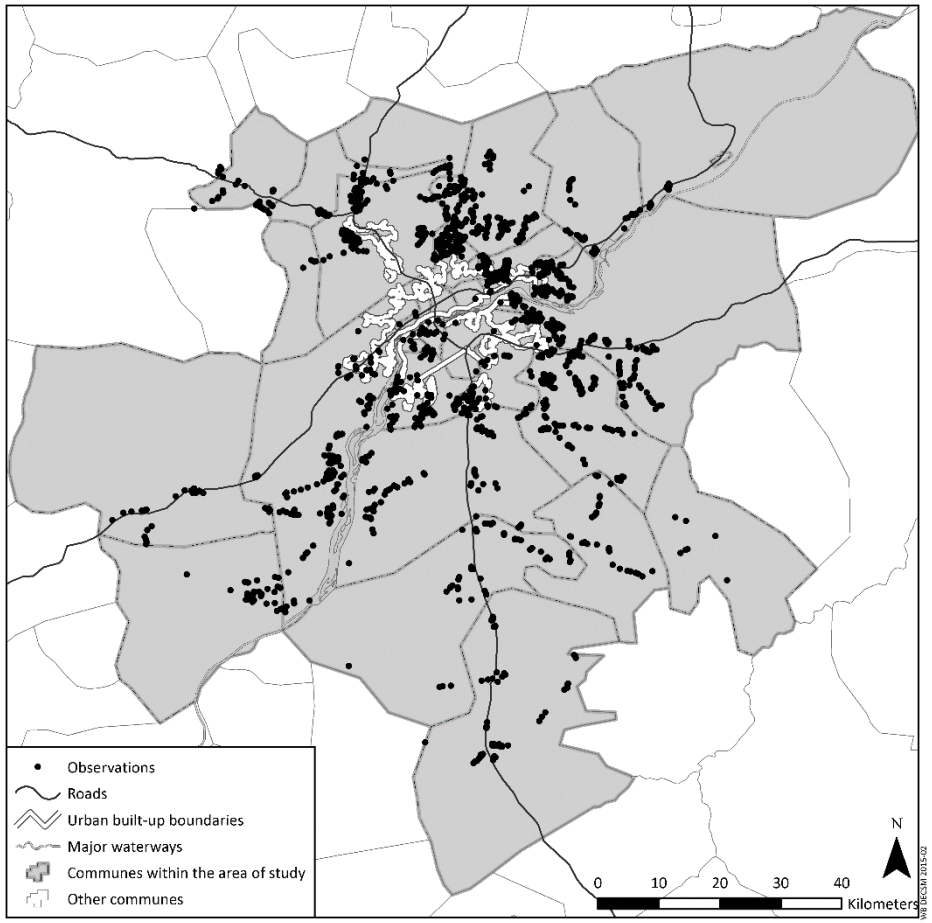
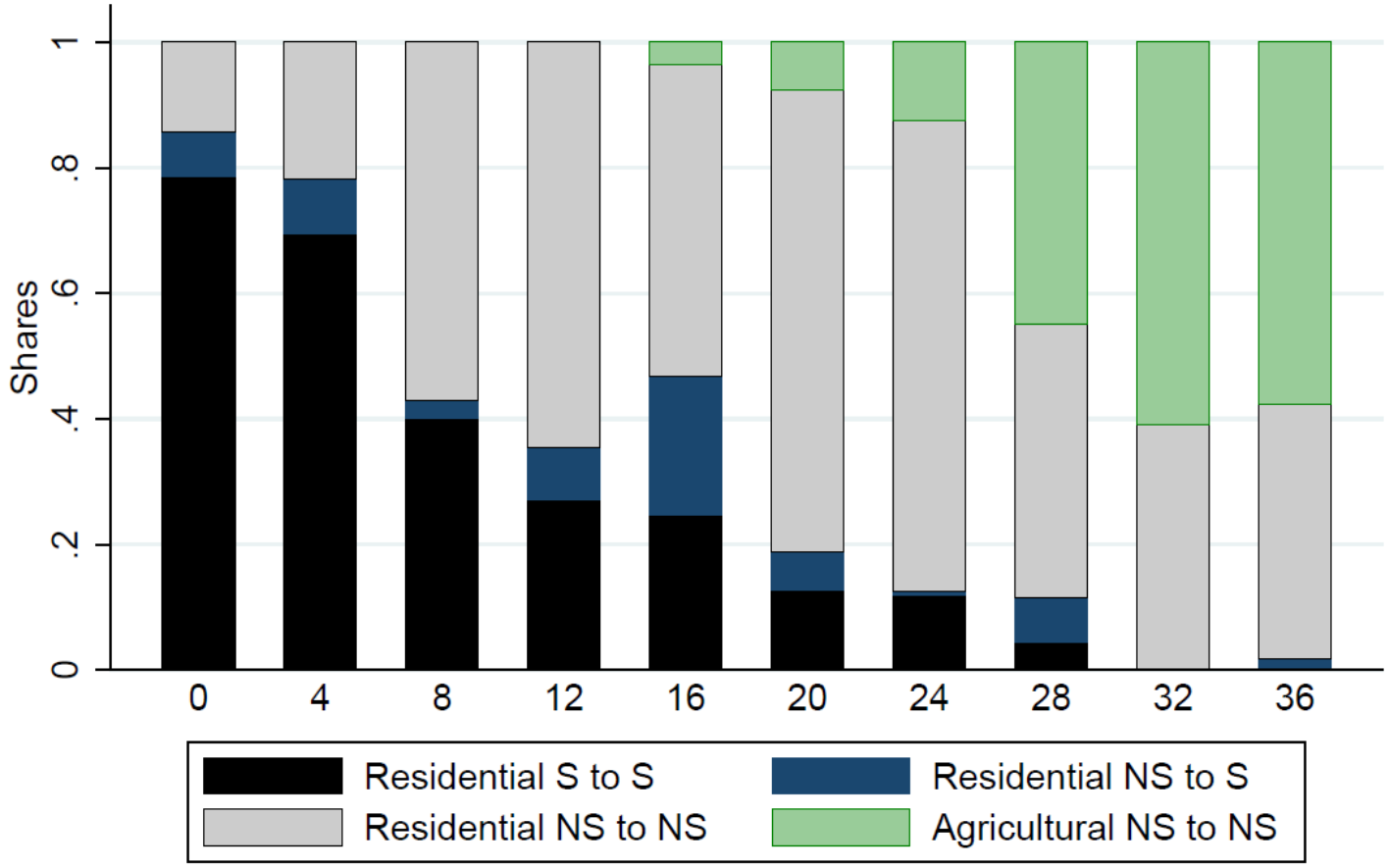


Figure 3: Surveyed land plots in the Bamako urban area and hinterland

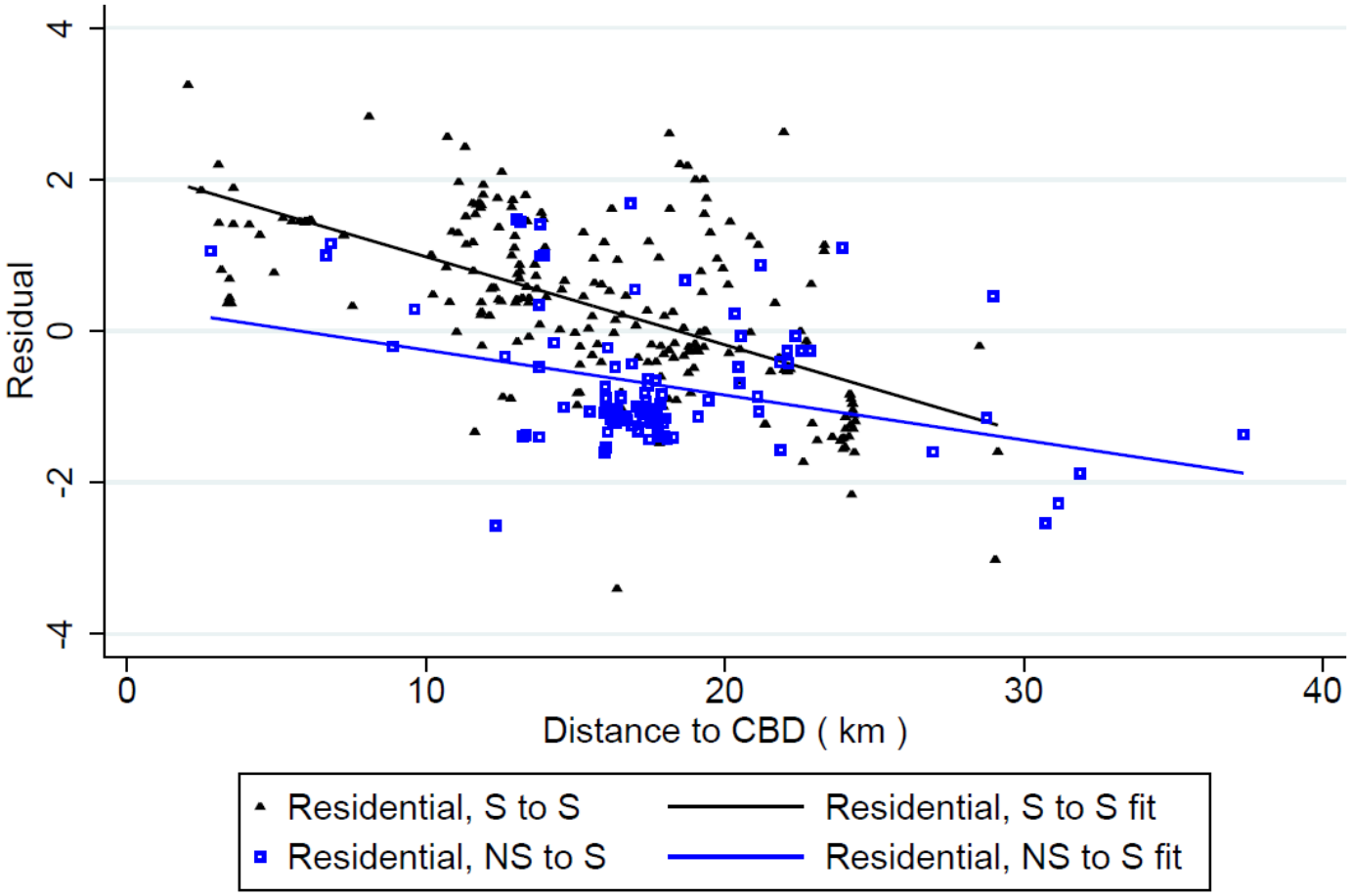
Note: The sample consists of plots that were transferred as unbuilt plots in Bamako and its surroundings between 2009 and 2012 (surveyed in 2012). Source: Durand-Lasserve et al. 2015.

Figure 4 - Land tenure and use by distance to the city center(km)



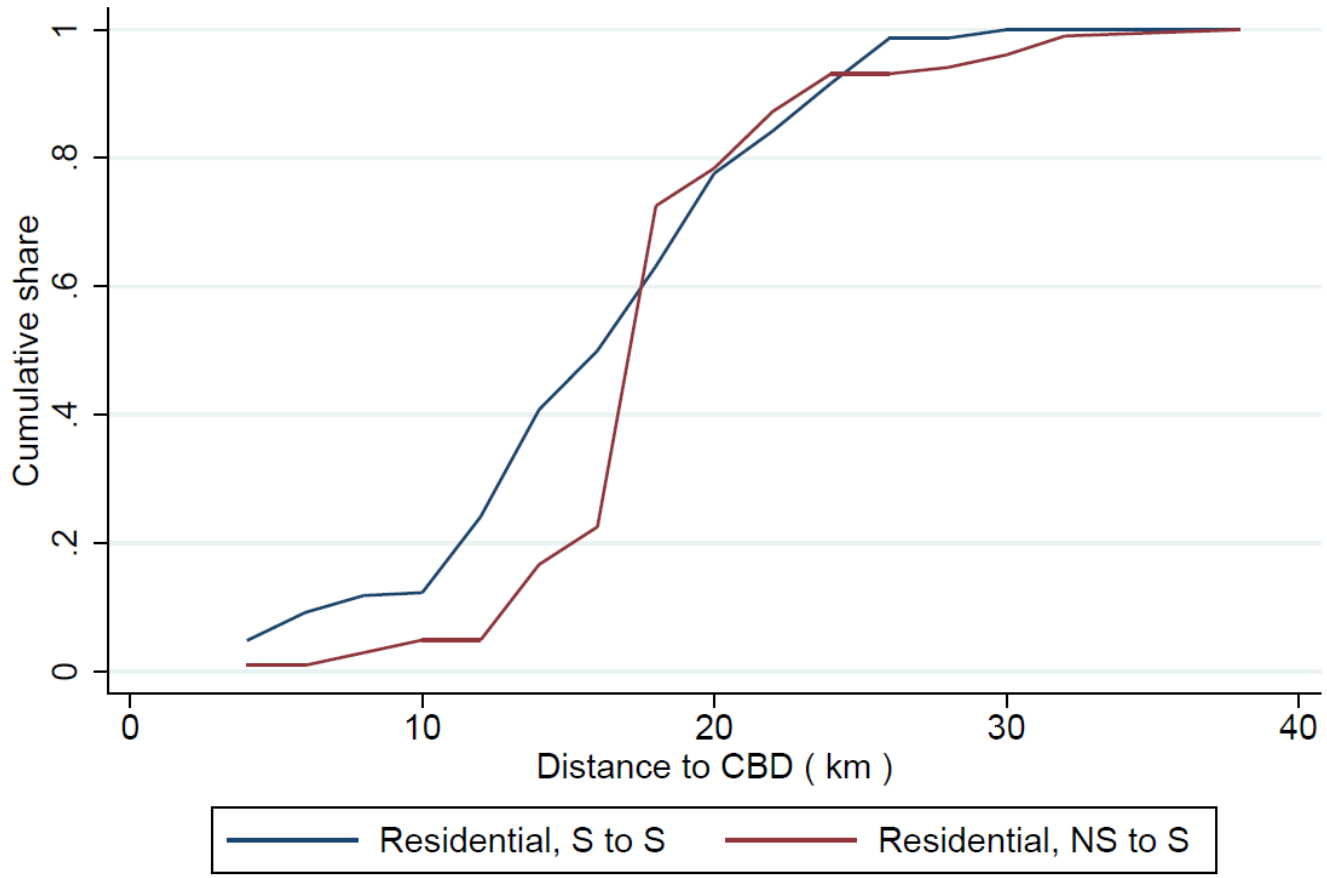
Note: The figure presents the share of property rights by distance to the city center at the time of the survey. The black color shows the share of residential plots that have statutory rights at the time of the survey. The blue color represents the share of residential plots that were transformed to statutory rights. The grey color represents the residential plots that were not transformed. The green color displays the non-statutory agricultural plots.

Figure 5 - Gradient of residual land prices (in log)



Note: The figure depicts the land price residuals after controlling for plot area, distance to paved main, road, dummies for water connection, electricity connection, South bank location and price inflation (see Table 2 column 1). The small black triangles denote the residential land plots that remained statutory. The small blue squares denote the residential land plots that were transformed from non-statutory to statutory rights. Black and blue lines depict the respective linear fit.

Figure 6 - Cumulative share by tenure transition



Note: The figure depicts the cumulative shares of observations across the geographical space of the residential plots that held statutory rights at the purchase time (blue curve) and those that did not but acquired them (brown curve).

Table 1: Summary statistics

	Residential						Agricultural	
	S to S		NS to S		NS to NS		NS to NS	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Log(land price) (CFA/m2)	8.16	1.462	6.808	1.403	6.759	1.231	3.952	1.226
Distance to CBD (km)	15.702	5.796	17.737	4.914	20.725	6.646	30.522	6.191
Log(area) (m2)	6.164	0.820	6.363	0.982	6.134	0.92	9.541	1.459
Distance to road (km)	3.295	3.259	3.189	2.71	4.84	4.588	6.674	6.338
Water dummy	0.066	0.249	0.029	0.17	0.024	0.152	0.014	0.117
Electricity dummy	0.022	0.147	0.01	0.099	0.001	0.038	0	0
South bank dummy	0.423	0.495	0.275	0.448	0.545	0.498	0.445	0.499
Number of observations	227		102		675		146	

Note: The table presents tenure transitions between the time of transaction (2009-2012) and the time of the survey (2012). Log is the Neperian logarithm. "NS to S" indicates plots with transition from Non-Statutory to Statutory right. "S to S" and "NS to NS" represents plots that remained Statutory and Non-Statutory respectively. Seven plots have been withdrawn as the price data was missing.

Table 2: Transition from Non-Statutory to Statutory Right (Residential, Probit)

Dependent variable: Transition NS to S				
Distance to CBD (km)	-0.041***	-0.047***	-0.056***	
	(0.010)	(0.011)	(0.014)	
Distance to road (km)		-0.080***	-0.081***	
		(0.019)	(0.021)	
Log(area) (m2)			0.25**	0.23**
			(0.080)	(0.071)
Water dummy			-0.41	
			(0.44)	
Electricity dummy			1.09	
			(0.98)	
South bank dummy			-0.42**	
			(0.15)	
Log(land price) (CFA/m2)			0.039	0.13*
			(0.071)	(0.056)
Observations	777	777	777	777

Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Year dummies included. Data: survey on Bamako, Mali, 2009-2012. The table reports the probit regression of log of land prices on distance to city center. The sample is restricted to the residential plots that were Non Statutory at the time of transaction.

Table 3: Land price gradients and tenure (OLS)

Dependent variable:	Log(land price) (CFA/m2)			
Distance to CBD (km)		-0.13***	-0.12***	-0.13***
		(0.010)	(0.0091)	(0.010)
NS purchase			-0.92***	-1.77***
			(0.11)	(0.38)
NS purchase*Distance				0.049***
				(0.021)
Log(area) (m2)	-0.69***	-0.42***	-0.41***	-0.46***
	(0.080)	(0.067)	(0.061)	(0.064)
Distance to road (km)	-0.12***	-0.12***	-0.13***	-0.12***
	(0.022)	(0.018)	(0.016)	(0.016)
Water dummy	1.04***	0.60*	0.48*	0.50*
	(0.31)	(0.25)	(0.23)	(0.23)
Electricity dummy	0.97	1.16**	1.12**	1.13**
	(0.52)	(0.42)	(0.38)	(0.38)
South bank dummy	0.91***	0.81***	0.68***	0.65***
	(0.14)	(0.12)	(0.11)	(0.11)
Constant	11.9***	12.4***	12.8***	13.3***
	(0.57)	(0.46)	(0.41)	(0.47)
Observations	330	330	330	330
R^2	0.457	0.649	0.715	0.720

Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Data: survey on Bamako, Mali, 2009-2012. The table reports the OLS regression of log of land prices at transaction date on controls (including year dummies). All plots are residential and statutory at the time of the survey. A share of plots are Non-Statutory at the time of the purchase (NS purchase)