The homogenization effect of land titling on investment incentives: evidence from Peru

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Abstract

Land titling programmes have been widely promoted as a necessary condition for enhancing farmer's incentives to invest in their land. The justification for public intervention of this type is increasingly questioned on the grounds of its limitation to replace or improve the effect of informal or customary rights already in place. If the main aim of the programme is to formalize previous land rights and its procedure is based on the recognition of informal documents and reliance on community rules, it could in fact contribute to increased farmer's tenure security and therefore boost land investments. We explored this relationship for a sample of Peruvian farmers who were part of a state-led land titling programme that shared the aforementioned characteristics. Using retrospective information on the type of informal documents that parcels had before the start of the programme we were able to categorize the parcels at two levels of initial tenure security. The effect of titling on investments was then analysed for these two groups, using a difference-in-differences estimation technique. The results show that there is a positive effect of titling on the probability of making investments as well as on the value of investments for both groups of parcels, but also prove that the impact of titling is greater for parcels with previously low levels of tenure security. This effect could be almost entirely attributed to changes in farmer's willingness to invest and not to better access to credit.

Additional keywords: informal rights, investment incentives, tenure security

Introduction

Because of the potential effect of land titling programmes on farmers' willingness and ability to make efforts to invest in their land, such programmes have been widely promoted as a necessary condition for enhancing the investments. Two different types of arguments are commonly used in the debate on the impact of land titling on investments. On the one hand, the lack of tenure security can create a risk of land loss, causing a drop in expected income from investments. On the other hand, it may shorten the farmers' time horizon, and discourage them from performing actions

that would increase benefits over time. A clear definition and registration of full-fledged private property rights to provide land holders with the required level of tenure security would solve these problems and enhance farmers' willingness to invest in the land (Demsetz, 1967; Feder *et al.*, 1988; Barzel, 1989; Libecap, 1989; Feder & Feeny, 1991; Besley, 1995; Binswanger *et al.*, 1995). At the same time, the establishment of freehold titles increases the collateral value of land for credit lenders by reducing their foreclosure cost in case of default, allowing farmers to receive better credit conditions to finance their investment projects (Carter *et al.*, 1994; Besley, 1995; Binswanger *et al.*, 1995; Carter & Olinto, 2003).

Although there is little disagreement about the role of these factors at conceptual level, their relative importance in explaining the investment effect – and its consequences in terms of the distributional implications of land titling – have been subject to much debate in the literature. In settings where credit markets are missing or do not function well, there may be little justification for this type of intervention when the lack of credit was thought to be the main limitation for investments (Platteau, 1996). If titling only improves credit access for farmers that were already better off (Zimmerman & Carter, 1999; Carter & Olinto, 2003), then the titling policy will cause concerns in terms of its distributional effect. On the other hand, if the lack of tenure security is the principal constraint for farmers to undertake investments, and titling helps to improve it, the policy may provide large benefits to the poor who are usually less able to acquire security by other informal means (Deininger & Chamorro, 2004).

The need for public intervention in the provision of land titles with the intention to increase tenure security has received much criticism in the literature. A large part of that criticism comes from studies in different African countries where titling policies proved to be ineffective for enhancing investments. The principal argument of these studies is that in customary land areas, basic land rights (i.e., freely choosing which crop to grow, freely marketing of harvest output, preventing others from exploiting the same parcel) provided by local authorities or custom seem to be sufficient to induce land holders to invest, and that adding transfer rights (assumed to be brought by titling) does not appear to significantly improve investment incentives. Apparently, the local informal order embedded in the rural communities of these areas guarantees basic land rights to all villagers that are sufficient to induce investments. In this situation there will be no need for the state to intervene through centralized procedures aimed at formalizing land rights (Atwood, 1990; Migot-Adholla *et al.*, 1991; Platteau, 1992; Bruce & Migot-Adholla, 1994; Platteau, 1996).

Even though property rights regimes [1] may differ between African and Latin American rural societies, some researchers have started to transmit these concerns about the relationship between customary or informal rights and the introduction of full-fledged private property rights to the debate on the latter region. According to Zoomers & Van Der Haar (2000), this interplay constitutes one of the most important issues that require further investigation to better understand the current land tenure situation in Latin America. Most studies that attempt to measure the effects of land titling policies in Latin America disregard informal land rights that are currently in place. One of the reasons for not considering these informal land rights could be related to the fact that titling policies in the region have been mostly oriented to the

'formalization' of individual rights over pieces of land that were already privately held, and not so much to the process of 'privatization' of land held before under other types of property regimes.[2] Even where the principal scope of the policy is the formalization of individual rights, it seems far too simplistic to assume that there were either no informal rights governing the rules of use and exchange of land before the titling policy took place, or that these rights were 'homogeneous' amongst all plots and farmers such that the levels of tenure security before titling were all the same.

Relaxing these assumptions compels us to explore the different ways in which farmers build and enforce their private rights over the land, and to observe whether or not these different arrangements result in heterogeneous levels of tenure security and investments across parcels. In particular, we want to know whether there is a correlation between selected indicators of households' wealth and market integration and the probability of holding a document that provides higher levels of tenure security, and also whether parcels with these types of documents presented higher investment levels prior to the start of the land titling programme. If the latter is the case, it could be expected that the effect of the titling programme on tenure security and investments, if any, would depend on that initial level. A higher effect on investments for parcels with a low level of tenure security prior to the entitling programme would indicate a justification for the programme, not only from an efficiency point of view but also from an equity perspective.

This paper explores these hypotheses by using information from the Peruvian Land Titling and Registration Programme. The particular history of land distribution in Peru, as well as the characteristics of the programme's implementation process and the performance of the sample of farmers selected for this study, makes this case particularly interesting and appropriate for addressing our research questions. The rest of the paper is divided into five chapters. The first chapter contains an overview of the changes in land policies in Peru during the last three decades, and presents key aspect of the land titling programme under analysis. The second chapter describes the database used for this study, presents a classification of parcels by tenure status before the start of the programme, and formalizes our hypothesis. The third chapter deals with the econometric model to be estimated and with some of its potential problems. The estimation results are presented in the fourth chapter, followed by some concluding remarks.

Land tenure reform in Peru

During the last three decades the legal framework regarding land issues in Peru has radically changed from a strongly regulated process towards a more market-based perspective. The Agrarian Reform Law of 1969, which sets the base line for a large transformation of the agrarian structure, was followed by many restrictive laws about the use of land. Following the expropriation of the large haciendas from their previous owners a co-operative land ownership scheme was introduced together with new legislation prohibiting to sell the land received during this process. By the end of the 1970s, most of these co-operatives went bankrupt and many farmers and their organizations initiated movements to push the government for a change in this law.

Legislative Decree 85 of 1981 established the possibility of dissolving agricultural co-operatives in an attempt to promote a change in their management, but this turned out to be the beginning of the fragmentation of many of them, transferring small pieces of land to their members.[3] Most of the time, these transfers from co-operatives to individual members did not encompass a property title issued by the state but only an informal document provided by the dissolved co-operative. In some cases there was no document at all.

During the 1990s, Peru turned towards a more liberal regime in terms of land ownership and land use. In 1991, the government passed Laws 653 and 667, which promoted cadastral and titling policies for rural areas and also lifted some of the previous restrictions on land sales, rentals and mortgages. According to Zegarra (1999), in 1990 only 10% of the estimated total number of parcels was registered in the registry office. From this moment onwards, the definition of private property and the demands for well-defined property rights over the land became more important.

The *Programa Especial de Titulación de Tierras* (PETT Programme) was started in 1992 in order to promote land titling and improve the situation of many farmers with different types of informal documents supporting their land ownership status. The programme has a nation-wide perspective with the objective of constructing a rural cadastral system with validity all over the country. By the end of 2005, the PETT Programme managed to title and to register more than 1.5 million parcels, increasing the percentage of formally owned plots to more than 50%. Over the last seven years the programme budget amounted to more than 100 million US dollars, making it also one of the largest formalized programmes for rural areas in the developing world.[4]

Different steps taken in the Programa Especial de Titulación de Tierras

The diagram in Figure 1 shows the different steps followed by the programme for awarding a registered title.[5] The methodology implemented by PETT during the titling and registration (T&R) process is one of 'universal coverage', which in principle rules out any potential self-selection bias of programme participants and typical problems of reverse causality between titling and some impact variables such as investment. The programme is completely free of charge for farmers and works in a strongly decentralized way, with several regional offices sending their personnel to the field simultaneously. The first step in the process is to create a cadastral database of all the parcels within a certain region (normally a valley, which in turn is divided into several 'sectors'). PETT officials rely on aerial photography, contrasting the photos with the actual parcel information collected later on in the field together with the owner and the adjacent neighbours (Bordering). Information about the owner, field characteristics, and proof of informal rights over the land are also collected at this stage (Census). Based on this information the PETT regional office then produces a Registry certificate, which will be required for the entire titling process (Registry Certificate).

The next step in the process consists in registering the ownership rights in the public registration system (SUNARP).[6] To that end PETT officials use the information recovered in the Census to distinguish two levels of proof of ownership over the parcels

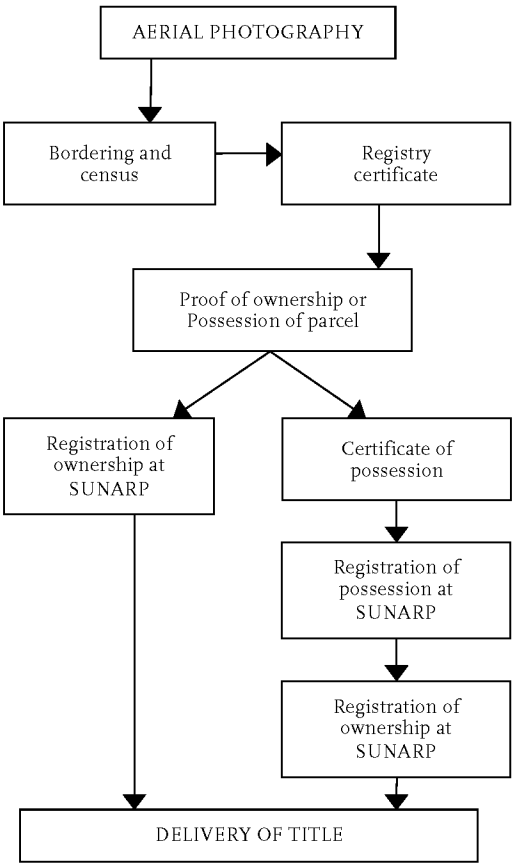

Figure 1. Diagram representing the steps followed by the PETT Programme for awarding a registration title.

(Proof of Ownership and Possession). If the documents presented by the farmer to the PETT officials provide enough evidence of ownership then the complete file for that parcel is ready to be sent to SUNARP. These documents include previous titles issued by the Ministry of Agriculture, private transfer contracts certified by a notary, or judicial resolutions. If the farmer could not present any document to prove his rights over the parcel or only has other documents not considered as proof of ownership, the procedure consists in issuing first a Certificate of Possession, later on to be converted into an Ownership Certificate for entering in the registers of SUNARP.

In order to obtain a Certificate of Possession, the farmer has to prove direct, continuous, peaceful, and public possession of the parcel for a minimum of 1 year for state land or 5 years for private land. To do so, it is enough to present a written declaration of all adjacent neighbours or a declaration of the producers association in the region. Adding any other document that shows possession is recommended but not mandatory. This Certificate of Possession together with the Registry Certificate is then

sent to SUNARP to register the possession right of the farmer. If accepted, SUNARP will then notify the owner and all community neighbours about the registration and give them 30 days to file any complaint. If by that time no complaint has been filed, SUNARP will proceed with the registration of the ownership rights. The final step in the process is the delivery of the registered titles to the owners, which is commonly done in a massive way with a public ceremony.

The classification of sampled parcels by tenure status

The database used for this study was collected during the last months of 2004 as part of the socio-economic evaluation process of the PETT Programme.[7] The survey was conducted amongst more than 2000 farmers distributed over five different regional domains in the Coastal and Andean region of Peru.[8] The sample frame used for this study was the National Registry Database, with information on more than 2 million parcels at the national level. As mentioned in the previous chapter, a parcel is added to this database when it just started the T&R process, which means that in principle all parcels are potential beneficiaries of the programme. In 2004, the year when the design was implemented, some of these parcels had already received a registered title, whereas other ones had not. This difference was the main feature for the initial selection of parcels as 'treatments' or 'controls'.

An important concern about this initial classification was the potential difference in registration time between a parcel with formal proof of ownership and a parcel that could only show actual possession. It is reasonable to think that the latter would encounter more conflicts and procedures to get an ownership registration. If this is the case, there will probably be heterogeneity in whether or not farmers ever receive a title and in the timing of receipt of title, and exogeneity of treatment will be compromised. However, there is an important characteristic of the programme that excludes this possibility. The titles are not issued on an individual basis but in a public ceremony. This means that officials normally wait until all or most of the parcels of a sector are titled and registered.[9] So heterogeneity in the time it takes to receive a title depending on the previous documents should not be a concern. Using a survey's question about the time it took to receive a title since the last visit of the PETT officials, we found that there was no statistically significant difference in time between farmers that had documents to show ownership and farmers who could only show possession of parcels (13 months for both groups).[10]

The survey also recovered recall-information on some variables that are of particular interest for this study. For example, data were collected for different types of land-attached investments made in each parcel of the household, recording also the year that the investments were made. In terms of the tenure status of each parcel, we collected information on the type of document the owners currently held as a proof of ownership or possession, and the year in which the document was issued, as well as on the type of document they held previously. This information helped us to reconstruct the changes in tenure status for each parcel of the household throughout the years, and in particular to identify the previous status of the parcels before being T&R by the PETT Programme.

We saw that the PETT Programme in fact makes a distinction between the different types of informal documents during the T&R process. Some documents contain enough initial evidence of ownership, whereas other ones first need to be 'validated' by the rest of the community members and by the Registry Office. This issue is an implicit recognition of previous land rights and might also be related to different levels of tenure security before titling. Even if these informal documents do not provide farmers with a complete 'bundle of rights' over their land, in some cases they can be sufficient to give farmers the tenure security needed to reduce their perception about any risk of losing the land in a dispute. If disputes over the land are mostly of local nature and can normally be solved by local authorities, it is likely that some of these documents provide enough enforcement power to make farmers feel secure. Moreover, if land transactions mostly occur between community members, some of these documents could provide enough security to the buyer in case of sales or to the owner of the land in case of leasing land for a period of time.

With this classification in mind, we made a further distinction in our treatment and control groups. Within the controls (parcels without T&R) we divided the parcels into parcels with 'low tenure security' (LTS) and parcels with 'medium tenure security' (MTS) according to the type of document that they currently held. Within the treatment group (parcels with T&R) we made use of retrospective information on the type of document they held before getting the PETT title so as to be able to subdivide these parcels in a similar way. Table 1 presents the distribution of parcels over these groups according to regional domains.

The parcels categorized as LTS were the ones without any document that proved possession or ownership, or the ones with a possession certificate issued by a Ministry of Agriculture's local agency or a peasants community, or a certificate of having registered a piece of public/abandoned land on your name. The parcels categorized as MTS were the ones with old titles issued by the Ministry of Agriculture, a buy-sell contract, or some type of public deed certified by a local judge or notary. The idea behind this categorization of parcels according to the type of documents was that land

Table 1. Numbers of parcels by regional domain, tenure security group and presence or absence of titling & registration (T&R).

Regional domain	Medium tenure security		Low tenure security		Total
	With T&R	Without T&R	With T&R	Without T&R	
North Coast	69	71	148	93	381
Centre-South Coast	60	35	39	17	151
North Andean	116	191	25	130	462
Centre Andean	220	227	148	128	723
South Andean	116	227	24	146	513
Total	581	751	384	514	2230

property rights in this setting could be better understood as a 'continuum of rights' instead of just a discrete indicator.[11] In this sense, low tenure security documents provide inferior rights as they serve at the most to prove possession of a parcel, but they cannot be used as a proof of ownership. Medium tenure security documents can be used legally to prove ownership of a parcel but they lack 'universal' recognition and approval as they are not registered in the public system. In this continuum, registered titles provided by the PETT Programme are supposed to give farmers the highest tenure security over their parcels.[12]

As mentioned in the introduction, we also wanted to know whether the probability of having an MTS document on a parcel before the programme had started is related to some characteristics of the farmers that would indicate a selection process to acquire them. In particular, we explored the possibility that farmers who are better off are more likely to have obtained an MTS document, so that the informal way of building land rights might be a constrained one. Table 2 shows the result of a Probit regression that

Table 2. Probability of having an MTS document on parcel. Situation 1994.

Variable	dy/dx [1]	SE
Total farm size (ha)	0.020 ***	0.008
No. of household members	−0.004	0.006
Sex of household head	0.022	0.025
Spanish main language	0.181 ***	0.031
House located on parcel	0.059 *	0.031
Time to walk from parcel to district capital (min)	−0.065 ***	0.007
Dummy Centre-South Coast	0.174 ***	0.030
Dummy North Andean	0.281 ***	0.025
Dummy Centre Andean	0.294 ***	0.032
Dummy South Andean	0.296 ***	0.027
No. of observations	2300	
Pseudo R^2	0.055	

[1] Statistical significance: * = $P < 0.10$; ** = $P < 0.05$; ** $P < 0.01$.

Table 3. Percentage of parcels with investments during the period 1990–2000, for the groups with low tenant security (LTS) or medium tenant security (MTS).

Group	Year					
	1990	1992	1994	1996	1998	2000
LTS	11.1	11.8	14.0	15.0	15.8	16.9
MTS	17.2	17.8	20.5	22.4	23.0	23.5

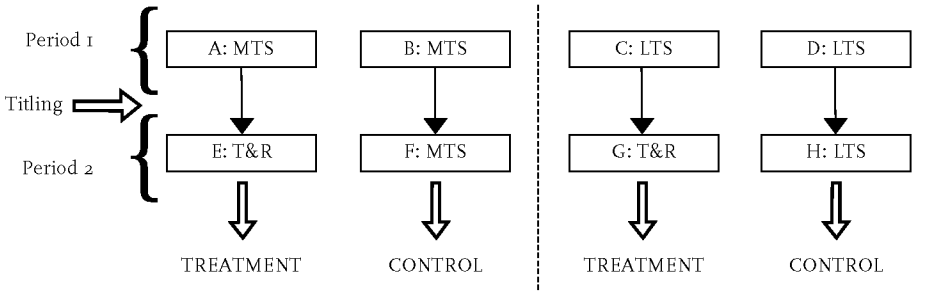

Figure 2. Methodological framework for testing the hypothesis about the effect of titling and registration (T&R) on investment for the low tenure security (LTS) and the medium tenure security (MTS) group.

explains the probability of having an MTS document on a parcel before the start of the programme, in terms of some indicators of household's wealth, education, or market integration.[13]

As we can see from Table 2, the probability of having an MTS document increases with total farm size and with the proximity of the parcel to the district's capital. Moreover, households where the head had Spanish as his main language – a variable strongly correlated with education – were also more likely to have acquired one of these documents. Finally, the positive relationship between stronger informal documents and higher initial levels of investment for the MTS and LTS groups is confirmed by the data in Table 3 over the period 1990–2000.

By using this classification of parcels we come to the following scenario for testing our hypothesis about the effect of T&R on investments for the two different groups of beneficiaries and controls (Figure 2). A detailed explanation of this figure, its construction using the data from our sample, and the estimator we derived from it, is provided in the chapter Results.

Following the model presented by Besley (1995), we can think of our particular case as observing farmer's investment decisions in two consecutive periods of time (period 1 and period 2), with an exogenous change in his property rights in between. Parcel's initial rights are heterogeneous in terms of the level of security that they provide, and thus can be classified into two groups accordingly: low tenure security parcels (LTS), and medium tenure security parcels (MTS). MTS parcels run a lower risk of expropriation and hence the marginal returns to capital, as well as the propensity to invest, are higher than those of LTS parcels. Under this scenario, the effect of the new assignment of rights can be derived from the observation on the change in the propensity to invest between period 1 and period 2. If the new rights do not contribute at all to a higher tenure security for the parcels, we shall expect no change in the propensity to invest in parcels of both groups. On the other hand, if the level of tenure security for the MTS parcels had already reached the maximum possible, we would anticipate no change for this type of parcels whereas a positive change would be expected for parcels in the LTS group. Finally, if the new rights enhance tenure

security levels for both groups of parcels, implying that their levels are 'homogenized' at a maximum, we would expect positive changes in both groups but also a higher increase for LTS parcels as these were more constrained before. In the next chapter we develop an estimation technique to test these hypotheses.

Econometric model and estimation strategy

The estimator that we wished to implement is called the Difference-in-Differences estimator (DID; Abadie, 2005). According to Figure 2, the differences we are interested in are [(E–A) – (F–B)] for the parcels with initial MTS, and [(G–C) – (H–D)] for the parcels with initial LTS. The idea is to compare the change in land-attached investments before and after the parcel was T&R, with the same change for the relevant control group. To measure this effect, we focused on the parcels that were T&R by the programme in the period 1994–2000 [14], and divided them into two groups according to the type of document they held before titling, i.e., LTS and MTS. The control groups are then presented by parcels with the same type of document in period 1 but that had not been titled yet in period 2.

Retrospective data on land-attached investments included fixed investments in different types of installations such as warehouses, cattle yards, mills, drainage works, water canals, and fences, and in land improvements such as terraces and land-grading. Following the predictions of the theoretical model, we expected a farmer to undertake one of these investments only if the expected return for doing so would be positive. As T&R on a parcel is supposed to increase this return, we expect the proportion of these parcels with investments to be higher in period 2 than in period 1. Consequently, we measured investments (I) as follows:

$$I_{it} = \begin{cases} 1 \text{ if at least 1 fixed investment was made on parcel } i \text{ in period } t \\ 0 \text{ otherwise} \end{cases}$$

Investments were recorded for the periods 1990–1994 (period 1) and 2000–2004 (period 2) in order to estimate the difference in the proportion of parcels undertaking land-attached investments before and after the treated parcels in our sample were T&R. To verify whether this change was not biased towards less valuable investments, we generated a variable for the value of these investments using auto-reported information on the money spent on the construction of these investments.[15]

The decision to select as treated parcels only the T&R ones during the period 1994–2000, excluding from the analysis parcels T&R between 2001 and 2004, mainly responded to the assumption that land-attached investments of the type referred to here are not undertaken continuously but rather sporadically. Given the retrospective nature of our data, and in order to have a relatively long period for registering investments, this selection was considered to be optimal.[16]

Because these changes over time could be reflecting only a natural increase in the propensity to invest or renovate investments, or any other time trend associated with

Table 4. Summary statistics. (see also note 20)

Variable	Medium tenure security			Low tenure security		
	With T&R	Without T&R	*t*-value	With T&R	Without T&R	*t*-value
Investments						
Investments (1990–1994)	0.05	0.07	−1.23	0.03	0.06	−2.11
Investments (2000–2004)	0.10	0.07	2.17	0.10	0.06	1.69
Investments (S/.; 1990–1994) [1]	6.77	14.09	−1.66	16.15	17.08	−0.08
Investments (S/.; 2000–2004)	27.81	35.61	−0.38	46.33	20.75	1.23
Parcel characteristics						
Parcel at altitude (0: no; 1: yes)	0.21	0.19	0.76	0.16	0.18	−0.61
Erosion index (0: no problem; 3: strong erosion)	0.40	0.33	2.06	0.36	0.33	0.81
Slope index (0: no problem; 2 pronounced)	0.73	0.69	1.09	0.57	0.62	−1.05
Soil quality index (1: very bad; 5: very good)	3.23	3.15	2.53	3.18	3.16	0.47
Parcel size (ha)	1.38	1.68	−1.21	1.70	1.36	1.44
Time to walk from house to parcel (min)	29.64	24.96	2.27	29.67	25.84	1.81
Road access to parcel (0: road not paved; 1: paved road)	0.08	0.15	−3.94	0.12	0.19	−2.82
Household characteristics						
Household size	3.81	3.91	−0.90	4.20	4.01	1.46
Sex household head (0: male; 1: female)	0.85	0.80	1.16	0.82	0.83	−0.35
Age household head (yrs)	63.36	63.28	0.11	60.44	63.79	−3.94
Education household head (yrs)	4.28	4.85	−2.66	4.33	4.21	0.48
Spanish main language	0.56	0.66	−3.45	0.56	0.62	−1.72

[1] Investments are in New Peruvian Soles (S/.) in 2004. 1 US$ = 3.4 S/..

the chosen periods, we made use of our control group to calculate DID estimates of the effect of T&R on these variables. So we assumed that the change in the situation of the control group between period 1 and period 2 was a good approximation of the change the treated group would have experienced in this period had they not received the title.[17] The equation that we estimated was as follows [18]:

$$I_{it} = \alpha_0 + \alpha_1(post)_t + \alpha_2(TR)_i + \alpha_3(post \times TR)_{it} + \beta' X_{it} + \varepsilon_{it}$$

where α and β are coefficients; *post* is a period dummy, *TR* identifies the parcels in the treatment and control groups, and X_{it} is a vector of parcel and household characteristics that could also be influencing the decision to invest. The period dummy *post* equals 0 for all observations in period 1 (1990–1994) and 1 in period 2 (2000–

2004). This dummy captures any aggregate factor that affects investments over time for both the treatment and the control groups.

As we were interested in the effect of T&R on parcels with an MTS document and parcels with an LTS document, this equation will be run separately for each group. The coefficient α_3 of the interaction $post \times TR$ is the estimated programme effect, which provides a measure of the conditional average change in investments for treated parcels.

Recent econometric studies suggest that in non-linear models the magnitude of the interaction effect is different from the marginal effect of the interaction term (Norton *et al.*, 2004), and that for computing the real magnitude of the interaction effect one must calculate the cross-derivative of the expected value of the dependent variable. As the sign and values of this interaction effect might be different for different values of the explanatory variables, we present in Appendix 1A the sample averages for these parameters. Additionally, we ran a linear probability model [19] as an alternative estimation that allows us to verify our findings (Appendix 1B).

Table 4 presents a comparison between the treatment and control groups for a set of parcel and household characteristics that could also influence investment decisions.

The differences in investments between the periods and groups show an interesting result (Table 4). Whereas the percentage of treated parcels with investments increases over time for both groups, control parcels remain unaffected. In terms of other characteristics, the comparison between treated and control parcels for both groups reveals a few small differences. For both groups, the treated parcels appeared to be more difficult to access and the heads of the households had not been raised with Spanish as the main language. Erosion appeared to be a problem on treated parcels of the MTS group even though the soil quality index was higher. Within this group there also appeared a small but statistically significant difference in the level of education of the heads of the households between treated and control parcels. Finally, within the LTS group the heads of the households with treated parcels were slightly younger than those with control parcels. The incorporation of all these parcel and household-related variables in the regression analysis (vector X_{it}) provides a simple way to adjust for observable differences between the different groups, and may also improve the efficiency of the estimate of α_3 by reducing the residual variance.

Results

Table 5 presents the DID estimates for the probability of having made a land-attached investment in the parcel (Probit model) and for the value of investments (Tobit model), controlling for the set of parcel and household characteristics presented before, plus dummy variables for the regional domains.

As can be seen from Table 5, there is a positive and statistically significant effect of $post \times TR$ (α_3) on the propensity to invest and on the value of investments in the MTS as well as in the LTS group of parcels. However, in both regressions the coefficients are smaller for the MTS group than for the LTS group. Compared with their pre-programme situation, receiving a title from the programme on the MTS parcels is associated with doubling the probability of making an investment, whereas on the LTS parcels the effect

Table 5. Probit and tobit estimates [1] from the difference-in-differences method applied to the full samples of parcels of medium and low tenure security.

Variable	Probit [2]		Tobit [3]	
	Medium tenure security	Low tenure security	Medium tenure security	Low tenure security
	(n = 2186)	(n =1547)	(n = 2186)	(n =1547)
post (α_1)	−0.002	−0.002	5.4	−5.2
	(0.014) [4]	(0.014)	(17.3)	(23.8)
TR (α_2)	−0.027 *	0.046 **	−34.8 *	−64.8 **
	(0.015)	(0.019)	(19.7)	(30.4)
post × *TR* (α_3)	0.054 **	0.085 ***	54.1 **	107.6 ***
	(0.027)	(0.036)	(29.1)	(45.1)

[1] Statistical significance: * = $P < 0.10$; ** = $P < 0.05$; *** = $P < 0.01$.

[2] Marginal effects.

[3] Conditionally marginal effects.

[4] Standard errors in parentheses.

of titling augmented the probability of making investments more than four times. This result confirms the presence of a 'homogenization effect' of T&R on investments.

Appendix 1A presents the results of the (average) calculated interaction effect using the Norton *et al.* (2004) method. Although the estimates of the interaction effect are lower for both groups, they are still statistically significant on average. Moreover, the results of the linear probability model in Appendix 1B show only a slight difference in magnitude of the α_3 coefficient from the DID regression [21].

In order to verify whether these results reflect a change in the tenure security perception of farmers, or whether they have to be attributed to an improvement in credit access brought by titling, we pursued two alternative strategies.[22] First, we distinguished between investments financed with credit and investments financed out of own pocket (OOP), and tested the effect of titling on the second category. This distinction is based on the respondents' answer to the questions about the type of financing used for each investment that was made on a parcel. This strategy, however, does not rule out the possibility that improvements in credit access could have been used for other purposes, thus affecting investment incentives in an indirect way. However, as 97% of the reported investments were said to be financed OOP, we do not expect a significant difference when following this approach. Second, a related test was performed by isolating the effect of titling on investments amongst non-borrowing households. Only 7% of the households in the sample reported having access to formal sources of credit over the past three years. Although our survey did not record access to credit prior to the programme intervention, including borrowing households at that time did not invalidate our test as these households did not show an increase in credit access after the programme. If the investment effect is robust to this limitation, we confirm that the principal mechanism at work is the one related to a change in tenure security.

Table 6. Difference-in-differences estimates [1] (standard errors in parentheses) of marginal (probit) and conditionally marginal (tobit) effects for OOP [2] investors and non-borrowers with medium (MTS) or low (LTS) tenure security.

Variable	OOP investors				Non-borrowers			
	Probit		Tobit		Probit		Tobit	
	MTS	LTS	MTS	LTS	MTS	LTS	MTS	LTS
	(n=2186)	(n=1547)	(n=2186)	(=1547)	(n=2039)	(n=1437)	(n=2039)	(n=1437)
post (α_1)	−0.001	−0.004	6.4	−9.6	−0.005	−0.003	2.2	−7.8
	(0.013)	(0.014)	(17.4)	(23.8)	(0.014)	(0.014)	(17.9)	(24.8)
TR (α_2)	−0.028 *	−0.044 **	−36.3 *	−61.8 **	−0.033 **	−0.048 **	−40.6 **	−69.8 **
	(0.015)	(0.018)	(19.9)	(30.2)	(0.016)	(0.019)	(20.7)	(32.2)
post × *TR* (α_3)	0.056 **	0.088 ***	56.8 **	111.9 ***	0.064 **	0.076 ***	62.5 **	104.1 **
	(0.028)	(0.036)	(29.5)	(45.2)	(0.03)	(0.036)	(31.0)	(47.8)

[1] Statistical significance: * = P 0.10; ** = $P < 0.05$; *** = $P < 0.01$.

[2] OOP investor = investing from own pocket.

As can be seen from Table 6, the estimates for the OOP investments are almost identical in magnitude and as statistically significant as the ones obtained when the total number of investments was used. Limiting the sample to non-borrowing households increased the α_3 coefficient by 1% on the MTS parcels, whereas on the LTS parcels it reduced the coefficient by the same percentage. These changes were not statistically significant when compared with the α_3 coefficients for the full sample.[23] These results suggest that the increase in investments was almost entirely driven by higher levels of tenure security brought by the title.

Concluding remarks

The results of this paper indicate that land titling policies aiming to formalize individual land rights have a differentiating effect on investments, depending on the farmer's level of tenure security over a parcel prior to initiating the policy. We showed that before the intervention of the programme, parcels could already be categorized into different levels of tenure security depending on the type of informal documents that farmers held. Accordingly, parcels with 'stronger' documents represented initially higher levels of investments than parcels with 'weaker' documents. The effect of the titling policy on the propensity to invest and on the value of investments was positive and statistically significant for both groups, but was larger on parcels with previously weaker levels of tenure security. This effect could almost entirely be attributed to changes in farmers' willingness to invest and not to better access to credit.

We expect that these results will contribute to the debate about the need for a

public intervention in the formalization of land property rights, particularly in Latin America. Although farmers have access to informal land documents to increase their security over the land, we showed that this procedure is mostly limited to farmers that were already better off. It is at best an imperfect substitute for the acquisition of full-fledged property titles such as provided by the PETT Programme. The differentiating effects of a title on investments in medium and low tenure security parcels, reinforced this idea and argue in favour of a public intervention to lift the limitations, enabling disadvantaged farmers to acquire tenure security through informal means. The recognition of different types of informal land rights and the reliance of the programme on community networks before the formalization of rights also appear to be fundamental for a successful intervention with a promising pro-poor orientation.

Finally, it is important to note that even though we found a justification for this type of intervention, there are many other aspects of the titling policy that need to be analysed in order to fully assess their potential effects and limitations. For example, the fact that the new investments brought by titling were mostly financed without the use of credit could indicate that they are limited to small and probably labour-intensive activities, which would not have a large impact on factor productivity or land values. When farmers were asked about their willingness to pursue more investments in land and about their principal constraints to do so, many of them pointed to the lack of credit as the main reason. So more work needs to be done in order to explore the constraints that farmers face in other markets and that can be influencing the potential effects of the programme.

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Appendix 1

A. Interaction effects of probit model

	Medium tenure security				Low tenure security			
	Mean	SD [1]	Min.	Max.	Mean	SD	Min.	Max.
Interaction effect	0.048	0.023	0.004	0.127	0.062	0.027	0.013	0.221
Standard error	0.024	0.010	0.003	0.058	0.029	0.011	0.009	0.093
z-value	1.936	0.203	1.044	2.251	2.106	0.289	1.309	2.688

[1] SD = standard deviation.

B. Linear probability model

Variable	Tenure security level	
	Medium	Low
	(n = 2061)	(n = 1476)
post (α_1)	0.000	−0.004
	(0.017) [1]	(0.018)
TR (α_2)	−0.032 * [2]	−0.073 ***
	(0.019)	(0.024)
post × *TR* (α_3)	0.057 **	0.091 ***
	(0.025)	(0.029)

1 Standard errors in parentheses.

2 Statistical significance: * = $P < 0.10$; ** = $P < 0.05$; *** $P < 0.01$.

Notes

[1] Following Bromley (1998), property right regimes comprise the nature of ownership, the rights and duties of the owners, the rules of use, and the locus of controls.
[2] By 'privatization' we mean the change from a communal to a private ownership of a piece of land and the consequent assignment of rights at the individual level. This case could be thought of as creating more conflicts between previous customary rights and the new individual rights brought by titling.
[3] Depending on the region, the type of production, and the status of the member, they got between 2 and 5 ha of land.
[4] Sources: The Peruvian Ministry of Finance, The Inter-American Development Bank, and The World Bank.
[5] This information was collected during personal interviews with PETT officials and is also available on the programme web page (<www.pett.gob.pe>).
[6] SUNARP is the 'Super Intendencia Nacional de Registros Publicos'. All this procedure is regulated under Legislative Decree (LD) 667 and its posterior modifications in LD 889 and Law Decrees 26838 and 27161.
[7] The evaluation of the programme was in charge of a research team from the Group of Analysis for Development (GRADE). A partnership with the Development Economics Group of Wageningen University was established in the technical proposal that was sent to the public contest.
[8] The coastal region was divided into the North-Coast and Center-South-Coast domains, and the Andean region into the North-Andean, Center-Andean, and South-Andean domains.
[9] The survey also includes some cases where farmers could not get the Certificate of Possession because of current conflicts over their land with other community members. These cases represented less than 2% of the sample of parcels and were excluded from our analysis.
[10] A problem will arise if there are sectors where all parcels had proof of ownership so that farmers belonging to this sector will get titles faster than farmers belonging to mixed sectors or sectors where parcels only had possession documents. However, our evidence indicates that almost all sectors had parcels in both categories.
[11] The classification of documents into LTS or MTS could be disputed for the ones located close to the middle of this continuum. Therefore, we created alternative classifications by changing these documents from one group to the other. The results presented in this study were not altered by these changes.
[12] One concern related to the validity of this classification has to do with the possible relationship between the duration of possession of the parcel and the type of informal document that the farmer holds. If the decision to acquire an MTS document is made mostly after a certain number of years the plot has been worked, and perhaps only after some investments have been made on it, then duration of possession will probably be the most relevant variable to differentiate parcels into tenure security levels previous to titling. To show that this does not appear to be the case in our study, we looked at the distribution of the years of possession for parcels in the LTS and MTS groups, and found that there was no major difference in the mean years of possession between parcels in these two groups and also that their distributions looked very much the same (see Appendix 1 A and B). Moreover, the median value of the difference (in years) between the time of possession and the time with an MTS document is located at 0, which means that in most cases the MTS document for the parcel was acquired when the farmer started to work on that piece of land.
[13] Total farm size and the number of household members at 1994 were obtained from the survey by using retrospective questions on land transactions and migration, respectively.
[14] This time period covers the whole 1st phase of the PETT Programme.
[15] Data on the magnitude of investments, however, are likely to suffer from problems of measurement

errors. The discussion of results and implications will be based only on the findings related to the incidence of land-attached investments.

[16] One problem with this set-up is that we introduced a negative bias in the impact estimate. Parcels T&R earlier in this period (e.g., 1995) could have made investments before 2000–2004 that will not be included. However, we believed this option is preferable to other ones in which we included investments made before T&R as outcomes of the programme. In that sense, we considered our impact estimates as a 'lower bound'.

[17] It is important to note that the final selected sample consisted of a balanced panel of parcels that belonged to the same owner in both periods of time. A small number of parcels (4% of total sample) were acquired after 1990 (had only information for period 2) and consequently were excluded from the analysis.

[18] A detailed explanation of this estimation technique can be found in Meyer (1995) and Wooldridge (2002).

[19] This estimation is based on The Linear Probability Model for Binary Response of Wooldridge (2002), who suggests using a weighted least squares regression.

[20] It is worth noting that all the variables that are not time-invariant (like sex, location of parcel, or main language) were measured at the time of the survey (2004). To avoid potential endogeneity problems we did not include control variables that could also have been affected by the programme intervention.

[21] The difference between the number of observations used in this regression and in the DID regression is due to the method applied to construct variance weights for the linear probability model. Approximately 5% of the total sample of parcels had to be excluded for having a negative predicted value of the dependent variable. The comparison between a simple OLS regression with and without these observations yielded almost no difference in the value and significance of parameters.

[22] The study by Field (2005) applies a similar test to distinguish changes in ability versus changes in the willingness to invest for households participating in an Urban Land Titling Programme. Besley (1995) suggest that the collateral effects can be distinguished by adding a dummy variable equal to 1 if the household has at least one parcel titled. As the PETT Programme titled all parcels located in the same valley at the same time, the households in our sample have either all or none of their parcels titled during the period 1994–2000, so that this method could not be implemented here.

[23] The test for equality of the coefficients across samples reports a $\chi^2(1)$ of 1.59 and a corresponding *P*-value of 0.21 for the MTS parcels, and $\chi^2(1)$ of 0.23 and *P*-value of 0.63 for the LTS parcels.