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Impact of land administration programs on agricultural productivity and rural development: existing evidence, challenges and new approaches

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Abstract– Investment in land administration projects is often considered key for agricultural productivity and rural development in developing countries. But the evidence on the effect of such interventions is remarkably mixed. This article reviews the literature and discusses a number of challenges related to the analysis of the impacts of land administration programs, focusing on developing countries where the starting position is one of land administration systems based on the Napoleonic code, with existing individual rights that may be imperfect and insecure. We examine a set of conceptual and methodological challenges including: 1. a conceptual challenge related to the need to unbundle property rights and to establish the plausible causal chain for land administration interventions; 2. the existence of other binding constraints on productivity, implying the need to consider heterogeneities in policy impacts and the complementarity between property rights and other productive interventions; 3. the need to account for spillover effects of land interventions on non-targeted households; and 4. methodological challenges related to the causal identification of the impacts of such interventions.

Keywords: *Land administration programs, property rights, agricultural productivity, rural development, impact evaluation methods*

Classification JEL: D23, O13, Q15

1. Introduction

Insecurity of property rights is often argued to be an important impediment for agricultural productivity, and more broadly for economic growth and prosperity (Besley and Ghatak, 2010). Land administration programs in many developing countries are designed to address such property rights insecurity, aiming at strengthening the rights of existing owners through clarification and formalization of individual rights, legislative changes, and/or improvements in conflict resolution mechanisms (IOB, 2011). Recent spikes in food prices have brought renewed attention to interventions that can

increase agricultural productivity, and hence land administration programs might seem an attractive avenue for further investment. Yet while donors and governments have invested in titling and other land administration programs for a relatively long time, rigorous quantitative evidence on the impact of such interventions is rare, in particular for rural areas (Lawry *et al.*, 2014).

Even more remarkably, the existing evidence is very mixed. The standard theoretical argument is that property rights can affect agricultural productivity through investment, credit and land allocation (Feder and Feeny, 1991; Besley, 1995). But empirical evidence on impacts of land administration programs on investment and land allocation is inconclusive, and the existing evidence for credit, if anything, mostly suggests no impact. As a consequence, empirically it is far from clear whether, how, and to what extent such programs can contribute to improving agricultural productivity.

This article reviews the literature and discusses a number of challenges related to the analysis of the impacts of land administration programs that, we believe, can in part explain the mixed evidence, and the confusing implications that may be derived from them. We focus on land administration interventions that aim at strengthening property rights, and consider a set of conceptual and methodological challenges including: 1. a conceptual challenge related to the need to unbundle property rights and to establish the plausible causal chain for a land administration interventions; 2. the existence of other binding constraints on productivity, implying the need to consider heterogeneities in policy impacts and the complementarity between property rights and other productive interventions; 3. the need to account for spillover effects of land interventions on non-targeted households; and 4. methodological challenges related to the causal identification of the impacts of such interventions.

The article focuses on developing countries where the starting position is one of land administration systems based on the Napoleonic code, with existing individual rights that may be imperfect and insecure.[1] Such settings are found mainly in Latin America. While differences between regions have frequently been ignored in the literature, the reasons for insecurity, and hence the starting positions for land administration interventions, often vary substantially. For example, the underlying causes of land rights insecurity can be very different in regions such as Sub-Saharan Africa, where groups often have strong pre-existing rights, and where there might be a complete absence of a systematic land administration system. Indeed, in a review of donor interventions to increase agricultural productivity, IOB (2011) notes that "efforts to increase land tenure security have taken place in very different contexts". It is unclear to what extent lessons based on evidence from one institutional setting are relevant in another. We therefore focus on a particular

[1] Other surveys have focused on land reforms in different contexts (Lawry *et al.*, 2014; Vendryes, 2014).

institutional context in order to avoid the risk that specific characteristics of this setting get lost within a more general review. That said, when discussing methodological challenges, we also draw on studies from other regions when they provide useful examples.

We use a broad definition of the concept of agricultural productivity, as the efficiency of agricultural production, which will depend on the allocation of land to different uses and productions, farming practices, and investments. While it could be examined using measures of land productivity, such as total output *per* hectare or farm yield *per* crop (labour productivity or total factor productivity could also be used), many studies in fact investigate agricultural investments such as the adoption of specific inputs or practices, or welfare outcomes derived from productivity gains, such as the agricultural income of farm households. We also consider a set of complementary outcomes, including broader measures of household welfare, land values, and municipal and higher-level outcomes such as land use planning.

The article is organised as follows: section 2 reviews the theoretical and empirical literature on land administration interventions in contexts of developing countries with legal systems based on the Napoleonic code. Since the evidence remains inconclusive, we then focus on a set of challenges that can explain this assessment. Section 3 discusses several conceptual challenges including: a) the need to make explicit the links between interventions and changes in rights, b) the presence of other constraints on the outcomes of interest likely to reflect in heterogeneities in the effects of interventions, and c) spillover effects of land interventions on non-beneficiary households and/or areas. In section 4, we then turn to the methodological challenges, discussing several methods to investigate the impact of property rights security and referring to previous studies. We discuss both experimental and non-experimental methods, highlighting the challenge of addressing selection bias and establishing causality. Section 5 concludes.

2. Evidence on the effects of land administration interventions

2.1. Unpacking property rights: which rights are changing?

There are several channels through which land administration interventions can change property rights, since property rights can be imperfect or incomplete in many different ways. Indeed, land rights are made up of a bundle of different rights, including the right to use the land, rent out the land and sell the land (Alchian and Demsetz, 1972). In practice, land rights can stem from a range of sources, including both customary and statutory authorities, they may be formal or informal, and they may be described as "ownership" rights or "use rights". For the purposes of this article, we abstract

from these differences, and focus on 'effective' rights, following Barzel (1997) in considering an individual's property right as their "ability, in expected terms, to consume the good (or the services of the asset) directly or to consume it indirectly through exchange". In the case of agricultural land, we can think of an individual consuming the services of the asset, either through farming the land themselves or through renting it out to someone else. In general, this ability could be affected in a number of ways–but typically the policies we will consider aim at "strengthening" rights by increasing the probability that a particular individual can essentially consume the services the land provides (Feder and Feeny, 1991).

In general, government policy may aim to affect land rights in a number of ways, but we are restricting ourselves to interventions that typically do not (overtly) aim to transfer rights from one individual to another. In particular, we can think of this as interventions that seek to maintain the relative ranking of land rights across individuals – if individual A had a greater expectation of consuming the land services than individual B before the intervention, then this remains the case after the intervention. What the interventions aim to change is the distribution of probabilities between the two individuals, so that individual A's expectation increases (and correspondingly B's decreases). For the purposes of this article, it is useful to think about three different ways land administration interventions aim to effect such a change. First, they may increase the expected security of an individual or group's claim to future land use – in other words, reduce the probability that the land will be consumed by some other individual or group who holds a weaker claim. Second, they may essentially individualize rights, essentially transferring to individuals rights that were previously held by groups. Third, interventions may focus on the "indirect" consumption part of the definition, through facilitating consensual land transfer. We distinguish along these three lines since they correspond to the major changes that are analyzed in the theoretical literature (see section 2.3).

Increased expected security

This includes any part of an intervention that makes the land rights less likely to be expropriated or contested, or that reduces the perceived likelihood of such events. Here we use the word expropriation to mean any transfer without the owner's consent, with two typical forms of such transfer being to squatters/tenants, or someone else at the behest of the government (local or central). Interventions may increase the security of all land rights (*e.g.* by reducing the potential of conflict), or just of certain plots that were previously contested (*e.g.* by issuing plot specific documents). They may increase ownership security for plots that are rented and reduce transaction costs for such rentals.

Individualization of land rights

This includes any aspect of an intervention that transfers rights from groups (*e.g.* families, communes, or the state) to individuals. This individualization may be an individualization of usage rights, income rights or transfer rights. In settings with existing individual rights, the latter two are most common, with individualization likely to take one of three forms: a) individualization of family-owned land, *i.e.* land in co-ownership after inheritance[2], b) individualization of government-owned land that is already being used by an individual, and c) individualization of communal or collective land that is already being used by an individual.

Facilitation of consensual ownership transfer

This includes any aspect of an intervention that reduces the transaction costs involved for owners of land to sell their land or control its inheritance.

2.2. Types of land administration interventions

The land administration interventions we focus upon in this article are the ones that change property rights.[3] We identify the different land administration interventions to be considered based on policy reports on land policies, notably Deininger (2003). While land policies on property rights often primarily aim at increasing tenure security, they can affect simultaneously several dimensions of rights altogether, including the transferability of rights.

The set of interventions affecting tenure security we focus upon includes: a) the provision of formal and individual ownership titles, b) institutional reforms, c) mapping and surveying, d) systematic registration, e) the regularization of legal rights over state land, and f) legal and policy changes. The provision of formal ownership titles has been the main intervention in Latin American and the Caribbean for increasing ownership security where land is owned informally or with incomplete titles (notably due to transaction costs). Institutional reforms, that aim at improving the efficiency of land administration institutions in charge of the demarcation of boundaries, registration and record keeping, adjudication of rights, and resolution of conflicts, will also affect ownership rights. Some reforms can rely on the

[2] Note that this is in fact land that was fully individualized in the past (and often may have an individual though outdated title on the name of the ancestor).

[3] We do not cover in this article interventions that focus on land transactions, for instance interventions aiming at facilitating or regulating land transactions, such as regulations of sales (*e.g.* restrictions on transferability and land ownership ceilings), interventions to facilitate the consolidation of holdings, and regulations of rentals (*e.g.* the imposition of rent ceilings or the award of implicit ownership rights to tenants) (for a discussion of those, see Deininger 2003). We also do not cover changes in fiscal policy.

introduction of digital Information Technology (IT) for managing cadastral and registry information. Other reforms can seek to improve coordination within and between government agencies (for instance in some cases the coexistence of different titles can create insecurity) or between government and the private sector, to reduce inefficiencies and possibly corruption that increase the costs of transactions over ownership rights and exclude some individuals from formal land markets. Those institutional reforms will notably be important when the focus is on renewing decaying systems of land rights management. Systematic registrations can be implemented when records are lacking or out of date. The former can usually include demarcation and mapping activities, a cadastral survey and a validation by communities after publicity, and possibly involve legal verifications of previous ownership rights. Such interventions can also include a regularization component that consists in giving ownership rights to users, for instance when ownership rights have become informal in previous transactions. Among these interventions, we distinguish surveying and mapping interventions from regularization ones. The regularization of legal rights over state land can improve the security of occupants of state land, notably in the cases in which those occupants have been using this land for a long time and are prevented from performing specific investments due to limited rights. It can occur through the provision of long-term, secure and possibly renewable and transferable rental contracts, or through the privatization and adjudication of state land (notably when government institutions cannot implement long-term rental contracts that are recognized by private institutions, notably financial ones). Legal and policy change include changes in laws concerning registration and verification of ownership, inheritances—which can be important to reduce discriminations against certain groups, such as women—, and expropriations, or rights over communal land (*e.g.* rights over communal "ejido" land in Mexico[4]).

The link between these different interventions and changes in rights is not straightforward—we consider this in section 3.1

2.3. Theoretical mechanisms and evidence on intermediate outcomes

The theoretical mechanisms motivating land administration interventions start from a set of assumptions about how changes in the bundle of rights described above affect the intermediate outcomes of households who own the land and communities in which they live. One can distinguish five potential intermediate outcomes of land administration interventions: increased investment, better access to credit, more transfers of effective rights, more efficient time allocation including increased off-farm labour market participation and migration opportunities, and less conflict. The empirical

[4] An "ejido" is an area of communal land in Mexico on which community members individually farm a specific parcel.

Table 1. **Categorisation of theoretical work on land administration policies: mechanisms and intermediate outcomes**

	Increased (expected) security	Individualization	Facilitation of transfer
Investment	Increases expected time horizon/reduces risk Reduces security enhancing actions *Reduces the effort of tenant farmers*	Removes moral hazard Removes tragedy of commons/free-riding - and under-utilisation of anti-commons *Reduces economies of scale* *Use of low-risk low-return crops/technology*	Increases expected time horizon/reduces risk
Credit	Can be used as collateral Increase in demand for credit		Can be used as collateral
Transfer of effective rights	Increase in renting out		Consensual ownership changes to those with relative use advantage (*i.e.* better information, economies of scale, lower transaction cost) *or those looking to store value and those less risk-averse* Used as a liquid asset
Time allocation and migration	Reduction of security enhancing actions	*Contracting problems may encourage self-use*	Can be sold/rented out by landowners
Conflict	Reduces potential returns to conflict	Reduces previous ambiguity of rights	Allows for transfer as a conflict resolution device *Increases possibility of contested transfer*

Notes: Mechanisms are classified according to the aspect of land right considered and the main intermediate outcomes. Impacts that are positive (*i.e.* roughly equivalent to welfare enhancing) are underlined, and impacts that are negative are italicized. References to papers describing mechanisms can be found in the text.

literature has focused on the impacts on these intermediate outcomes hypothesized by the theoretical literature.

Below, we discuss the theoretical mechanisms and the empirical evidence for each of these five potential intermediate outcomes. Table 1 displays some of the key theoretical mechanisms through which changes to land rights can impact these outcomes. In order to concentrate on the impact of land administration interventions, we focus on evidence where the impact of such an intervention has been isolated from that of other reforms. Note however that this may lead us to underestimate the impact of such interventions if there are complementarities with other reforms that are carried out simultaneously (see section 3.2).

Investment

Perhaps the most frequently cited theoretical benefit of land administration interventions is that increased security will increase the expected time horizon of land-users and hence increase their investment. A slightly more subtle reason why investment may change, and actually decrease due to increased security, is that certain investment activities may directly influence the probability of expropriation. For example, leaving land fallow may increase the expropriation probability, while the planting of trees may reduce such probability. Hence, interventions that increase security may reduce the need for these security-enhancing actions (de Meza and Gould, 1992; Sjaastad and Bromley, 1997; Goldstein and Udry, 2008). This could lead either to a reallocation of investments to more productive land or agricultural assets, or to a decrease of investments in land. Another potentially negative effect of increasing owners' security on investment is that this may reduce the investment incentives of tenants who were hoping for beneficial expropriation (Banerjee and Ghatak, 2004; Besley and Ghatak, 2010). Besides, individualization may increase investment by reducing moral hazard (Alchian and Demsetz, 1972) and the tragedy of the commons (Hardin, 1968) or underutilization that characterizes the one of anticommons (Buchanan and Yoon, 2000).[5] It may however reduce the scope for economies of scale, and induce incentives to use low-risk low-return technologies. Finally, transfer facilitation may also increase the expected time horizon, and hence investment, if it enables land to be passed on to a designated heir or sold on a market.

Empirically, some previous evaluations of land administration interventions have found positive impacts on investment. Alston *et al.* (1996), Deininger and Chamorro (2004), Deininger *et al.* (2011) and Ali *et al.* (2011a) have found increased investment alongside households reporting lower perceived risks of expropriation, and the range of investments in these studies suggests that it is the greater expected time horizon that is the main channel. Castañeda Dower and Pfutze (2013) on the other hand attribute the greater investment they find to the "reduction in security enhancing actions" channel, since the main affected action they find to increase is leaving land fallow which, prior to the intervention, increased the risk of expropriation. In the same vein, de Janvry *et al.* (2014a) find evidence that titling leads to a reallocation of investments in more productive land. As far as we are aware, no study has identified an impact on investment through individualization or facilitation of transfer. Moreover, other studies find no effects of other titling interventions on investments (*e.g.* Fort *et al.*, 2006). Drawing attention to *de*

[5] The tragedy of the commons refers to an area of land that is over-farmed due to the lack of an ability to exclude. On the other hand, an anticommons arises when there are multiple rights to exclude, and hence a resource is under-utilised as a result.

facto rather than legal tenure security, Gould (2006) finds that a land regularization intervention in a frontier region of Guatemala did not increase investments, as tenure insecurity persisted after the intervention, together with other risks (wildfires) and constraints (access to credit and output markets).

Credit

Following the work of de Soto (2000) and others, it is hypothesized that interventions that facilitate the transfer of land to financial institutions and subsequent land transactions will increase the ability of landowners to receive credit. But empirically there is little evidence of an effect on credit of land administration interventions. Several studies have tested and rejected the presence of such effects (Deininger and Chamorro, 2004; Field *et al.*, 2006). Possible explanations include the existence of credit rationing in the countries where impact evaluations have been carried out, or risk aversion of landowners (Carter and Olinto, 2003; Boucher *et al.*, 2005). Carter and Olinto (2003) in particular find evidence, using data for a panel of Paraguayan farms, that a pattern of wealth-biased liquidity constraints is not reverted by a titling intervention. These constraints continue to distort the portfolio of investments of smallholders, with reduced demand in movable capital, even after they have received formal ownership titles.

Transfers of land rights

Land administration interventions may impact the frequency and nature of three types of land rights' transfers: sales, rentals and non-financial transfers.

Sales

Facilitation of rights' transfer often focuses on improving the market for ownership rights. Theoretically, this is hoped to increase the transfer of land to owners who have a relative advantage, through exploiting economies of scale or a greater capacity for investment (Besley, 1995; Feder and Feeny, 1991). It has been argued that, by securing the rights of all agents independently from their characteristics or behaviors (*e.g.* whether they currently occupy the land), improved security and transferability can increase participation to, and thus activate, markets for both land sales and rentals that are often thin when rights are limited. The frequency of sales may also increase if owners use land as a liquid asset to smooth consumption. Interventions that increase expected security may increase sales since they are likely to increase the security of potential purchasers more than that of existing owners. On the other hand, fixed costs of formal land transactions might make small transactions too costly and prevent participation of individuals with no or little land. Moreover, market segmentation, with no transactions between the rich and/or large landowners on the one hand, and the poor and/or smallholders or landless on the other hand, can occur, and persist after land

interventions, if bargaining or subdivision or agglomeration costs constrain those inter-class transactions and discourage participation of resource-poor individuals (Carter and Olinto, 1998). Finally, land may also be transferred to those looking to store value and those who are less risk-averse, which may not necessarily be welfare enhancing (Deininger and Feder, 2001). Whether it is or not will depend on the extent to which security is increased and/or efficient rental occurs. With such persisting constraints, some potential efficiency and poverty-reducing gains from land transfers might not occur. Complementary interventions to reduce the attractiveness of speculative land accumulation and increase the demand from small producers, such as technical assistance and credit, have thus been argued for (Deininger *et al.*, 2003).

Most empirical studies do not find an impact of land administration interventions on land sales. An exception is Castañeda Dower and Pfutze (2013), who find an increase in sales as a result of the Procede reform in Mexico. They suggest that this is likely to be due to an increase in demand from outsiders as a result of greater security. Lack of evidence for the "facilitation of transfer" channel may reflect the lack of studies that look specifically at interventions focusing on this channel. In related works, Stringer and Lambert (1989) and Lambert and Stanfield (1990) document the segmentation of land markets in Guatemala and Ecuador. Carter and Olinto (1998, 2003) find that, in Paraguay, participation of the land-poor to the sales market remains limited even when titles increase security due to financial constraints. And Henderson *et al.* (2014) consider the relationship between land titling and inequality of land ownership in Paraguay and find that, while the market of land sales tends to be segmented, land titling may benefit small and medium-holders with originally more insecure rights.

Rentals

Theoretically, increased ownership security may make owners less fearful of renting out their land, and hence reduce the expected transaction costs of rentals (Conning and Robinson, 2007; Macours *et al.*, 2010). This reduction in transaction costs may also lead to rental contracts of longer duration, with more diverse partners and under different contract types.

Indeed, several empirical studies have found a positive relationship between property rights security and land rentals, including Alston *et al.* (2012), Castañeda Dower and Pfutze (2013), Deininger *et al.* (2008), Macours *et al.* (2010) and Macours (2014).

Non-financial transfers

Though land administration interventions are not typically aimed at affecting transfers outside of market processes, such transfers may be influenced. In particular, land administration interventions may transfer effective rights within the household, thereby empowering women or giving future

generations enhanced inheritance rights. An unintended consequence may also be the transfer of rights in cases of conflict, where rights may be gained by those that can use the intervention to their advantage.

Empirically, Ali *et al.* (2011a) find an increase in married women's land ownership as a result of the intervention, which was one of the programme's objectives. To our knowledge there is no direct evidence that land has been unintentionally redistributed through land administration programs, though this may be because it is not generally looked for. A piece of indirect evidence is given by Selod *et al.* (2012), who find that in between knowledge of the intervention and its implementation, land security drops rapidly, suggesting perhaps that many owners fear a resulting redistribution.

Time allocation and migration

Greater security of ownership is expected to reduce the need to spend time on the land in question, and hence increase the time household members spend on other activities. This may include greater labour market participation and, in the extreme, migration away from the land in question. Transfer facilitation may also reduce the time spent by landowners on the land, since owners may be more able to sell or rent out their land rather than work on it themselves.

Recent empirical studies have examined the effects of land titling on land use, labour supply and migrations away from rural areas. Valsecchi (2014) thus finds that the Procede land certification program giving ownership rights for land in Mexican "ejidos", increased migrations away from areas of the intervention, apparently due to changes in transfer rights, and specifically more secure inheritance rights. Related evidence has been collected in other regions (*e.g.* Chernina, Castañeda Dower and Markevich, 2013). For the same Mexican "ejido" context, de Janvry *et al.* (2014a) also find evidence of increased out-migration, but attribute it mostly to the transition away from use-based rights that had forced households to inefficiently supply too much labour in agriculture. Related studies focused on titling interventions in urban areas. Field (2007) and Moura *et al.* (2011) find empirical evidence that the titling interventions they studied did increase labour market supply as a result of increased security. Galiani and Schargrodsky (2010) find related effects on the educational outcomes of children in households receiving titles.

Conflict

Greater security of ownership may reduce conflict over land, since the increased certainty should decrease the payoffs of fighting over land. Indeed, the process of providing greater security, *e.g.* through rights' clarification, might explicitly include efforts to resolve existing conflicts. Individualization may also reduce conflict amongst groups that previously jointly held rights to a piece of land, since the process clarifies the rights of individuals that may previously have been fought over. However, to the extent that stakeholders

expect to see their claims recognized, the announcement of a clarification or individual titling intervention may spark latent conflicts in the short run. Facilitation of transfer may have ambiguous effects even in the long run. On the one hand, a greater set of potential transfers may help to resolve conflicts in ways that were previously not possible. On the other hand, the greater possibility of transfer may increase the returns to conflict for non-owners, as well as allow transfers over which there is discord. Evidence is lacking on those effects though, with the exception of preliminary evidence by Selod *et al.* (2012) of an increase in insecurity in the short run following a titling intervention in Benin.

2.4. Evidence on the impacts on final outcomes

Whilst the above impacts are those that are most likely to result directly from land administration programs, they are not normally the ultimate objective of such interventions. Typically, it is hoped that positive impacts on the above direct variables will lead to improved final outcomes for farms and households, but also for broader communities (municipalities or higher level).

Agricultural productivity

Productivity gains may result from the increased investment as well as from the transfer of land rights to other parties. The increased renting out of land might put it in the hands of more efficient producers. In addition, an activation of the land sales markets can imply an increase in land ownership by those less risk-averse, possibly resulting in more crops with "high-risk, high-return" profiles. At the same time, there is some risk that agricultural productivity may decline–for example, if land is transferred to owners who use it mainly as a store of value. The evidence on the effects of titling and other land administration interventions on agricultural productivity in the long run is scarce. Field and Torero (2006) consider a major titling program in Peru (PETT) and interpret the empirical results as effects on the type of production, with more land allocated to cash crops, but no effects on other agricultural investments, access to credit or land transactions, which suggests that risk aversion might be at play. De Janvry *et al.* (2014a) find that transition from use-based rights to ownership rights on land in Mexican "ejidos" leads to a reduction in labour supply with no reduction in cultivated land.

Household welfare

For land right holders, the largest impact on household consumption levels will probably come about through changes in agricultural productivity. Note however, that non-farm income may also be affected, particularly if there are effects on labour use, resulting, for instance, from new investments on land, changes in used agricultural technologies or a reduction in time spent securing

their rights (for evidence on the latter in rural settings, see Giles and Mu, 2014, for China, and Houngbedji, 2014, for Ethiopia). In the short-term, any observed increase in investment may come about through decreased consumption if households are credit constrained. In terms of consumption stability, greater access to credit and the ability to use land as a liquid asset may improve stability. However, the granting of ownership transfer rights may facilitate distress sales, which in cases of large covariate shocks, may lead to a more unequal distribution of land and negative welfare outcomes for poorer households. Income fluctuations may, on the other hand, be greater if the intervention results in the adoption of riskier technologies and crops. Individualization of land may also reduce risk-sharing amongst the group. Finally, changes in land rights may alter the proportion of income received by various members within the household, such that it may be interesting to measure intra-household income allocation. At a more aggregate level, total production of food is likely to follow changes in agricultural productivity. An important exception however may be in the case where land is moved away from food crops (for example, due to lower risk aversion). However, here again, the evidence is very thin. Field and Torero (2006) find no statistically significant effects on total household expenditure.

Land values and asset ownership

Increases in owners' rights towards land should increase its value, whilst increases in renters' rights may have the opposite effect. If the intervention implies that land can now be used as a liquid asset (*i.e.* it can be bought and sold easily), this may change households' overall asset portfolio. For example, ownership of land may increase while the ownership of other liquid assets decreases. With the exception of Alston *et al.* (1996) who provide observational evidence of increases in land value with the development of property rights in a frontier region of Brazil, we are not aware of other empirical evidence on those effects.

Political support, increased tax base, and land use planning

Beyond the household-level impacts, there are a number of important municipal and higher-level policy impacts that may result from land administrative programs. First, land reforms may have a significant impact on political preferences (Castañeda Dower and Pfutze, 2015; de Janvry *et al.*, 2014b). Possible mechanisms may include lower dependence of poor rural households on local elites, support for the party that led the intervention or a greater participation in the market economy (and, likely, support for pro-market parties). The dependence on local elite might actually be a constraint to the implementation of the intervention; for instance Fergusson (2013) argues that politically influential large landowners might seek to maintain weak property rights so that poor peasants are constrained to stay in rural areas and supply agricultural labour at low wages. Second, a more

accurate and detailed cadastral and registry system will increase the ability of a government to tax land, and more complete information records may enable the enforcement of property laws, for instance those specifying maximum ownership caps or nationality requirements. Moreover, citizens may be more supportive in paying such a tax if they believe that the government is supporting their land rights. Third, land planning provides a number of important benefits, and is likely to be facilitated by clearer land rights. One example is the provision of infrastructure, for which provision to insecure plots can be problematic. While this mechanism may be more important in urban areas, it may also apply to a certain extent in rural areas in cases such as the provision of irrigation schemes. Finally, a reduction in land conflict is likely to free up time within the judicial system for other cases, and hence improve justice overall.

Overall, the empirical evidence on the potential benefits from titling and other land administration programs thus remains inconclusive. Indeed, for several of the mechanisms posited, the number of studies remains small, and while some studies find supporting evidence, others do not. In particular, while the evidence on the increase in investments (and to a lesser extent on migrations) is relatively consistent, there is mixed evidence of effects on land allocation and, if anything, zero impacts found on credit. Evidence is mostly lacking on agricultural productivity, and long-run outcomes such as household consumption and food security, land values and conflicts.

3. Impact evaluations and conceptual challenges

The lack of conclusive evidence on many potential impacts suggests that new approaches are required for better re-examining this assessment and obtaining more conclusive evidence on the effects of land administration interventions. Those should address two sets of challenges.

A first set of challenges to be overcome, before the methodological ones discussed in the next section, are raised by the conceptual analysis of the effects of land administration interventions. This analysis poses several difficulties related to: a) the links between interventions and changes in rights, b) heterogeneity in impacts notably due to other constraints on the outcomes of interest, and c) spillover effects of land interventions on non-beneficiary households and/or areas.

3.1. Unpacking property rights: what are we evaluating?

A first conceptual challenge is that property rights have several dimensions that can all (under certain conditions) be affected by a particular land administration intervention, so that a given intervention can generate a set of outcomes or affect the same outcomes through different mechanisms. Establishing the links between an intervention and the theoretical arguments

on expected impacts, and deriving hypotheses related to the outcomes that can be expected to change and those that are unlikely to be affected, is key to gather meaningful evidence.

In order to understand how land administration interventions may have an impact, it is useful to distinguish how they might affect the bundle of land rights along the three different dimensions discussed above: a) increased expected security; b) individualization of land rights; and c) facilitation of transfer. Some land administration interventions may only have impact through one of these channels. For instance, an increase in the capacity of the department responsible for land transfers may simply facilitate ownership transfer without increasing its security or individualizing any group held rights. However, in practice, land administration projects can often change the nature of the property rights in several ways simultaneously. For example, land titling could potentially operate through all three channels: security may be enhanced if titles increase the enforcement of existing individual or group rights; rights could become more individual if the previous *de facto* arrangement was to treat the rights as belonging to a group (*e.g.* the family); and transfers may be facilitated if these are allowed by law but were previously prevented due to uncertainty. The channels a particular project or policy works through will be determined by the specific components of the intervention, but also to a large extent by the country context.

Table 2 below gives a potential mapping of the intervention types described above to the channels they are likely to work through. In each cell, we describe part of the necessary conditions for a particular type of intervention to act through each of the three channels identified above. The channels that operate will be very dependent on the exact nature of the intervention and the context in which it operates. A key first step in evaluating the impact of an intervention is therefore to identify the conditions under which each channel may operate. This will help focusing on the intermediate and final outcomes likely to be affected and identifying heterogeneity that could be useful to exploit in understanding the intervention's impact.

Furthermore, economic theory has worked mostly on the question of what the impact of a change in land rights is, and typically ignored the question of how land administration interventions affect land rights. This absence is surprising given that it is well known that a simple change in the law is neither necessary nor sufficient to change effective rights. An exception is Castañeda Dower and Pfutze (2015), who model how certification may enable a community to coordinate on enforcing a regime with different expropriation rules, and hence increase expected security. Perhaps partly resulting from this theoretical absence, studies rarely explore how a particular intervention changes land rights. Similarly, few empirical studies have examined the extent to which interventions do change actual rights and tenure security and whether those changes are sustainable. On the former, while Gould (2006) finds that, due to other risks, ownership regularization was insufficient

Table 2. **Mapping of land administration interventions to possible channels**

	Increased expected security	Individualization of land rights	Facilitation of consensual ownership transfer
Land-titling	Yes	Only if previous system involved use of group rights	If transfer of titles is permitted and relatively cheap/easy
Institutional reforms and strengthening (including institutions in charge of conflict resolution and information technology (IT))	If previous institutional weaknesses led to lack of enforcement. Even then, effect is likely to be slow unless accompanied by information campaigns.	If previous weaknesses led (in some cases) to use of group rights, and strengthened institutions enforce individual rights.	If strengthened institutions allow such transfers, and either formal registration of transfers is easier, or relative enforcement of land that has changed ownership is stronger.
	IT can contribute on longer term by keeping cadastral information updated.	IT does not contribute.	IT contributes by facilitating updating of cadastral information reflecting transfer.
Cadastral survey and mapping	Possibly, if mapping strengthens existing informal rights	No, unless through sub-division of land in family co-ownership.	Possibly if mapping strengthens existing informal rights
Systematic regularization (and registration)	Yes Registration contributes if formal enforcement mechanisms are stronger than informal ones.	If "irregular" system involved use of group rights, and formal enforcement mechanisms are stronger than informal ones	If transfer of regularized land is permitted and relatively cheap/easy, and formal enforcement mechanisms are effective
Regularization of use of state land (*e.g.* long-term rentals)	Yes, if previous rights were limited	Only if regularization replaces group by individual rights	No, unless use rights can be transferred
Legal and policy changes	Possibly, for instance changes facilitating ownership registration or verification, or changes reducing expropriation risk.	Possibly, for instance changes granting individual use rights on communal land.	Possibly, for instance changes facilitating ownership verification or granting of rights to rent and/or sell plots of land for which only use rights were previously held (*e.g.* over communal land).

Notes: Potential for specific land administration interventions (listed in rows) to affect different dimensions of property rights (listed in columns), and conditions under which such effects likely occur.

to significantly enhance security, in other contexts land rights could be sufficiently secure, thanks to informal enforcement mechanisms (*e.g.* through local communities), so that interventions might not either affect *de facto* rights. On the latter, Barnes and Griffith-Charles (2007) find that a titling and registration intervention in St. Lucia was not sustainable in the long run (after 18 years) as the local system for land transactions reverted to informality (notably through inheritances).

While most empirical papers study interventions which are intended to increase expected security, there are a number of ways in which a given intervention may do so. Possible mechanisms include:

a) Providing information to land users on their existing rights;
b) Reducing the cost and/or increasing the expected probability of success in invoking central government enforcement in the case of future conflict (*i.e.* the courts);
c) Coordinating local enforcement mechanisms;
d) Reducing the expectation of future land reform and/or government expropriation.

Establishing which of these mechanisms is at work is important to derive policy implications from studies of land administration interventions.

3.2. Heterogeneity of impacts and complementarities with other interventions

A second conceptual challenge stems from heterogeneities in the effects of interventions. The theoretical assumptions discussed in section 2 describe a range of possible impacts of land administration interventions. However, the empirical literature has shown that each of these impacts is not necessarily consistently found across interventions, even when carefully distinguishing how property rights are affected. This points to the fact that the standard models make a range of assumptions about the context from which the hypotheses on the link between land rights and outcomes are derived. Yet the assumptions are not necessarily relevant for all contexts. For instance, credit rationing may prevent both the increase in credit and the increase in investment predicted. Once such assumptions are relaxed in the theoretical models, they point to clear and rather intuitive predictions on the potential for heterogeneous impacts along a variety of dimensions.

In order to address these concerns and shed light on the relevance of the context, empirical studies should explore heterogeneity in impacts across beneficiaries of a project, as a given land administration intervention is likely to have impacts that vary across plots and households. For example, Ali *et al.* (2011a) find that the impact of the intervention they study is greater for female-headed households, whose previous land rights were likely to be the most insecure. Even if the change in rights is uniform across plots and households, there may be variation in impacts due to the necessary conditions for the mechanism to operate. For instance, Carter and Olinto (2003) show that the total investment impact will be greater for wealthier individuals in the presence of credit constraints. Exploiting such heterogeneity can give insights into the mechanism at work.

In some cases, the presence of other binding constraints may even suggest the potential need to complement land administration interventions with other complementary interventions. For instance, in certain contexts, the potential for land administration projects to affect productivity might be limited by the lack of access to new technologies or credit. When such complementary interventions can become incorporated in the overall project, or even when they are envisioned to occur in the same region and target population, evaluations can try to shed light on the possible complementarity of these interventions. While this can be very promising, further methodological challenges arise from the need to establish causal inferences regarding both the land administration and these complementary interventions, which we address in section 4.5.

3.3. Spillover effects

The discussion so far has focused on the impact of land administration interventions on households and areas targeted by the intervention. In addition to these direct effects, however, there are also likely to be spillover effects in areas not subject to the intervention. These spillover effects, a third conceptual challenge, are important to consider for two major reasons. First, the spillover effects may be of intrinsic interest. Second and methodologically, if the spillover effects impact upon a group that is considered as a "control" group—and hence is implicitly assumed not to have been impacted by the program—this may complicate attempts to measure the impact of the intervention on those targeted.

In the case of land administration interventions, there are several possibilities for spillover effects. One group of such effects is likely to be the result of anticipation amongst households not targeted. Since land administration interventions are generally sanctioned by the national government, it is very reasonable for non-targeted households to believe that they will be targeted in the near future (evidence for this can be found in Selod *et al.*, 2012). This belief is of particular concern for evaluating land administration interventions due to the importance of *expected* security in the mechanisms outlined above. An intervention such as land-titling may, for example, increase expected security even amongst non-titled households if they believe that in the near-future they will receive such a title. On the other hand, for certain households, expected security may decrease if they believe that there is a high probability someone else may receive the title. The two other channels discussed above - individualization and facilitation of transfers - may also potentially suffer from anticipation effects. If it is believed that an individual rather than a group will soon hold rights over a plot, group members' behaviour is likely to change in a variety of ways. Meanwhile, if it is believed that transfers will soon be facilitated, this may temporarily reduce land transfers, or households may change the way they use the land if they anticipate a future sale.

Another set of spillover effects that may occur are those that result from the relationship between land markets across both targeted and non-targeted areas. If the intervention increases the probability of land being rented, those that rent in the land may come from outside the targeted area. An increase in the value of land that benefited from the intervention may result in a decrease in the value of non-targeted land. Migration and labour supply decisions may also lead to spillover effects if they are large enough. This set of spillover effects should be noted in particular when measuring the impact of interventions on land transactions, since such transactions can easily involve households from outside of the treatment group.

4. Methodological challenges

Besides the conceptual challenges discussed above, another possible reason for the mixed evidence on the effects of land administration interventions is the large number of empirical studies that are likely to suffer from severe endogeneity bias.

Indeed, much of the empirical evidence consists of associational-based evidence from observational studies. These tend to investigate the correlations at a given point in time between the distribution of land rights and individual outcomes. In such observational studies, interpreting the relationship between land rights and outcomes as the causal effect of a specific policy change relies on strong assumptions, as many unobserved confounding factors could drive the observed correlations. For instance, landowners with formal titles usually differ in many ways from those without such documents, so that attributing their different behaviours and outcomes to their land ownership *status* is simply not credible.

Selectivity into treatment is the main methodological challenge to be addressed. Because land tenure interventions tend to affect the rights of specific sub-groups of individuals, *e.g.* those with initially more insecure tenure or farmers in regions with a higher agricultural potential, the potential outcomes of beneficiaries with or without the intervention are likely to differ. Simple comparisons of the outcomes of beneficiaries with those of non-beneficiaries are thus unlikely to produce unbiased estimates of the intervention's impacts.

Rigorous evidence can only be produced if the evaluation data was collected in ways that carefully account for the allocation of treatment and allow identifying a comparison group that provides a valid counterfactual for the outcome of program participants in the absence of the intervention. If, in some favourable instances, natural experiments can provide robust evidence, prospective impact evaluations of interventions are the most reliable way for obtaining a valid comparison group, and thus credible estimates of the impacts of land interventions. Such evaluations may also allow isolating the impacts of specific changes in rights or examining complementarities that

accrue when removing several different constraints. A prospective impact evaluation can be done by using experimental (*i.e.* randomized assignments) or non-experimental methods.

Below, we discuss the main options for impact evaluations, natural experiments, and ways to account for heterogeneities and spillover effects. We refer to previous empirical studies and try to derive recommendations for future ones.

4.1. Identification based on randomized assignment

The most rigorous, and in some senses the most straightforward, way to assure that one can identify the causal impact of a land administration intervention is to assign the intervention randomly among a large group of villages or individuals that is eligible for the intervention. By making sure that assignment to the treatment group is independent from potential outcomes, Randomized Controlled Trials (RCTs) provide an adequate comparison group to the group of beneficiaries, *i.e.* a group from which one can learn about the potential outcomes of beneficiaries had they not been treated. In general, RCTs therefore provide the most reliable evidence on the causal effects of interventions. The general advantages of RCTs have been discussed in much detail elsewhere (*e.g.* Duflo, Glennerster and Kremer, 2008) and certainly hold for the case of land administration interventions.

However, the use of RCTs for such evaluations raises several issues regarding implementation modalities and statistical power, internal validity issues, and external validity considerations.

First, consider implementation aspects. There are several ways to implement RCTs, and notably different possible units of randomization, and those have bearings for both the measurement of impacts and the operations. On the one hand, because land interventions, in particular those that seek to clarify rights, involve activities that are performed at the level of communities (such as information campaigns, surveying, conflict resolution), and because the externalities they generate between neighbours are likely to be strong (due for instance to changes in local land conflicts, anticipation of future eligibility, or land markets equilibrium), randomization generally must be conducted at the level of some sort of geographic cluster (which could be localities or communes). On the other hand, to ensure the balance of characteristics between the two treatment groups and achieve a given statistical power, randomization needs to be performed at the level of sufficiently numerous (and thus small) areas. Thus, for land interventions with clarification activities, a design that accounts for both local externalities and statistical power may need to consist of several hundreds of geographic clusters.

However, such RCTs may imply considerable constraints on operations. In most cases, it may seem difficult to implement a land intervention in dispersed small geographical clusters and not in other neighbouring clusters.

The typical solution is therefore to implement the RCT through the context of a staggered phase-in where control clusters would be incorporated in a second phase. Operations would then have to be adjusted to accommodate the RCT. In particular, the surveying and clarification operations that involve a pre-cadastral sweep of covered clusters have to be adapted to involve at least two sweeps. That will be easier to do when the program administration is centralized so that the schedule of phase-in is controlled.

We are aware of only two RCTs having been implemented for evaluating the impacts of a land tenure intervention. The first is an ongoing evaluation of a pilot land surveying and certification program ("Plans Fonciers Ruraux") implemented by the government of Benin with support from the Millenium Challenge Corporation. A preliminary impact evaluation was conducted by Selod *et al.* (2012). The randomization was conducted at the village level within each commune (the control group should benefit from the program when it will be scaled-up nationally). Also in an African country, but in an urban setting, Ali *et al.* (2011b) have implemented a RCT for evaluating the variation of a titling component of a tenure securization program. The RCT was run in two urban slums in Dar es Salaam, Tanzania, and consisted of providing access to formal land titles to informal settlers at randomized prices. The randomization into the treatment group was conducted at the level of "blocks" (contiguous groups of approximately 40 parcels).

The second set of issues to take into account relates to internal validity. Because some of the program components and effects are likely to affect behaviours of households and farmers whatever the cluster they live in, it is important to be able to distinguish the direct effects of the surveying and/or formalization of the plots owned by individuals in the treatment group from broader program and spillover effects. Broader program effects are likely to occur, for example if public awareness and information campaigns on the importance of secure land rights and responsibilities of land owners and occupants that precede the pre-cadastral sweep, cover the entire pilot communes. As little evidence is available on those, disentangling direct effects from spillover effects would be of interest (more on this further in the text).

The third set of considerations relate to the external validity of RCTs. The specificities of the areas selected for the evaluation might limit the external validity of the results, as it applies to any evaluation of a small-scale program. A concern more specific to RCTs is the length of the experiment: the effects of land interventions can take time to appear, so that it is important to observe the outcomes of the treatment and control groups after a sufficiently long period of time. A staggered phase-in might put limits on the time before the control clusters are incorporated, while a period of two to three years, depending on the context, seems a minimum to observe impacts on some investments (*e.g.* land improvements or tree planting) or income (*e.g.* perennial cultivations).

Fourth, unexpected political developments might complicate and possible endanger compliance with the experimental design. Given the political

sensitive nature of land rights, political will is key to implementing a rigorous RCT of a land rights intervention. Moreover, once the intervention has started, local pressures might increase and demands by households in the control areas possibly could mean that the experimental control group also receives land rights, leading to contamination of the experimental design. On the other hand, delays, as well as logistical, administrative or political problems could imply that part of the treatment group does not receive the land rights in time.

In case there are program components that in theory could affect the whole population, but in practice might have limited impact without additional complementary interventions, the randomized addition of such complementary interventions, in encouragement designs, can help to evaluate their impact. For example, it would be possible to randomize information about a certain legislative change that increases tenure security to analyze the impact of increased security. Similarly, it would be possible to randomize subsidies for a titling program that implies cost for individual households in such a way that it increases (randomly) demand by households for such titles, thereby allowing an evaluation of the impact of titles. The above-mentioned evaluation in Tanzania uses such a design. The evaluation only shows impacts for the population of people that change behaviour because of the encouragement, and hence only allows estimating a local average treatment effect. In addition, the encouragement designs may have low statistical power, as take-up among the "encouraged" population might be low. As such, they are not a first best strategy, but they should be considered as a possible option for components or interventions that because of their large scale or reach do not allow identifying another plausible counterfactual.

4.2. Non-experimental prospective approaches

Regression discontinuity design

In many cases, a second-best approach for obtaining credible estimates of impacts of titling interventions would be based on a Regression Discontinuity (RD) design (Lee and Lemieux, 2010). The RD design can be applied for obtaining estimates of the impacts of land administration programs in several ways, depending on program implementation. For example, the targeting of land interventions might rest on some explicit *criteria* that are effectively enforced and generate a discontinuity in treatment assignment that does not correspond to any substantial differences between the two groups.

One application includes land surveying and titling interventions that are implemented at a small scale during a pilot phase covering areas delimited by precise borders, such as a few communes or municipalities. One can then compare the outcomes of individuals owning or exploiting parcels lying on the two sides of the borders. This approach was followed by Ali, Deininger and Goldstein (2011a) to estimate the impacts of a pilot land titling program in

Rwanda. One concern with this type of discontinuity is that the borders of the selected pilot areas could correspond to specific geographical barriers (river or mountain range) that could be associated with changes in some determinants of agricultural production (such as climatic or soil conditions).

Another potential application of RD can be when legal rules might generate thresholds determining which, and in what ways, different parcels or individuals are affected by the intervention. Vranken *et al.* (2011) thus consider the effects of the restitution of land to former owners and their heirs at liquidation of former communist cooperatives and state farms in the early 1990s in Bulgaria. They exploit the discontinuity generated by a law preventing excessive land fragmentation, which had plots below a given size (0.3 acres) remain undivided in co-ownership among the different heirs.

A limitation of RD design estimates is their limited external validity. Indeed, the effects of assignment to the intervention are estimated only locally around the threshold, *i.e.* for individuals that may have specific characteristics and do not compare well to other potential beneficiaries. For instance, estimates exploiting a geographical threshold would inform on the impact of an intervention for individuals with parcels of land near the border. The validity of the insights then depends on the extent to which those groups look similar or differ from other potential beneficiaries.

Difference in difference evaluations

The main alternative non-experimental method consists in using comparison groups of non-beneficiaries who have similar (or sufficiently close) observable characteristics to the ones of beneficiaries of the land rights intervention in a Difference-in-Difference (DiD) scheme. This is feasible when an intervention is phased-in sequentially and the impact evaluation was planned sufficiently in advance, so that baseline data was collected among some program participants before they benefited from the intervention.

In a DiD setting, the key assumption of common trends is not testable - any unobserved heterogeneity that is not time invariant would lead to different trends and hence bias the results. DiD studies hence provide less credible estimates of the intervention impacts than experimental studies. The comparison group might be more likely to violate the common trend assumption when it is drawn in geographical areas that are remote from the treatment areas, or in different administrative divisions. For instance, suppose that land titles have been delivered first in poorer areas and that some catching-up would be taking place independently of the intervention. In this case, farmers' productivity and income would increase faster in those areas, and this would bias the estimates of the effects of titling. Variations in climatic conditions could similarly drive differences in trends. Moreover, identifying potential beneficiaries at baseline in control areas is key to control for individual selection into treatment, which represents a challenge as soon as the treatment depends on beneficiaries' characteristics and potential outcomes.

The identification assumption is not testable, but its plausibility can and should be assessed. One approach for this consists of testing for the presence of pre-intervention trends (similar to a pseudo-outcome) using data for several points in time prior to treatment (*e.g.* de Janvry *et al.*, 2014a and b) (alternative assessments can be based on pseudo-treatments). It is hence critical to use both pre- and post-intervention data.

Several non-experimental studies of the effects of titling interventions have relied on DiD estimates. Field, Field and Torrero (2006) for instance investigate the effects of the Special Rural Cadastre and Land Titling (PETT) program, which was implemented in Peru starting in 1993 and consisted in a complete securization process with surveying and titling of parcels and establishment of a cadastre in rural areas. Zegarra *et al.* (2008) combine matching with DiD estimates for the same program. And de Janvry *et al.* (2014a) examine the effects on migration of Procede, a large-scale land certification program implemented in Mexico from 1993 to 2006. Deininger *et al.* (2011) similarly study the impacts of a land certification intervention in Ethiopia on agricultural investments, land transactions and conflicts using DiD estimates implemented in a panel random effects model. In urban settings, Field (2007) and Moura *et al.* (2011) use control groups located in areas yet to be covered by land registration and titling programs, respectively in Peru and Brazil, to evaluate their impacts[6]. Finally using separate non-parametric regressions using pre- and post-intervention data, Boucher *et al.* (2005) use an approach akin to DiD to study the effects, on farm size and access to credit, of a set of market-orientated reforms, including privatization of lands previously owned by cooperatives, provision and strengthening of property titles and activation of rental markets and private credit markets in Honduras and Nicaragua.

4.3. (Non-prospective) natural experiments

A last type of evaluations, which consists of exploiting sources of arbitrariness in the allocation of treatment, can be performed in some favourable settings. In certain cases, whether some individuals are treated by a policy intervention depends on some exogenous factors that are independent from the potential benefits and costs treatment would incur for them. For instance, in the case of land titling programs, some arbitrary rules in program administration

[6] Previous observational studies have used cross-sectional data. For instance, Deininger and Chamorro (2004) examine the effects, on agricultural investments, of the regularization of land obtained through land reforms in Nicaragua, using one round of data. Similarly, Bandiera (2007) examines the effects of cultivating land under either tenancy or ownership on investments in tree crops in Nicaragua. In a variant of the DiD strategy, she compares investments on different plots cultivated by the same farmer, assuming that plots do not differ otherwise than by tenure *status* (she assesses this assumption using information on soil quality).

might determine which areas are treated first and which ones only later without an explicit targeting based on observable characteristics and related to potential outcomes. Castañeda Dower and Pfutze (2013) thus argue that, for the Mexican certification program Procede, the timing of the first contact made by program staff with "ejidos" was determined without an explicit targeting strategy, but mainly depending on distance to the state capital where the staff were based (which, they assume, is not associated with potential outcomes of program beneficiaries). Fort *et al.* (2006) use a similar argument of random placement driven by spatial variations in program implementation for studying the effects of the titling and clarification PETT program in Peru.

In other instances, it might be possible to argue that program placement is independent from individual beneficiaries' choices and outcomes. Galiani and Schargrodsky (2010) study the case of squatters in Argentina who occupied from 1981 urban land that they partitioned into small parcels; while the squatters believed the land belonged to the state, it was actually private property of 13 landowners. In 1984-1986, the Congress of the Province of Buenos Aires passed a law to expropriate these parcels and allocate them to the squatters with a monetary compensation to the former owners, but, while eight owners immediately accepted the expropriation and associated compensation, the other five contested the decision in courts. As a result, some squatters obtained formal land titles in 1991 while others had to wait until the dispute was settled in 1998. Other historical accidents, such as political changes affecting the content and implementation of interventions, might provide similar conditions for 'natural experiments' whereby some exogenous factors influence the allocation into treatment.

Natural experiments allow the identification of the causal effects of interventions for subpopulations that have their treatment *status* modified by the exogenous factor. While these subgroups are not necessarily the most interesting, they can nevertheless provide internal valid evidence on the local effects of some land administration interventions.

4.4. Measuring and controlling for spillover effects

While the evidence remains limited, measuring and controlling for spillover effects should be an important part of evaluating the impact of any land administration intervention, and the data collection strategy must account for this. One way of doing so is to consider heterogeneity amongst the control group, particularly spatial heterogeneity if it is believed that those closer to the targeted areas are more likely to feel spillover effects. For example, Fort *et al.* (2006) examine the spillover effects of the PETT titling program in Peru on the agricultural investments implemented by farm holders yet to be incorporated in the program, arguing that the placement of the intervention over space was quasi-random.

A design that combines two control groups, with and without exposure to externalities, can allow both to identify an intervention's impact and to detect externalities. Anticipation effects may also be measured by having one control group that knows it will be treated in future, and another one that does not. The optimal way to ensure such heterogeneity may be through using a two-stage randomized control trial. In this case, the evaluators first randomly select geographical areas that may indirectly benefit from the intervention (*i.e.* in which the spillover effects are more likely to take place), and then within these areas they pick individuals or smaller areas that will benefit directly from the program.

4.5. Complementarity with other interventions

Heterogeneity analysis can be done by estimating impacts for specific subgroups (*e.g.* large *versus* small farmers). Yet the identification concerns are equally relevant for heterogeneity analysis. In order to rigorously explore heterogeneity, potentially interesting variables should thus be identified prior to sampling and the sample stratified on those variables, *e.g.* if we are interested in the differential impact of titling on female owners, the sampling frame should purposely include enough female owners.

When the heterogeneity of impacts is expected to depend on interactions with other interventions, impact evaluations can go one step further and specifically analyze the complementarity between interventions, by defining strategies to identify the causal impact of each of the interventions and of the interactions. For instance, if the impact of titling on credit uptake is expected to depend on the availability of credit, a simultaneous evaluation of a titling intervention and of a credit intervention would be needed, designed in a way that it allows separating their effects and considering their complementarity. When evaluations are designed prospectively, and especially when randomized allocation is an option, two interventions could notably be randomized orthogonally on each other[7].

5. Conclusions

We have reviewed studies of the effects of land administration interventions on agricultural productivity, household welfare and local development. While theoretical models have produced strong predictions on the effects of titling and related interventions, the empirical evidence of those effects remains mixed. More empirical studies and innovative approaches are thus required to obtain more conclusive evidence on the effects of those interventions.

This article discussed a number of challenges to be addressed by those studies. We first focused on a set of conceptual challenges to be overcome

[7] Gignoux, Macours and Wren-Lewis (2013) describe a possible example.

when analyzing the effects of land administration interventions. One such challenge relates to the need to unbundle property rights that encompass several dimensions, including the level of security they provide, whether they are individual rights, and their transferability. A key first stage will be asking how the intervention of interest, and its specific components, may change effective land rights and, based on theoretical models, how changes in land rights may lead to changes in intermediate and final outcomes. Identifying the conditions under which each channel may operate will help tailor the data collection to the potential mechanisms at work. Then, to understand which components of an intervention have the largest effects, and what are the mechanisms at work, it is also important to collect data on intermediate outcomes, such as conflicts and perceived security, agricultural practices and other labour activities, investments, financial and land transactions. In addition, evaluation designs should plan for explaining the non-results as well as the potential positive results. This is particularly relevant for land administration programs, for which the available empirical evidence suggests that expected impacts seem often lower than what would be theoretically expected.

We insisted on the existence of other binding constraints on productivity, implying the need to consider heterogeneities (across space and/or households) in the effects of interventions, and the complementarity between property rights and other productive interventions. Methodologically, RCTs allow examining heterogeneities and evaluating (notably through orthogonal randomizations) the separate impacts and complementarities of different interventions, *e.g.* property rights interventions and agricultural development interventions (such as subsidies, access to credit or extension).

Spillover effects also constitute a conceptual challenge. They can occur when non-targeted households believe they will be treated in the future or through the equilibrium of land (or other, *e.g.* labour) markets. While the existing evidence is limited, empirical studies should aim at documenting these effects, notably through designs that allow their identification, *e.g.* by controlling for information release of the local density of treatment.

As the methodological challenges related to the causal identification of the impacts of such interventions are numerous, we review several ways for addressing those. Smart designs combining several methods might be needed to obtain rigorous estimates of both short and long-term results. RCTs bring strong internal validity, and can be complemented with non-experimental control groups for evaluating long-term impacts. This will also allow testing for the presence of possible spillover and side-effects (*e.g.* information campaigns) of interventions. Studies based on a RD design and natural experiments can also in some favourable cases provide rigorous evidence.

High quality monitoring and administrative data are also necessary inputs for good impact evaluations, as it will allow documenting what exactly happened in terms of the implementation of the interventions on the ground.

In addition, qualitative data evaluations designed to be complementary to the quantitative evaluations can allow answering how the intervention affected expected outcomes. Given the complexities in the causal chain related to land titling programs (where latent conflicts and perceptions of tenure insecurity can sometimes be hard to capture in quantitative surveys) this can be especially important.

Studies of the effects of land administration projects can serve not only to evaluate the overall impact of interventions, but also to provide information on their optimal design, allow the comparison of different designs and possible sequencing, and provide the opportunity to test complementarities with other interventions. This can make such studies more relevant for policy makers. It also makes them more attractive for research, as it opens the black box, sheds light on mechanisms of impact, and therefore provides information on generalizability of results.

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