Loss of plot formality through unregistered transactions: evidence from a natural experiment in Peru

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Abstract

Titling programs are considered by policymakers as an effective instrument for reducing poverty in developing countries. However, they have focused only on the process of granting the title; but have not paid attention to which conditions are necessary to maintain the formality of future plot transactions. Evidence from urban Peru shows a low registration rate, which considerably reduces households' ability to reap the benefits of tenure security. This paper identifies the determinants of registration of plot transactions and examines the impact of a modification in the registration process in 2004, involving higher fees and a more complex procedure, due to a change in legislation. Estimations from a duration model demonstrate the importance of education, income, and fees to the likelihood of registration. In addition, results from a difference-in-difference duration model indicate that the estimated average treatment effect of the change in registration process implies a reduction in the probability of registration of almost 3 percentage points, which represents a decrease of 34 percentage of the initial registration rate. These results are robust to the performance of falsification tests with different placebo interventions. Also, evidence suggests that there are negative effects of the change in registration process on some benefits associated with titling. Particularly, households who live in areas where the registration process became more complicated invested less in housing.

Keywords: tenure regularization, property rights reform, titling programs, informality, title registration, loss of formality, natural experiment, Peru.

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Introduction

Nowadays, policymakers consider titling programs one of the most effective instruments for reducing poverty in developing countries. The idea, according to promoters like De Soto (1990), is to provide assets for the poor and allow them to use those assets without restrictions in order to generate more wealth.[1] Along the same lines, a rigorous empirical literature on the impact of tenure security and titling has developed over the past decade. Titling has been associated with increased housing investment (Field 2005), increased labor supply (Field 2007), and greater access to credit (Carter and Olinto 2003), resulting in increased consumption (Galiani and Schargrodsky 2010), smaller household size (Field 2003), better education of children (Field 2003;Galiani and Schargrodsky 2010), better health and nutrition (Galiani and Schargrodsky 2010; Vogl 2007), and more pro-market beliefs (Di Tella et al. 2007). However, little attention has been given to the importance of maintaining transactions involving those titled plots fully formalized over the years.

In fact, this type of reform relies on the assumption that individual whose property was recently titled are familiar with the formal requirements associated to ownership. Plot owners may engage in transactions involving the plot such as inheritance, plot subdivision and mortgage, which need to be registered to be considered formal. Otherwise, plot owners may lose some of the benefits associated with formality, like the ability to use the plot as collateral or the ability to properly sell the plot. Evidence from urban Peru reveals that many transactions involving a change of ownership of the titled plots have occurred after the titling reform, but significant proportions of them have not been registered. Therefore, in order to maintain the benefits of the titling reform, it is crucial that policymakers address the conditions that are necessary to maintain future plot transactions formal.

Failing to register transactions involving recently titled plots can undermine the entire reform. To understand why, consider the possibility that an individual has recently bought a titled plot. If this individual does not register this transaction, the title will remain in the name of the previous owner. This situation, of course, will be exacerbated as the number of transactions involving the same plot increases. This situation could be worse, for example, in twenty years, when a high percentage of occupants of the titled plots are not the formal owners (and the costs associated with the legal solution to this problem cannot be afforded by the poor in many cases).

In such scenarios, investing in a titling reform without the right regulation of future plot transactions could be wasteful. The real underlying question is: why are these new owners not interested in registering their newly acquired properties? Perhaps the new owner perceives that the costs associated with registration are greater than the potential benefits. But if that is the case, what happened to all the benefits that secure tenure was supposed to provide? We can assume that the new owner knows that she cannot be evicted from her property, since it has already been titled. But why doesn't she demand the other desirable properties of the title, such as use of the plot as collateral? Here, the lack of knowledge about

[1] The protection of property rights has long been emphasized as an essential precondition for development (North and Thomas 1973; Demsetz 1967; Johnson et al. 2002).

the importance of registration, high fees, and unclear future benefits should play a relevant role in any tentative answer.

This phenomenon is currently observed in Peru. The Peruvian experience is particularly interesting, since it is one of the first and largest government titling programs targeted to urban areas.[2] In fact, areas that were titled at the beginning of the program have experienced an increasing number of plot transactions, a situation that was reinforced by the good performance of the Peruvian economy over the last decade. However, according to our sample, only 21 percent of those transactions involving a change of ownership have been registered. How can we understand the remaining 79 percent?

Along similar lines, in a recent study on slums in Argentina, Galiani and Schargrodsky (2011) find that only 23 percent of transactions are registered. The authors provide evidence that this phenomenon may be attributable to the high costs of remaining formalized. According to the authors, their evidence suggests that the title premium on these low-value parcels is insufficient to justify the legal costs of remaining formal.

This study analyses the importance of formal registration of plot transactions at the household level.[3] To do so, I use data on urban dwellers in Peru to identify the determinants of transaction registration and to measure the impact of a change in the registration process on the rate of registration. This analysis will allow me to provide some policy recommendations that can be useful not only to Peru but also to other developing countries where the sustainability of titling reform is threatened by an inappropriate registration system.

Using detailed data of plot transactions and registration from 3550 properties in urban slums, I construct a spell between the transaction and registration dates. For some plots, the occurrence of registration cannot be observed because the event had not occurred at the time of the survey. I use a survival model to identify the main determinants of registration because it is the most appropriate model to deal with the empirical issue of right-censored observations and the specific duration data structure. Based on this empirical analysis, I find evidence that different variables, such as the schooling and income of the head of the household, are relevant and positively affect the probability of registration. On the contrary, costs associated with registration seem to be very significant in reducing the rate of registration.

However, since it is very difficult for the authorities to control variables such as education and income, I explore the relevance of other variables, such as fees and procedures that can be controlled by policymakers. To do so, I evaluate the impact of a change in legislation that increased the fees and complicated the procedures on the registration rate. This will allow us to explore the causal relationship between the registration process (fees and procedures) and the rate of registration. The primary identification strategy of this evaluation exploits an exogenous variation in the registration process that occurred in mid-2004 in poor areas due to a change in legislation and the staggered implementation of *Registro Predial Urbano* (RPU), the parallel registration system created to focus on slums. Results from a difference-in-

[2] The Peruvian program started in 1996, and since then, almost 2 million property titles have been recorded by the government agency.

[3] As far as I know, only Galiani and Schargrodsky (2011) have explored this phenomenon at the micro level. At the macro level, Amin and Haidar (2012) analyze the relevance of legal origin of each country to explain the cost of registration of property. In a sample of 121 countries, they find that the cost of registering is lower by 26 percent in common law compared with civil law countries which is largely driven by differences in non-notary costs.

difference duration model indicate an important, highly significant and negative relationship between the registration process and the probability of registration. These results are robust to the employment of falsification tests, which provide more confidence in the causal interpretation of the main results.

The rest of the paper is organized as follows. The next section describes the setting and the data. Section 3 explains the survival model employed in the study and discusses the identification strategy of the evaluation. Results of the empirical analysis of the determinants of registration are discussed in Section 4. This section also shows the impact of the registration process on the registration rate and on some of the benefits associated with titling, as well as the robustness analysis. Section 5 concludes.

Institutional Background and Data

Plots are subject to different types of transactions, such as purchasing, inheritance, plot subdivision and mortgage, among many others. These transactions need to be registered at the corresponding Registration Office to be considered formal. The registration processes and fees vary according to the type of transaction. A plot becomes informal whenever the parties involved in a plot transaction fail to register it. When plots become informal, they lose many of the properties that formality provides, such as the ability to properly sell the plot or the ability to use the plot as collateral for loans from the banking system. Failing to register a plot transaction that involves a change in ownership has more serious consequences, like depriving the new owner of the right to legally claim the property.[4] For example, as it often occurs in urban slums, individual A buys a titled plot from individual B, but fails to register the transaction. Therefore, legally, the plot still belongs to individual B. This can give rise to different types of situations. First, if individual B dies, his inheritors can claim the plot. Secondly, if, after having sold the plot informally to individual A, individual B sells it again to a third party, individual C, who does register the transaction, individual C has the legal right to evict individual A.

There are two legal solutions to this problem. The first alternative is to register the transaction ex-post. For that to happen, both parties involved in the original transaction have to agree to register it. However, the longer it has been since the transaction occurred, the harder it is to get in touch with the other party. The second alternative requires the occupant of the plot to show legal proof that he has been living in the plot for a certain period of time in order to legalize his possession. Both alternatives require long and expensive procedures that become increasingly cumbersome and complex with time. Moreover, costs are high enough to exclude the poor, who are usually the ones involved in this type of situation.

Therefore, the registration of transactions is important in general; but it is particularly relevant in the case of urban slums, where informality is a major problem. That is why a titling reform should include not only the process of granting titles properly, but also the process of preserve those titled plots formalized by the correct registration of subsequent transactions.

In fact, the Peruvian government has been developing a general property rights reform for urban settlements since the beginning of 1990s, which originally involved both processes. As

[4] In many cases, informal buyers do have signed documents, but they are not legally valid.

a result, Peru started an area-wide titling program (named Cofopri) in 1996, and since then almost 2 million property titles were recorded by the governmental agency. Also, a complementary system of registration of transactions was implemented in that decade. In the 1990s, the *Registro Predial Urbano* (RPU) was created as a parallel system to the traditional Registration Offices. The focus of RPUs activities were urban slums, the same target population of the titling program. The idea behind that policy was to partially subsidize the registration for those households whose property was recently formalized. As a result, those areas treated by RPU benefited from a simpler and less costly registration process. The sequence of implementation of the RPU followed the geographic progression of the titling program. However, in mid-2004 this parallel system, RPU, was eliminated and the simplified registration process was substituted by the more complicated procedure provided by the traditional Registration Office.

Data

The objective of the empirical analysis can be divided in two: first, to identify the determinants of registration of plot transactions and, second, to evaluate the impact of a change in the registration process. To do so, I employ specific household surveys with detailed information provided by the household's head regarding plot characteristics, transactions and registration.[5] In particular, two datasets are used in the analysis. The first one (primary dataset) corresponds to a cross-section commissioned by Cofopri, collected during the first semester of 2010 from five different regions in Peru reached by the RPU program. This dataset is used with two purposes: (a) to analyze the determinants of registration; and, (b) to identify the treated units for the impact evaluation analysis. It includes information from 3550 properties, with 2493 of them having done at least one housing transaction in the past. The second source of data (secondary dataset) is a cross section collected in mid-2010 that was commissioned by Cofopri and includes information of 4020 properties from eleven different regions, including many districts that were not reached by the RPU program. This dataset is employed in the construction of the control group for the evaluation analysis.

For the purpose of the impact evaluation analysis, it is important to notice that both surveys have a similar sampling design and the same unit of analysis: the plot. The main difference between both surveys is that each focused on a different sub-sample of the population of plots in urban slums. The first survey is informative of areas that were early titled, while the second one focused principally on areas that were titled more recently. Since implementation of the RPU follows the geographic progression of the titling program, the first sample contains areas benefited by RPU (treated areas), while the second one is representative of areas that are less likely to have benefited by RPU (control areas).[6] Therefore, the comparison between treated and control group in the evaluation analysis involves comparing the households from the primary dataset with those households in the secondary data living in districts not reached by RPU.

[5] The information employed for this analysis is based on self-reported data, which could potentially lead to measurement error. However, since most of the transactions analyzed are informal, this is the only source to obtain this kind of information. In addition, we must take into account that measurement error is independent of the treatment.

[6] This is because this survey was collected as the baseline of a future impact evaluation of the titling program. As a result, it is possible to find in this sample some districts that were treated by RPU before the elimination of the program and others that were not treated. The latter are only used in the analysis. I could perform the impact evaluation by employing only the secondary dataset. However, the sub-sample of plots located in areas that were titled early (e.g. benefited by RPU) in this survey is too small.

Given that the information is based on household surveys, I am only able to re-construct the complete history of each plot since the current dwellers inhabit the plot. However, around 70 percent, for example, identified themselves as first dwellers of the plot in the primary database.[7] Additionally, there are similar retrospective questions in both datasets about transactions and registration. In that sense, each household's head is asked for the situation of her plot regarding each of eight different types of transactions. As a consequence, per each plot, there is information for eight different categories of transactions. The type of information available enables us to identify not only if the plot has been involved in a specific transaction, but also the year in which that transaction occurred. Also, both databases provide information regarding whether the transaction has been registered or not and the year in which the registration has been done.

With such information, we are able to construct the spell between the transaction and the registration. However, it is possible that we cannot observe for some plots the occurrence of the registration, because the event has not occurred yet at the time of observation. In fact, some plots involved in a transaction have been registered during the period covered in the analysis, but others have not. These right-censored observations should be included in the analysis, since they provide useful information, but they cannot be treated empirically as those registered ones. Survival models are appropriate to deal with the empirical issue generated when the spell end date is unknown, as well as with the specific duration data structure.

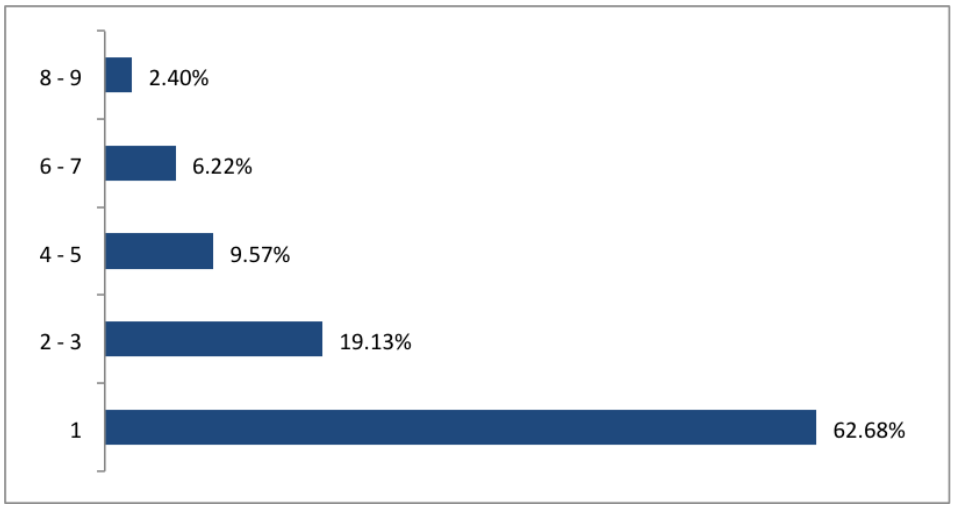
Since we are interested in analyzing the importance of the RPU program, we need to pay attention to the relevant period.[8] The empirical analysis therefore focuses on the sub-sample that covered the period between 1999 and 2009, which means that only those plots that have made a transaction occurring after 1999 are included in the analysis. As a result, there are 1267 properties in the analysis, having each plot 1.31 transactions on average.

In addition, the average length of the spell is 2.11 for those transactions that have been actually registered during the period of analysis. Figure 1 shows the number of years that households spent on registering a plot among those households who have performed at least one of these transactions. Like most of the plots that have been registered, about 62 percent of the plots were in fact registered within a year of the transaction. Around 6 percent of them required 6 or 7 years to abandon the unregistered situation.

[7] This rate may seem high but it should be noted that these households are located in zones that were previously unoccupied. Thus, many of the current owners were the first families arriving to these places.

[8] Also, since this analysis is based on retrospective questions, it is important to take into account potential problems associated with recall bias. This issue would suppose that the further we go back in time, the worse is the quality of the data, which would tend to reduce the number of transactions or registrations produced in those years. This issue reinforces the idea of analyzing only those transactions that occurred since 1999. If such problem would persist even in that period, the bias in the estimation of the parameter of interest is likely to have the opposite sign than the expected effect in the evaluation.

Figure 1: Years spent before registration of plot transactions 1999–2009 (only those transactions that have been effectively registered)



Also many household and community characteristics that can be used as control variables are included in both surveys. Other variables that can be important in the analysis are obtained from other sources. On the one hand, the fees of registration per each district in the sample have been obtained from a report provided by a consultancy firm. On the other hand, variables at the district level have been collected from the census (e.g. literacy rates, HDI, population density).

Empirical Analysis

The Survival Model[9]

Regarding its registration status, any plot can be in either one of two states: registered or unregistered. This analysis explores plot i's transition between these two states (from unregistered to registered). All the plots are considered registered (or fully formalized) before the occurrence of any transaction.[10] After being involved in a transaction, the plot moves to the unregistered state until the registration event, when it returns to its formalized condition.

For instance, we shall pay attention to both figure 2 and figure 3. In the first, we notice that plot A was fully formalized until 2005. At that point, the owner made a transaction but did not register it in the following 3 years. During this period, due to lack of registration, the plot was not fully formalized. In 2008, the owner eventually registered the transaction and the plot was again fully formalized. However, as pointed out earlier, many transactions may have not been registered at the time of the survey (in 2010). An example of this latter case is presented in figure 2. Now, we see that, in 2005, some other owner made a transaction with plot B but it remained unregistered until the date of the interview. Thus, unlike plot A, plot B is still not fully formalized.

[9] This subsection is largely based on Jenkins (1995, 2005).

[10] In this framework, formalized and non-formalized states are associated only with the plot's registration condition.

Figure 2: Transition of Plot *A*

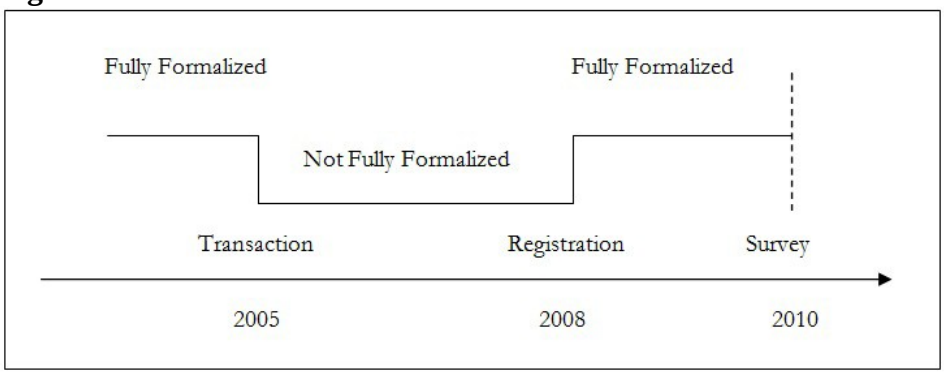
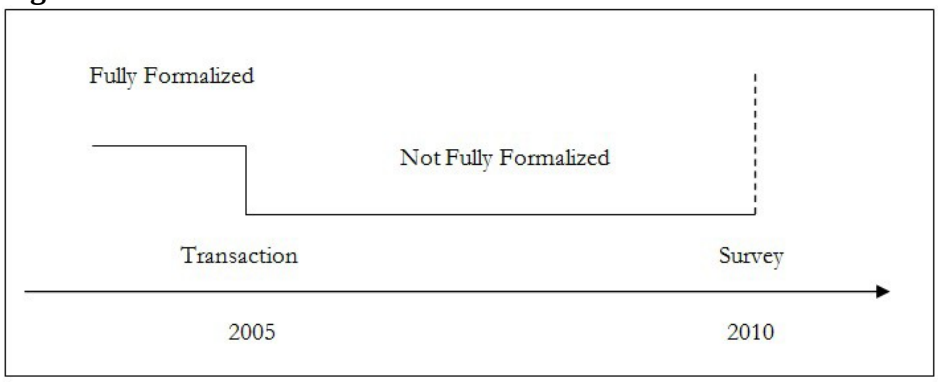


Figure 3: Transition of Plot *B*



As was explained previously, the data allow me to identify how much time each plot spent in each of these states for all types of transactions and when the transition from one state to the other occurred for each case. Using this duration data structure of the data set, this study analyzes the probability that an unregistered plot becomes registered, conditional on its having remained unregistered for a certain period of time after the transaction occurred. Since I am interested in examining the determinants of registration, I restrict my attention to plots that have been involved in at least one transaction. In that sense, the analysis is conditioned on a plot's having been involved in a completed transaction.

During the period of time observed, it is possible that the event (transition out of the unregistered state) has not occurred yet. In such situations, the total length of time between entry into and exit from the unregistered condition is unknown (we only know that the completed spell in this case exceeds the period of time in the analysis). As a result, in order to treat those observations differently, we need to distinguish whether plot i's spell is complete or right censored.

Even though events occur in continuous time, the lengths of the spells are observed in our data only in yearly intervals (we only have information about the year in which transactions and registration have taken place). Thus, we model empirically the following discrete hazard rate, which measures exactly the conditional probability of failure (e.g., occurrence of registration) during the *j*th year after the transaction took place, given that it remained unregistered up to that point in time:

$$hij = Pr(Ti = j | Ti \geq j) \quad (3.1)$$

More specifically, we use the following empirical specification:[11]

$$h_{igdt} = \alpha_g + \varphi_g \, log(t) + \gamma X_{it} + \lambda W_i + \psi Z_d + \rho V_t + u_{it} \quad (3.2)$$

where *i* indexes for each individual transaction (or plot); subscript *d* stands for the district where plot *i* is located; g indexes for the type of transaction; and *t* indexes for the duration or the time elapsed (in years) since the transaction took place (starting at t = 1 for transactions registered within one year). Notice that the model allows for different intercepts for each type of transaction (αg), as well as for the effect of time to differ for each type of transaction as well (φg). Xit is a vector of time-variant characteristics, including some household and plot characteristics and registration fees; Wi represents household and plot characteristics that are constant over time; Z_d are some time-invariant characteristics at the district level, such as the human development index or some geographical features; and Vt are year dummies. Finally, the term uit is the idiosyncratic error component.

In other words, the model specification measures the determinants of the probability of registration. The model controls for potential heterogeneity at the household, type of transaction, and district level. It includes not only some time-invariant variables but also some controls that vary over time, and the role of time itself (allowing it to differ for each type of transaction).

To evaluate the impact of a change in the registration process on the probability of registering, I expand the specification provided in (3.2). Thus, I include a `time' variable (T), which is a binary variable that takes the value of one if the observation corresponds to a period after the change in the registration process and an `area' variable (A), which is equal to one if the plot is located in a district treated by the RPU. The treatment effect of the change in the hazard rate of registration is provided by the coefficient associated ($\beta 3$) with the interaction of both variables (TA).[12]

$$h_{igdt} = \alpha_g + \varphi_g \, log(t) + \beta_1 T_{it} + \beta_2 A_{id} + \beta_3 TA_{idt} + \gamma X_{it} + \lambda W_i + \psi Z_d + \rho V_t + u_{it} \quad (3.3)$$

Also, in a complementary specification, I allow the treatment effect to vary with time because I anticipate that the change in the registration process should have a stronger effect on the initial probability of registration and a smaller effect on the hazard rates of registration at later periods. In this case, the treatment effect on the hazard rates for subsequent years is given by $\beta 3 TA_{idt} + \beta 4 TA_{idt} * log(t)$.

Identification Strategy

The main purpose of this section in the empirical analysis is to identify the impact of the registration process on the probability of registration. After analyzing its determinants, it is very evident that there are many variables that cannot be controlled by authorities. Therefore, any potential policy that tries to increase the probability of registration should focus on those

[11] Unlike OLS or classical binary models, duration models have no problem dealing with some characteristics of `survival time data' and show some advantages over those models. In particular, OLS models are not able to deal with (i) the existence of censoring in the data, (ii) the inclusion of time-varying covariates, and (iii) the particular structure of the duration data. Binary models cannot take into account the differences in time in which each observation can experience a transition of state. In fact, duration analysis captures timing and changes in circumstances over time, making it more dynamic than other models, such as the classical Logit model (Jenkins, 2005).

[12] A similar setting can be found, for example, in Behaghel et al. (2008).

variables that can be controlled by policymakers. Among them, the registration process (procedures and fees) is definitely the key one. To evaluate the importance of that variable, I will exploit an exogenous variation in the registration process in poor areas in mid-2004 due to a change in legislation that eliminated the RPU program. Identifying causal effects requires controlling for the natural trend with a comparison group. To do so, I take advantage of the staggered implementation of the RPU among the different districts targeted by the program.

As I previously indicated, the Peruvian government has been developing a general reform of property rights for urban settlements since the 1990s. It originally included not only the area-wide titling program, Cofopri; but also the RPU, a complementary system of registration for plot transactions. The RPU was created as a parallel system to the traditional Registration Offices (RO), and the focus of the RPU's activities was the same population targeted by the titling program.

The RPU has several benefits. In particular, the RPU introduces many legal and administrative policies that made the registration process less cumbersome. For example, the procedure allows the registration of the plot by any registered lawyer, instead of the more complicated process in the traditional Registration Office that must be authorized by a notary. As a consequence of this reform, the registration fees are much lower in the RPU than in an RO (around one-third of the original fees); this was the expected result, since the RPU was considered a kind of subsidy for the poor whose plot had recently been formalized. In particular, the average amount of this subsidy is not trivial: it represents a quarter of monthly family mean income in our sample.

However, the Peruvian government decided to change this system and consolidate both offices (incorporating the RPU into the RO), due to pressure brought to bear by the lobby of notaries. This policy became effective on June 14, 2004, when all of the functions of the RPU were completely absorbed by the RO; subsequently, procedures changed and fees increased (the differentiated treatment was cancelled, and the RO procedures were established as the general ones in every district).

Given that I use the staggered implementation of the RPU to construct the control group, it is important to first describe how it was executed. In fact, the sequence of implementation of the RPU followed the geographic progression of the titling program. As a result, by the time of the survey, it is possible that the RPU had not yet reached some districts either because the RPU office had not yet been set up in that area, even though the area was titled or because this area was not titled (it is even possible that some of those areas have still not been titled.) In any case, it is clear that those areas that did not benefit from the RPU seem to be less formalized.

The treatment group is defined as those districts where the RPU was implemented (and, therefore, underwent the change in registration process). The control group includes those districts that were also targeted by the RPU program but had not yet been included in the RPU by the time of the change in the process. Therefore, households in control areas never faced the modification in registration process, since they had the same process before and after the change. In the empirical analysis, in order to include as the comparison group only those districts not included in the RPU by the time of the change in the registration procedures (June 2004), I use administrative data provided by the RO.

Because control households should be comparable to treated ones, it is important to investigate if this is supported by the data. Table 1 shows some descriptive statistics of the sample. Even though there are some discrepancies between the groups, they are not very large. However, as I indicated earlier, if there is a difference between them, it would be produced by the disparity in the level of formalization.

Table 1: Summary Statistics

	Beneficiary	**Control**
HH Monthly Income per Capita (in current US ☆)	68.88	74.07
	(43.33)	(49.62)
HH Head Age	34.98	42.59
	(26.59)	(16.93)
HH Size	5.20	4.50
	(2.14)	(1.74)
HH Head is Female	0.16	0.12
	(0.36)	(0.32)
HH Head is Married	0.48	0.79
	(0.50)	(0.41)
HH Head Years of Schooling	6.37	4.80
	(5.47)	(2.64)
Access to Water	0.51	0.40
	(0.49)	(0.49)
Literacy rate (district level)	0.97	0.86
	(0.01)	(0.09)
HDI (district level)	0.66	0.58
	(0.02)	(0.05)
Obs.	4113	3927

Note: Standard deviations are reported in parentheses.

However, it is still likely that there is systematic heterogeneity between the treated and the comparison groups that may affect registration behavior but not due to the change in registration process. In order to verify that my results are not driven by community-specific characteristics, first, I include in the estimations several variables at the district level to control for any potential heterogeneity by area (such as population density, altitude, human development index, and geographical characteristics, among others). To allay concerns that there may also be differences in performance among households due to location, I also include in the analysis differential behavior of the control variables in treated areas by using the interaction of an area dummy (which is one if the household lives in the treated area) with all of the control variables.

After controlling for several characteristics, it is still possible that, due to the different timing with which the RPU reached each area, an unobserved heterogeneity correlated with location persists. However, if that is the case, the potential bias goes in the opposite direction; that is, it would tend to reinforce my results instead of undermining them. The fact that comparison districts were not in the RPU by the time of the change in the registration process would be related to the fact that these areas were less exposed to formalization (at least for a shorter period of time). Therefore, we could expect fewer incentives for registration in those areas (or, in other words, we can suppose that there would be an increasing trend in registration if these areas were exposed to formalization for a longer period of time). Consequently, we could anticipate an even larger effect than the estimated impact of this analysis, in which case my estimated effect would be a lower bound.

Results

Analysis of Determinants

The empirical analysis first explores the main determinants of the probability of registration. We are interested in analyzing the probability that an unregistered plot becomes registered, conditional on its having remained unregistered for a certain period of time after the plot transaction occurred.

Table 2 presents the results from the duration model that tries to identify the determinants of registration.[13] I have included in the analysis many different categories of control variables with the purpose of incorporating all the potential relationships (e.g., plot attributes, household head and household characteristics, type of plot transactions, and area characteristics). Several of those control variables appear to be significant in the model.

Among the determinants found in the duration model displayed in Table 2, we can distinguish the length of the period since the transaction was carried out. As expected, the longer a plot remains in the unregistered state, the lower the probability of registration. This result can be explained not only by inertia, but also by the fact that registration procedures become more complicated when longer periods of time are involved. The estimated impact of this variable is rather large. In particular, for each 1 percent longer that the plot remains unregistered after the transaction, the probability of registration decreases by approximately 0.055 percentage points (in the empirical specification which includes the common effect of time regardless the type of transaction). When allowing for different effects of time for each type of transaction, I found that when the transaction represented the sale of part of the property, each 1 percent longer that the plot remains unregistered was related with a decrease of 0.33 percentage points in the probability of registration; in the case of household improvement, this lead to a decrease of around 0.028 percentage points.

Regarding the characteristics of the household heads, education level seems to be relevant and highly significant. In that sense, higher education of the household head may also be associated with a higher probability of registration. This result suggests that a higher probability of registration may be associated with a better understanding of the importance of registration and its consequences, which, in turn, is related to a higher level of education.

[13] In order to preserve the consistency of the results, I employed an OLS model in order to identify the factors that detemine registration. However, the use of Logit or Cloglog models lead to similar results.

Table 2: Basic Duration Model: Determinants of Registration Probability of Registration (Conditioned that a transaction has been performed) 1999–2009

	(1)	(2)	(3)	(4)	(5)	(6)
Fee	-0.0192***	-0.0164***	-0.0177***	-0.0195***	-0.0213***	-0.0212***
	(0.0037)	(0.0037)	(0.0039)	(0.0039)	(0.0044)	(0.0042)
Duration	-0.0645***	-0.0632***	-0.0627***	-0.0591***	-0.0549***	-0.0257***
	(0.0048)	(0.0048)	(0.0049)	(0.0050)	(0.0049)	(0.0064)
Invasion		-0.0235***	-0.0209***	-0.0174***	-0.0040	-0.0049
		(0.0040)	(0.0041)	(0.0043)	(0.0045)	(0.0042)
HH Head Education			0.0023***	0.0021***	0.0016**	0.0015**
			(0.00069)	(0.00073)	(0.00074)	(0.00069)
HH Income per capita				0.0075*	0.0089**	0.0092**
				(0.0039)	(0.0043)	(0.0040)
Buy - sell					0.0542***	0.1841***
					(0.0116)	(0.0276)
Sale of a part of the property					0.2153*	0.4240***
					(0.1175)	(0.1401)
Mortgage of the property					0.0399***	0.1219***
					(0.0108)	(0.0293)
Obs	7264	7015	6925	6224	6224	6224
R^2	0.1044	0.1099	0.1133	0.1120	0.1361	0.1822
Baseline Hazard	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies x area	Yes	Yes	Yes	Yes	Yes	Yes
Plot Characteristics	No	Yes	Yes	Yes	Yes	Yes
HH Head Characteristics	No	No	Yes	Yes	Yes	Yes
HH Characteristics	No	No	No	Yes	Yes	Yes
Type of Transactions	No	No	No	No	Yes	Yes
Area Characteristics	No	No	No	No	Yes	Yes
Transaction x Duration	No	No	No	No	No	Yes

Note: Adjusted standard errors for intra-group correlation are reported in parentheses; * indicates 10 percent significance level; ** indicates 5 percent significance level; and *** indicates 1 percent significance level.

Variable Fee is expressed in thousands of Nuevos Soles, which is Peruvian currency.

Controls: (*i*) HH Head Characteristics: Education, Age, Sex, Marital Status; (*ii*) HH Characteristics: Family size, Household's income per capita; (*iii*) Plot Characteristics: Plot size, Obtaining the property by intrusion, Telephone, Electricity, Water Connection; (*iv*) Area Characteristics: Population density, Coast region indicator, Altitude, HDI; (*v*) Transaction dummies: binary variable for each type of transaction.

Similarly, a household's income influences positively the probability of registration and its estimated effect becomes more significant after including additional controls. This is because registration is costly: it involves not only the payment of fees but also the opportunity cost associated with the time engaged on the different procedures. As a result, it is more difficult for a poor family to assign a proportion of its income to the payment of registration fees and allocate time for the completion of all of the registration procedures. For the poor, these costs represent a higher proportion of their total income. At the same time, deprived households are less likely to obtain some of the benefits provided by a fully formalized plot, because they face other restrictions in making use of their properties. For instance, it is less likely that poor people gain access to credit markets using the titled plot as collateral because other financial restrictions remain binding. Therefore, poor households seem to face proportionally higher costs and lower benefits from registration, consequently decreasing their incentives to register.

Another interesting result from the model is that informality does not completely determine the behavior of residents of urban slums. Households that were initially informal (those who got the property by invasion) are not conditioned to always be in that state and may be interested in registering further plot transactions. In Table 2, we find that although the associated variable seems to be statistically significant in the initial specification, it is no longer relevant after controlling for area characteristics.

In order to capture the different incentives to register depending on the type of plot transaction, I include binary variables for each of them in the estimations. As anticipated, the results suggest that the probability of registration depends on the type of transaction. In fact, dummies associated with transactions that involve a change in ownership are highly significant and are associated with a positive coefficient, indicating that households are more interested in registering these types of transactions than the transaction included in the baseline (registration of an addition to the property, which is a transaction that does not involve a change in ownership). Thus, the results shown in Table 2 indicate, for example, that the probability of registration in the case of purchasing is 0.18 percentage points greater than the simpler transaction included in the baseline.

However, even though the relationships mentioned previously in this section provide important information regarding the problem of the observed lack of registration, they cannot give us straight policy recommendations, since all the variables included in the estimations cannot be easily controlled by the authorities, except for registration fees.

The fees charged in the registration process are under the control of policymakers and have been modified in the period of analysis. I include in the estimations the total costs (direct and indirect) associated with registering each type of plot transaction in each district under analysis, an approach that exactly resembles the heterogeneity faced by households in this respect. I also incorporate the increase in costs that occurred in 2004 due to a change in legislation. In fact, the increase in the average fees was about 225 Soles and it roughly represents 25 percent of the mean family income in the sample. The results indicate that costs associated with registration are highly significant and negatively correlated with registration, independent of the specification employed in the analysis. In particular, an increase of 100 Soles in the fees would reduce the probability of registration in 2 percentage points. This result moves in the same direction as income, also increasing the chances that costs overcome the perceived benefits associated with registration.

These results shed light on the main variables that explain the probability of registration, helping us to understand the complexity behind the decision to register. The empirical analysis will now focus on measuring the importance of the registration process, a variable under the control of the authorities, in the probability of registration.

Impact of a change in registration process on the probability of transaction

Additionally, it is important to determine if the change in the registration process in 2004 also influenced the probability of engaging in plot transactions, which would have an impact on my results. To evaluate whether the probability of a transaction is independent of the change in the registration process, we estimated a difference-in-difference (DD) model that measures the impact of said policy change on the possibility that affected households engage in a transaction. This analysis uses a binary variable as a dependent variables that measures if the household conducts any transaction during the relevant period. The "before" and "after" treatment periods are defined as corresponding to 1999–2003 and 2005–2009 respectively.

As is evident in Table 3, the results indicate that the exogenous change that occurred in 2004 did not affect the probability of engaging in a transaction. We conducted the same analysis to examine the impact on the number of transactions and obtained similar results. Despite these results, and to ensure that each type of transaction had an independent pattern, we allowed the estimates from the duration models to contain different intercepts for each type of transaction and also permitted the effect of time to differ for each type of transaction.

Table 3: DD Model: Impact of Exogenous Change in Registration Process on Probability of Transaction (1999–2009)

	(1)	**(2)**	**(3)**	**(4)**
Treatment	-0.5743	-0.4035	-0.5887	-0.6474
	(1.0479)	(1.0654)	(1.0866)	(1.0883)
Obs	3795	3728	3697	3697
R^2	0.0054	0.0077	0.0132	0.0146
Area Characteristics	Yes	Yes	Yes	Yes
Plot Characteristics	No	Yes	Yes	Yes
HH Head Characteristics	No	No	Yes	Yes
HH Characteristics	No	No	No	Yes

Note: Adjusted standard errors for intra-group correlation are reported in parentheses; * indicates 10 percent significance level; ** indicates 5 percent significance level; and *** indicates 1 percent significance level.

Controls: (*i*)Area Characteristics: Population density, Coast region indicator, Altitude, HDI; (*ii*) Plot Characteristics: Plot size, Obtaining the property by intrusion, Telephone, Electricity, Water Connection; (*iii*) HH Head Characteristics: Education, Age, Sex, Marital Status; (*iv*) HH Characteristics: Family size, Household's income per capita.

Impact evaluation of a change in registration process on the probability of registration

In this section, I present results from a difference-in-difference (DD) analysis to measure the impact of a change in the registration process on the probability of registering for the period between 1999 and 2009. To do so, I use different specifications, including gradually a more complete set of control variables. Taken together, the results tell us a single compelling story:

the elimination of the RPU considerably reduced the likelihood that households register their own plot transactions, even after controlling for their own “pre-treatment” baseline and comparing it with the trend provided by the control group.

First, I use a DD duration model that estimates the impact on the probability of a change in registration status due to the modification of the registration process in RPU areas, conditional on the plot having remained unregistered for a certain period of time after the transaction. With this purpose, I employ the specification provided by Equation (3.3). Thus, I incorporate to the previous estimations the variable “time,” which is defined as a binary variable that takes the value of one from 2004 onward; as well as the variable “area,” identified also as a binary variable that is activated if plots are located in districts treated by the RPU. The treatment effect of the change in the registration process is provided by the interaction of both variables (time and area). Control variables similar to those used in the previous duration model are employed in this analysis.

Table 4 exhibits the DD duration model estimates for the impact of a change in the registration process on the likelihood of registration. Results present a large and highly significant effect, with an associated coefficient of -0.027. This implies that the elimination of the RPU-subsidized benefits reduces the probability that a household registered its plot transaction by almost 3 percentage points (column 6). The estimated effect is large since it represents a decrease of 34 percent of the baseline registration rate of this sample. As we see in Table 4, the coefficients associated with the treatment effect are very robust to the inclusion of observed characteristics. Also, in column 7, I incorporate the possibility of a time-varying treatment effect. The results show that the treatment effects diminish with time (in percentage points) as shown by the positive value of the interaction of treatment with duration, although the pace of this reduction is very moderate and not statistically significant. These results suggest that in order for recently titled plots to remain formal, the registration system should be based on the specific characteristics and requirements of the poor.

Also, I investigate whether there are heterogeneous effects depending on some observable household characteristics. In particular, I interact the treatment variable with indicators associated with head of household's gender and household financial constraints (i.e. household income per capita in the lowest quartile of the distribution). I anticipate that households lead by women will be more interested in preserving formality and that poorer households will react more to the changes in registration fees. Table 5 presents the results of these estimations. Results confirmed the expected behavior, even though they are not significant at conventional levels. The latter can be considered evidence supporting the fact that, in our sample of slum dwellers, poorer households could not afford the fees from neither the previous RPU subsidized-system nor the current RO.

Table 4: DD Duration Model: Impact of Exogenous Change in Registration Process on Probability of Registration (1999–2009)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Time (after change)	0.0498***	0.0545***	0.0484***	0.0313*	0.0556	0.0477	0.0557
	(0.0071)	(0.0079)	(0.0086)	(0.0169)	(0.0442)	(0.0432)	(0.0444)
Area (location of change)	0.0319***	0.0347***	0.0326***	0.0330***	0.0253	0.0353	0.0341
	(0.0089)	(0.0098)	(0.0099)	(0.0100)	(0.0333)	(0.0320)	(0.0320)
Change in Registration Process	-0.0324***	-0.0355***	-0.0353***	-0.0352***	-0.0332***	-0.0270***	-0.0326***
(Area*Time)	(0.0092)	(0.0095)	(0.0095)	(0.0095)	(0.0095)	(0.0095)	(0.0146)
Time-varying change in Registration							0.0042
Process (Area*Time*Duration)							(0.0061)
Obs	9195	9052	8985	8985	8985	8985	8985
R^2	0.0796	0.0860	0.0911	0.0912	0.0993	0.1239	0.1240
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transaction dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transaction dummies x area	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plot Characteristics	No	Yes	Yes	Yes	Yes	Yes	Yes
HH Head Characteristics	No	No	Yes	Yes	Yes	Yes	Yes
HH Characteristics	No	No	No	Yes	Yes	Yes	Yes
Area Characteristics	No	No	No	No	Yes	Yes	Yes
Control Variables x Area	No	No	No	No	Yes	Yes	Yes
Transaction x Duration	No	No	No	No	No	Yes	Yes
Time-varying Treatment Effect	No	No	No	No	No	No	Yes

Note: Adjusted standard errors for intra-group correlation are reported in parentheses; * indicates 10 percent significance level; ** indicates 5 percent significance level; and *** indicates 1 percent significance level.

Controls: (*i*) HH Head Characteristics: Education, Age, Sex, Marital Status; (*ii*) HH Characteristics: Family size, Household's income per capita; (*iii*) Plot Characteristics: Plot size, Obtaining the property by intrusion, Telephone, Electricity, Water Connection; (*iv*) Area Characteristics: Population density, Coast region indicator, Altitude, HDI; (*v*) Transaction dummies: binary variable for each type of transaction.

Table 5: Heterogeneous Effects

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Household income per capita in the lowest quartile						
Treament Effect	-0.0266**	-0.0304***	-0.0309***	-0.0308***	-0.0293***	-0.02486**
	(0.0109)	(0.0113)	(0.0113)	(0.0114)	(0.0113)	(0.0113)
Interaction term	-0.0276	-0.0243	-0.0208	-0.0210	-0.0188	-0.0105
	(0.0194)	(0.0194)	(0.0192)	(0.0192)	(0.0189)	(0.0195)
Obs	9195	9052	8985	8985	8985	8985
R^2	0.0801	0.0864	0.0914	0.0914	0.0996	0.1242
Panel B: Household Head is Female						
Treatment Effect	-0.0335***	-0.0365***	-0.0362***	-0.0363***	-0.0336***	-0.0285***
	(0.0098)	(0.0101)	(0.0101)	(0.0101)	(0.0100)	(0.0101)
Interaction term	0.0111	0.0098	0.0072	0.0080	0.0061	0.0129
	(0.0286)	(0.0289)	(0.0294)	(0.0294)	(0.0293)	(0.0294)
Obs	9195	9052	8985	8985	8985	8985
R^2	0.0806	0.0869	0.0917	0.0918	0.0997	0.1242

Note: The interaction term in Panel A includes a dummy variable that has a value of one if family income per capita is in the lowest quartile. The interaction term in Panel B includes a dummy variable that has a value of one if the HH Head is female. Adjusted standard errors for intra-group correlation are reported in parentheses; * indicates 10 percent significance level; ** indicates 5 percent significance level; and *** indicates 1 percent significance level.

Controls: (*i*) HH Head Characteristics: Education, Age, Sex, Marital Status; (*ii*) HH Characteristics: Family size, Household's income per capita; (*iii*) Plot Characteristics: Plot size, Obtaining the property by intrusion, Telephone, Electricity, Water Connection; (*iv*) Area Characteristics: Population density, Coast region indicator, Altitude, HDI; (*v*) Transaction dummies: binary variable for each type of transaction.

Finally, it is also important to explore the adverse effects of not registering. One way of analyzing the adverse effects of the lack of registration entails checking to see if the change in the registration process in 2004 affects any of the positive effects attributed to formalization, including investment in housing. To test this issue, we developed several difference-in-difference models (see Table 6 and 7) to measure the impact of the change in registration policy in 2004 on the number of investments developed by households over a period of two years. In line with these estimates, we found that the households that live in areas where the costs increased and the registration process became more cumbersome invested less, which suggests that households invest less when it is more difficult to register transactions relative to their property. To increase the robustness of these results, we have used two different periods for the after- treatment period (2006–2005 and 2007–2006). In both cases, the result is similar

Table 6: DD Models: Impact of Exogenous Change in Registration Process on Housing Investment (Baseline: 2003–2004, Follow-up: 2006–2007)

	(1)	(2)	(3)	(4)
Treatment	-0.6797	-0.5361	-0.7653*	-0.7460*
	(0.4177)	(0.4270)	(0.4560)	(0.4487)
Obs	3795	3728	3697	3697
R^2	0.0055	0.0070	0.0137	0.0150
Area Characteristics	Yes	Yes	Yes	Yes
Plot Characteristics	No	Yes	Yes	Yes
HH Head Characteristics	No	No	Yes	Yes
HH Characteristics	No	No	No	Yes

Note: Adjusted standard errors for intra-group correlation are reported in parentheses; * indicates 10 percent significance level; ** indicates 5 percent significance level; and *** indicates 1 percent significance level.

Controls: (*i*)Area Characteristics: Population density, Coast region indicator, Altitude, HDI; (*ii*) Plot Characteristics: Plot size, Obtaining the property by intrusion, Telephone, Electricity, Water Connection; (*iii*) HH Head Characteristics: Education, Age, Sex, Marital Status; (*iv*) HH Characteristics: Family size, Household's income per capita.

Table 7: DD Models: Impact of Exogenous Change in Registration Process on Housing Investment (Baseline: 2003–2004, Follow-up: 2005–2006)

	(1)	(2)	(3)	(4)
Treatment	-0.4550	-0.2890	-0.4737	-0.4599
	(0.4113)	(0.4284)	(0.4581)	(0.4578)
Obs	3795	3728	3697	3697
R^2	0.0068	0.0090	0.0179	0.0185
Area Characteristics	Yes	Yes	Yes	Yes
Plot Characteristics	No	Yes	Yes	Yes
HH Head Characteristics	No	No	Yes	Yes
HH Characteristics	No	No	No	Yes

Note: Adjusted standard errors for intra-group correlation are reported in parentheses; * indicates 10% significance level; ** indicates 5 percent significance level; and *** indicates 1 percent significance level.

Controls: (*i*)Area Characteristics: Population density, Coast region indicator, Altitude, HDI; (*ii*) Plot Characteristics: Plot size, Obtaining the property by intrusion, Telephone, Electricity, Water Connection; (*iii*) HH Head Characteristics: Education, Age, Sex, Marital Status; (*iv*) HH Characteristics: Family size, Household's income per capita.

Robustness Analysis

In order to verify the causal interpretation of the main results, I conduct a falsification test. This test enables us to investigate the effect of omitted time-varying factors not attributed to the change in registration process, but that could produce a spurious treatment effect. In other words, the potential concern about my previous results is that the reported impact could be driven by something else related to the behavior of treated households (or even in the control ones) but not associated with the 'treatment' itself, such as a specific registration trajectory that would persist even in the absence of the change in the registration process.

For instance, it may be possible that there is a decreasing trend of registration in treated areas (or a higher increasing trend in the control neighborhoods). To address this, I employ a placebo intervention, established in a period when no one in the sample was exposed to the change in the treatment status. If indeed this unknown factor is the real driver of my results, we should still be able to find an effect, even though I am using in this analysis outcomes that are clearly unaffected by the change in the registration process. On the contrary, if it is not the case and my results reflect a causal impact of the change in the registration process, I would definitely expect insignificant estimates. This would reinforce the causal implications of the previous results, especially since there is no other specific policy intervention that affected the registration of plot transactions in the same period.

Table 8 shows these estimations. Since the change in the registration process (or 'treatment') occurred in mid-2004, I have modified the period of analysis to exclude any observation affected by treatment. Therefore, I use the period between 1999 and 2004 instead of the 1999–2009 that was used in the original analysis. In order to replicate the DD analysis, I use 2002 as the placebo intervention. I have also included alternative placebos (2001 and 2003) in the analysis for more robustness. As expected, the estimated effects are not significant at any conventional level, independent of the date of the placebo intervention used in the estimation. Also, the coefficients associated with the treatment effect are either very small or positive (opposite sign of the estimated effect). The results from this robustness analysis give us more confidence in the causal interpretation of the main results. These estimations strengthen the idea that the impact found in previous estimations is principally driven by the 'treatment'. As a consequence, these results emphasize the relevance of a simplified registration process to increasing the registration of plot transactions.

Table 8: Robustness Check: Placebo Test 1999–2004

	2001	2002	2003
Placebo	-0.1056	-0.1028	-0.1098
	(0.0821)	(0.0818)	(0.0814)
Area	0.0521	0.1103	0.1166
	(0.0879)	(0.0783)	(0.0794)
Placebo*Area	0.0523	-0.0038	-0.0154
	(0.0592)	(0.0207)	(0.0143)
Obs	2160	2160	2160
R^2	0.1850	0.1840	0.1844

Note: Adjusted standard errors for intra-group correlation are reported in parentheses; * indicates 10 percent significance level; ** indicates 5 percent significance level; and *** indicates 1 percent significance level.

Controls: (*i*) HH Head Characteristics: Education, Age, Sex, Marital Status; (*ii*) HH Characteristics: Family size, Household's income per capita; (*iii*) Plot Characteristics: Plot size, Obtaining the property by intrusion, Telephone, Electricity, Water Connection; (*iv*) Area Characteristics: Population density, Coast region indicator, Altitude, HDI; (*v*) Transaction dummies: binary variable for each type of transaction; (*vi*) Control variables x Area; (*vii*) Transaction dummies x Duration.

Final Remarks

Nowadays, policymakers consider titling programs to be one of most effective instruments for reducing poverty in developing countries. However, they have focused only on the process of granting the title; but they have not yet paid attention to which conditions are necessary for future plot transactions to remain registered. The absence of registration of those transactions involving plots that were titled as part of the titling program could undermine the entire property rights reform, since this non-formalized state considerably reduces households' ability to benefit from the security of tenure. Evidence from urban Peru shows that there are an increasing number of plot transactions, but very few of them are registered.

Using detailed data from urban slums, I constructed a duration model to identify the main determinants of the registration of plot transactions. According to the empirical analysis, there is evidence that a household head's education and income are relevant and influence positively the probability of registration. Also, households seem to be more interested in registering transactions that involve a change in ownership than other types of transactions. On the contrary, the longer a plot remains in the unregistered state, the lower the chance of registration. Additionally, the costs associated with registration (direct and indirect) are very significant and negatively correlated with registration.

However, since variables such as education and income are very difficult for the authorities to control, the empirical analysis focuses on measuring the importance of the registration process, a variable that is under the control of policymakers, in determining whether registration takes place. To do so, I exploit an exogenous variation in the registration process that occurred in mid-2004 in poor areas due to a change in legislation that eliminated the RPU program (the parallel registration system created to subsidize registration in slums). The results from a difference-in-difference duration model indicate that the elimination of the RPU benefits (simplified procedures and lower fees) reduced the probability that a household register its plot transaction by almost 3 percentage points. This estimated effect is rather large

if we compare it with the low baseline average rate of registration. The results are robust to a falsification test with different placebo interventions.

Finally, some evidence suggests that there is a negative effect of the change in registration process on some benefits associated with titling. In particular, I found that households who live in areas where the registration process became more complicated invested less in housing, which indicates that households invest less when it is more difficult to register transactions pertaining to their property.

These results suggest that in order for recently titled plots to remain formal, the registration system should be based on the specific requirements of the poor. This recommendation may be useful not only to Peru but also to other developing countries where the sustainability of the formalization reform is threatened by an inappropriate registration system and the subsequent lack of registration of plot transactions.

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