Institution and Development:
Evidence from a randomized information field experiment in India

Abstract: Property rights are central to economic development. Though land titling can ensure these rights on land, its implication in encouraging investment and stimulating land markets is theoretically ambiguous and empirically unclear. While land titling can reduce efficiency by eliminating the threat of eviction, it can also have the opposite effect on productivity by ensuring returns on investment. We conduct a randomized experiment that generates exogenous variation in the access to information for farmers in India. Combined with detailed survey data, we causally identify the impact of land titling "nudge" on farmers' investment behaviour, consumption pattern and production outcomes. Our results show that simple "nudges" can increase agriculture productivity by up to 8 percent for treatment farmers relative to the control group. While these investments are financed by credit, the household borrowings can also result in unintended investment in consumption smoothing.

Keywords: Institution; land titling; experiments; productivity; economic development

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1. Introduction

The significance of property right institutions in economic development can hardly be overstated and has implications for income growth and poverty reduction in developing countries. The lack of property rights manifests itself into expropriation risk, prohibits access to capital, and exclude gains from trade. Property rights are not exogenously given – they evolve over time, driven by economic and political forces – which makes the study of its impact empirically challenging. Unfortunately, despite an emphasis on strengthening property rights in both economic theory and policy domain, we still lack a rigorous empirical understanding of the extent to which property rights actually affects resource allocation, and how the resulting resource allocation affect economic outcomes.[1]

Land titling by ensuring property rights over land has the potential to enhance access to capital, improve intra-household labour allocation, alleviate expropriation risks, encourage investments and stimulate land markets. Worldwide, several countries have attempted to improve these rights with land titling programs to alleviate poverty and improve welfare.[2] Though land titling can ensure these rights on land, its implication in encouraging investment and stimulating land markets is theoretically ambiguous. For instance, while land titling can reduce efficiency by eliminating the threat of eviction, it can also have the opposite effect on productivity by ensuring returns on investment.

Empirically, the relationship is even more challenging – while title acquisition and maintenance involve expenditure, farmers tend to register land with greater scope for higher returns – when past investment ensures rights by use of land to secure land rights as in many developing countries (Besley and Ghatak 2010). The main identification challenge is to isolate the impact

[1] Though the classical economics literature, from Smith to Marx, emphasised the significant role that property rights play in the process of economic development, it is only after the work of North (1990) that has brought property rights once again at the centre of thinking about development. Recent years has seen a remarkable and exciting revival of interest in the empirical analysis of how a broad set of institutions affects growth. The focus of these research is on exploiting cross-country variation in institutional quality to identify whether a causal effect runs from institutions to growth (Acemoglu et al. 2001; Acemoglu et al. 2002; Acemoglu 2005; Rodrick et al. 2004). These papers show that institutional quality is a significant determinant of a country's growth performance. Given the coarseness of cross-country data, Pande and Udry (2005) suggest an alternative agenda utilising within country micro-data to exploit policy-induced variation in institutional form to examine how specific institutions influence economic outcomes. There is now significant literature based on micro-empirical studies, but the results from these studies are often highly confusing and contradictory (Fenske 2011). See Fenske (2011) for an interesting summary of key concerns in the literature and a rigorous meta-analysis of the results from studies in Africa.

[2] Encouraged and fostered by the international development agencies, land titling programs are launched throughout the developing and transition economies as part of the poverty alleviation strategy (Galiani and Schargrodisky 2010). See Deininger and Binswanger (1999) for a good summary.

of land titling from spurious effect caused by selection into the tenure security. To add to this, researchers have to grapple with serious concerns where institutions coevolve with other potential determinants of economic development (Pande and Udry 2005).

We conduct a randomized experiment that generates exogenous variation in the access to information on the significance of land titling among Indian farmers. The setting of the experiment is ideal in which to study the implications of property right institutions. Over 60 percent of the population is in the agriculture sector, and land distribution is mostly governed by customary law. As in the rest of the developing world, land rights are weak and informally determined. Modern and informal tenure systems coexist and overlap to a considerable extent. Consequently, there exist significant contrasts between de jure and de facto land tenure rights. India, like many other developing countries, has a colonial past over which current land tenure systems have evolved, and the formal legal system on land rights was also concurrently introduced by these colonial powers. Indigenous systems by legitimizing land transfer and ownership provide some security but offer little safeguard against expropriation by powerful outsiders. Land markets are thin, and succession is often unregistered. Registration is expensive, and red tape, lack of political will and poor administration all contribute to the failure of land registration to deepen land markets and limits access to credit. Growing population, limited adoption of improved technology, and the continued importance of the agriculture sector, similarly all render land tenure issues of great relevance to not just India but also many other parts of the developing world, especially countries in the Africa continent.

Our main result is that redefining property rights with land titling can increase crop productivity by 11 percent for the treated relative to the control group. With land title change, households were subsequently 22 percent more likely to receive credit from formal institutions at negligible costs. Though titling did not affect the total area cultivated, the share of cropped area decreased slightly by 4 percent reflecting land use change – reallocation of land to long duration lucrative crop. Titling increases access to cheaper credit that channels the finance into more productive investment, subsequently reducing the fallow land by 9 percent facilitated by land use change. The driving channel for better outcomes is collateral rather than expropriation risk or land transfer rights. Titling removes constraints on land use inducing investment in high-value crops.

We assess the household welfare implications of land and credit reallocation induced by land titling using household-level food and non-food consumption. We find that per capita

consumption increases by 6 percent for the treated relative to the control. The increase in the consumption of non-food is higher at 10 percent, while the food consumption increase by 7 percent for the treated. The disaggregated consumption results show an even more dramatic effect on household welfare from land titling. The increase in consumption can be expected from greater access to credit and also from an increase in incomes. Though we are unable to causally distinguish between the two effects, our results show that consumption increase by 2 percent from greater access to credit induced by land titling. The overall impact on food consumption is negligible but the consumption of non-food increases by 4 percent, giving support to the proposition that titling effect can result in an unintended diversion of productive capital to investment in consumption smoothing.

We make two key contributions. First, using a unique experimental intervention we are able to isolate the different competing mechanisms in explaining the effect of property rights on economic outcomes. The literature makes no clear distinction as to which of the channels that well-defined and secure property rights over land can the benefits materialize: enhanced investment incentive, facilitation of land trades, increased access to credit, and improved intra-household labour allocation. Second, we estimate the extent to which land rights can affect investment behaviour, household welfare, and production outcomes.

Our results relate to a number of papers that span the institution and economic performance literature. Most directly, we contribute to voluminous literature that seeks to identify the significance of property rights in economic performance. The evidence from these studies is mixed[3], though it is not clear whether this is due to variation in programs offered, or methodological challenges associated with evaluating programs without plausibly exogenous

[3] Besley (1995), while finding that more secure land rights lead to greater investment, suggests that investment on the land may also have been undertaken with a view to strengthening land rights. Studies in Brazil and Indonesia find that investment in land and land values are positively associated with the possession of formal titles (Alston, Libecap and Schneider 1996; SMERU Research Team 2002). Many other studies have also found a positive effect of secure property rights on investments in many different contexts (Goldstein and Udry 2008; Bandiera 2007; Rozelle and Swinnen 2004). Similarly a positive association between urban titling and housing investment was also found in Buenos Aires (Galiani and Schargrodsky 2006). De Janvry, Emerick, Gonzalalez-Navarro and Sadoulet (2015) show that land certification in Mexico improved migration resulting in efficiency and welfare gains. However, Braselle, Gaspart and Platteau (2002) review a number of studies that show very little impact of land titling on investment. Moreover, Jacoby and Minten (2007) find that land titling has no impact on investment and productivity, and has only a small positive effect on land value. On access to credit, Galiani and Schargrodsky (2006) find no impact of property rights on access to credit, and Boucher, Barham, Carter and Chamorro (2002) and Field and Torero (2004) find low access to credit despite the implementation of land reforms. Contrariwise, Feder, Onchan, Chalamwong and Hangladoran (1986) find that the possession of legal titles leads to an increase in credit access for the poor. See Galiani and Schargrodsky (2011) for a review of literature on the impact of land titling in urban areas.

variation. We confront the selection issue head-on through random assignment and measurement of property rights by exogenously varying the nudge to obtain land titles. To the best of our knowledge, our study is the first rigorous experimental evaluation to test the significance of institutions, in general, and land rights, in particular, on economic outcomes.

There is an active literature recognising the significance of behaviourally-motivated policies to nudge for higher savings (Bernheim, Fradkin and Popov 2015; Karlan, McConnell, Mullainathan, and Zinman 2010; Somville and Vandewalle 2018)), organ donation decisions (Johnson and Goldstein 2003), energy conservation (Costa and Kahn 2013; Alcott and Kessler 2015), exercise commitment contracts (Bhattacharya, Garber and Goldhaber-Fiebert 2015), and charitable giving (Reyniers and Bhalla 2013; Cain, Dana and Newman 2014) among others. Our findings complement this literature by demonstrating that nudging farmers to land titling can enhance access to credit, improve welfare and increase agricultural productivity.

Finally, although the use of RCTs is novel in the new institutional economics literature, the methodology has been used to understand supply constraint in the adoption of profitable technologies in agriculture (e.g., Emerick et al. 2016; Duflo et al. 2011; Hanna et al. 2014). We complement this literature by providing the first experimental evidence on the significance of property rights in resource allocation and how these institutions shape the incentives to make a productive investment.

The rest of the sections are organised as follows. The next section provides the experimental design and describes the data followed by the section presenting the empirical results. The last section concludes the study.

2. Experimental design and data

2.1. Context

Over the past three decades, poor property rights have been recognized as an important impediment to economic development. Hence, reforming agricultural property rights has been undertaken in several countries across Africa, Latin America and Asia (Deininger, Jin and Nagarajan 2009). Formalizing land ownership, through registration and titling, have also been widely undertaken in India. Land ownership in India is established not by a government guaranteed title but from registered sale deed, a record of rights, property tax receipts or survey documents (Mearns 1999). Therefore, land ownership in India is rather presumptive in nature with possession of only a record of the transfer of property that may be subject to challenge.

Henceforth, we will refer to the possession of the above documents as (informal) land titles. A World Bank study suggests that land-related disputes account for two-thirds of all pending court cases in India (World Bank 2007).

A further concern is that these land titles are not in the name of the farmer who is presently cultivating the land (owner-cultivator). Often, the titles are in their fathers or mothers name, who may or may not live with the owner-cultivator, or even may have died some time ago. The current system of land records is the legacy of colonial land revenue system set up by the British in India. The Transfer of Property Act, 1882 provides that the right, title, or interest in an immovable property (or land) can be transferred only by registered instrument. The Registration Act, 1908 is currently the primary law governing the registration of land-related documents. Since registration of property is not mandatory, heirship partitions do not get registered due to the high costs involved in the registration fee and stamp duty (Mearns 1999). Apart from these costs, the involvement of three state departments and multiple record types also raises the implicit costs of changing the land title.[4] Mearns and Sinha (1998) provide an empirical assessment for Orissa showing that land-related transaction costs could amount to at the least about 34 percent of the value of land transacted. The discrepancy in property data between different records also builds in inefficiencies into the land markets, and hence, agricultural land markets are virtually non-existing. With the titling of land, it is expected that land markets may be stimulated.

After independence, land reforms was a state subject under the 1949 Indian Constitution that had three main components (Besley, Leight, Pande and Rao 2016). The first component is tenancy reform to regulate tenancy contract by registering and stipulating the contractual terms. This led to the improvement in terms of tenant's contracts and enhanced the security of tenure. Meaning, that threat of eviction is no longer a credible incentive device (Banerjee, Gertler and Ghatak 2002). The second component is the abolition of intermediaries (*zamindars*), who had permanent property rights prior to the independence. Since the intermediaries were mainly interested in maximising rent collection, a system of land records was created and maintained to facilitate this process. Hence, land records furnished information related to area and details

[4] The three government departments are Registration Department responsible for registration of sale deeds and collection of stamp duty (transaction records); Revenue Department for maintaining Record of Rights and tax register for collection of land revenue (property records); and Survey and Settlement Department executes surveys to collect land related data and spatial maps (spatial records). To sell the land all three records have to be match manually. The Committee of Financial Sector Reforms (2009) had recommended moving from a presumptive to a conclusive titling system. Conclusive titles are state guaranteed titles, where the state guarantees the title for its correctness and provides for compensation in case of any disputes.

of the tenant important for land revenue assessment. Post-independence, the intermediary system was abolished, but land ownership continued to be determined through a combination of these records. The third component is the imposition of ceiling on land size holding to cap on the amount of land a person could own.

Land titles can increase access to capital through the ability to use land as collateral. One key eligibility condition for institutional credit is holding land titles on their name. Unclear titles may, however, inhibit access to institutional credits because the eligibility conditions exclude farmers with no land titles. Credit markets using land as collateral in India are likely to be an active channel through which land rights may affect investment. Not having land titles also affects the ability to obtain insurance. For example, if the actual area being cultivated is more than the area marked in the land records, the area insured is less than the cultivated area. This could lead to a reduction of the insurance claims of farmers. The small and marginal farmers who do not have titles on their name could also lose the agricultural subsidy offered under various government-sponsored support programs.

2.2. Experimental design

The experiment was conducted in Karnataka, a south-western state of India. We follow a two-stage randomization procedure wherein the first-stage we randomly allocate 12 of the 25-gram panchayats (GP) in Siriguppa taluk (sub-district) to the treatment and control group with an allocation of 6 GP each (Figure 1a and Figure 1b). To control for the information spillover between treatment and control GP, we applied the criterion that no two control and treatment GPs are contiguous. In the second stage, for a wider spread, we randomly selected households within the GPs ignoring village boundaries. The average distance between the closest control and treatment household is 30 km. This is to minimise the flow of information between them and hence, contamination of the control group.

From the Bhoomi database[5], which is a census of land ownership in Karnataka, we randomly sampled 800 households from across 39 villages. We deliberately oversampled to include households (i) who are current cultivators, (ii) households cultivating at least two of the six focus crops – ragi, sunflower, bengal gram, cotton, paddy and chili, and (iii) households may be split but not their farmland. We dropped those households who were not cultivating any

[5] Bhoomi database is an outcome of the Bhoomi project for the online delivery and management of land records in Karnataka. The project was implemented by the state government of Karnataka to digitize all the manual Record of Rights, Tenancy and Crops (RTC).

land while the land was in their name but migrated to a nearby town. Among the split households, we kept the household with whom the land title holder lived. In the case where the title holder is dead, we randomly choose one from the split households (only two cases).

In June 2013, the trained enumerators visited the sampled households at home and farm to administer a baseline survey. At the end of the interview, all respondents received a leaflet and a wall-hanging calendar in local language listing the eligibility conditions for institutional credit, government subsidy programs, and crop insurance (Figure 2). This information was part of a whole host of information on "Best Practices in Agriculture", referred to as the Package of Practices (POP) that were delivered to the farmers. One of the key precondition to receive credit or enrolment in a subsidy program, or receive crop insurance is that the land title has to be in the name of the applicant. Unclear titles may inhibit access to institutional credits because the eligibility conditions exclude farmers with no land titles. We randomized the way this information was relayed at the farmer level. To make the information salient, the enumerator's readout and explained the eligibility conditions to only the treatment farmers, while the control farmers received this information only in print. The information was relayed to treatment farmers over four years at the time of the farm surveys.

Note that no prompts were delivered asking farmers directly to change the land title to the cultivator's name. This was done deliberately to avoid the "Hawthorne effect" impacting the experiment. Despite the indirect delivery of information, 70 percent of the treatment farmers changed the land title in the RTC form no. 16 over the four-year period. With this change, all other relevant government records were also updated which ensured the farmer-owner to be eligible for the sale of land, access to credit and insurance, and qualify for government-sponsored subsidy programs. A year-wise breakdown of the adoption of the intervention is provided in the next section.

2.3. Data, take-up and attrition

We collected multiple rounds of detailed data from farm surveys at the end of each agricultural season in the four-month intervals.[6] The household surveys were conducted annually for 4 rounds. In total, households were interviewed twelve times for farm surveys and four times for the household surveys.

[6] The agriculture seasons are *Kharif* season from June to September, *Rabi* from October to January, and the rest, summer.

The baseline round occurred before households were provided with information using leaflet and wall-hanging calendar and included questions on (i) farm production, (ii) input cost , (iii) household and demographic characteristics, and (iv) household consumption. We repeated this full survey for the follow-up round 9 of farm surveys and the follow-up round 3 of household surveys.

The farm survey includes production module that records the output of crops for the months preceding the survey interview. We collect the type of crop produced, the area planted, output quantity and prices, and the duration of the crop produced. In the cost module, we collect total labor hours worked, input quantity and prices, and revenues. This information was recorded for each crop and farming operations.

The household surveys have two modules: a demographic module and consumption module. The demographic module records member-wise information on age, sex, education, occupation, salary and wage incomes earned from agriculture and non-agriculture employment, and details of assets owned. The consumption module records the price and quantity of all food and non-food items consumed for the month preceding the survey interviews. Certain non-food expenditures like clothing and footwear, medicine and health costs, ceremonies, education, etc. are recorded for the 12-months preceding the interviews.

The main reason for farmers not changing the land title is the cost associated with land titling. The costs for changing land title has two main components: (i) registration fee and (ii) stamp duty. The registration fee is 1 percent of the market value of the land while the stamp duty is much higher at 5.65 percent of the total land value. The combined cost raises the cost of land transactions, leading to avoidance of land registration. Since heirship partitions do not require registration, several land divisions are not currently recorded.

After the baseline survey of 660 households, 53 households dropped in the third year of the project with 8 percent attrition rate split equally between treatment and control groups. These households, however, were included in the final analysis because we had at least two previous rounds of data collected for these households. In the same year, we replaced these households with a new set of households randomly selected from the *Bhoomi* database. We kept the same number of the split between control (29) and treatment (24) groups. In the following year, seven households dropped from these replaced samples. The splits were one in treatment and six in the control group. Unfortunately, we had to exclude these households from the final analysis because they refused to be interviewed in the final survey and we only had one data point for

these households. The overall attrition is low at 10 percent. For the rest of the households, we have data for all the four years.

In total, we use information from 706 households with 660 from the original samples and 46 from the replacement samples. These are split as 313 treatment and 393 control households. Of the treatment households, 220 changed their land title while only 93 did not change their land title even after 4 years of intervention. Despite the high costs of land registration, the uptake in the first year of the intervention was 57 percent gradually increasing to 70 percent in the final year. Figure 3 reports the cumulative land titling between 2014 and 2017. Though expensive to change the land title still farmers changed.

2.4. Summary statistics and balance check

Table 5 shows the baseline balance between the treatment and control groups. The table reports the randomization balance check of each variable and reports the mean of the control household in column 2 and the difference between control and treatment means in column 3 (standard deviations in parentheses). The last column reports the p-values. The statistical significance of the difference is tested to assess comparability across the different treatment groups. Panel A shows the summary statistics for the household characteristics of the farmer. The control sample population is equally split between males and females. Roughly 57% of the control farmers are illiterate. The mean age in the control group is around 27 years, and on average, farmers have 21 years of experience in farming. Majority of the control farmers belong to the higher caste and Hindu religion. The average family size of 7.3 which though is higher than the all India rural average of about 4.7 (Government of India 2010). The average monthly food consumption is Indian Rupees 7169 ($107) and annual average non-food consumption is Indian Rupees 110,428 ($1654).

Panel B reports statistics on farm characteristics. The average land holding among control farmers is 8 acres, though the cultivated area is higher (9 acres) from land leased-in from other farmers in the village. The irrigated land on average is lower with 5 acres. The 58 percent of control farmers on average borrowed from different sources including institutional credit from banks. The mean crop yield that includes all crops cultivated among control farmers is 15 quintals per acre and the crop output is 108 quintals per acre. The final row of Panel B reports the average crop-wise share of area cultivated across the 34 crops grown by the control farmers. Across both panels, we find no statistical difference between treatment and control households with one exception: treatment farmers report significantly lower family size at baseline.

2.5. Estimation strategy

Our randomization procedure allows us to use a straightforward estimation strategy to assess the impact of land titling on production outcomes, investment behavior, and consumption pattern:

$$Y_{it} = \alpha_0 + \beta_1 Treatment_i + \eta_1 Y_{i0} + T_t + \delta_{gp} + \varepsilon_{it}$$

Y_{it} is the outcome of interest in crop plot *i* in period t; $Treatment_i$ is a dichotomous variable equal to 1 if land title for plot *i* is changed; Y_{i0} is the value of the dependent variable at baseline, T_t is time fixed effects, δ_{gp} is group fixed effects , and ε_{ijt} is an error term. The effect of interest (β_1), capture the average impact of the treatment relative to the control group. Since we randomize the intervention at GP level, standard errors are clustered at this level in all regressions at the individual plot level. Since inference employing clustered standard errors with only 12 clusters can be more unreliable than inference using standard heteroscedasticity-robust standard errors, we employ a wild bootstrap to bootstrap the T-statistics. We follow Cameron et al. (2008) by adapting the codes in which estimation requires imposing the null hypothesis and employing Rademacher weights.

Before showing results on our key variables for impact, we first show that the intervention worked, insofar as treatment farmers were more likely to transfer land titles to their names. To do so, we replace $Y_{it}$with a dummy variable that takes the value 1 if a farmer transferred the land title to his name. As shown in Table 6, being in treatment raises the probability of changing the land title to their name by 70 percentage points relative to control households with only printed information. Since a clear majority of the households changed the land titles in the first year and very few in rest of the years after the intervention, we essentially combine all the follow-up survey rounds to increase precision. The above equation is an intent-to-treat specification because the take-up percentage was high overall among households.

3. Empirical results

3.1. Impact of land titling on agriculture productivity

Table 6 reports the crop share of major crops grown, mean yield and the average price per quintal. About 50 percent of the total crop area is cultivated by paddy, an important staple crop widely grown under irrigated conditions for both market and home consumption. It is grown

twice a year – kharif-paddy and summer-paddy. The cropping duration is about 90-120 days, and the kharif-paddy is sown in July and harvested in October and summer-paddy is sown in November to be harvested in February. Though there may be some variation in the time-scales of the two crop-cycles, not all farmers go for paddy twice a year. The choice of the timing and the decision whether to go for summary-paddy is highly dependent on the rainfall and water availability in the Tungabhadra canal.

Cotton is a long duration cash crop cultivated under both irrigated and unirrigated conditions, which is grown only for the market. Although its share is only a quarter of the total cultivated area, it is grown almost by all households – especially, the small and marginal households – who have no irrigation facility. Another staple crop jowar (sorghum), though widely grown in the region for fodder and being drought tolerant, is not ubiquitous among our samples. Both paddy and cotton are widely grown, chili, which is a highly risky, though a lucrative crop, is grown by fewer households. Note that both paddy and chili are grown only under irrigated conditions while cotton and jowar can also be grown under drought conditions. Although a risky crop, chili is highly profitable. Table 6 shows that the average returns to chili crop are the highest among all the crops grown; about thrice the returns to paddy (though paddy yields are almost double, prices received for chili are seven times greater than paddy reflecting the higher risk premiums associated with growing a riskier crop like chili).

Columns 1 to 3 of Table 7 presents coefficient estimates of the impact of land titling treatment on crop yield. These regressions show that changing land titles to the cultivator's own name increases aggregate crop yields by 11percent relative to the control group. Evidence from the disaggregated analysis suggests that the yield response to land titling differs by crop. Results presented in column 2 shows that cotton yield for the treated group increased by 12 percent with land title change relative to the control group. The yield increase for paddy presented in columns 3 is about half at 6 percent for the treatment group compared to the controls. Both regressions include GP and year fixed effects, and standard errors are clustered at the GP level.

3.2. Impact of land titling on land use

Having shown that land titling led to the increase in the yields of both cotton and paddy, we now turn to the question of the effects of titling on land use. We examine if the yield increase is due to the additional area brought into cultivation from either renting-in, converting fallow land or buying new land. An increase in yield could result from greater use of inputs including land. In other words, land titling, in theory, can not only lift the use restrictions but also

eliminate restrictions on land sales, land rentals and sharecropping. Additionally, land titling can also enhance credit access to facilitate the use of inputs in converting the fallow land. Consequently, either more land is brought into cultivation or the cropping pattern could shift towards more profitable crops, supplemented from better access to credit. Hence, verifying empirically whether land titling reallocated land is important to determine if there is an efficiency gain in terms of land allocated to more profitable crops.

To examine the impact of titling on land use in Table 7 we estimate the impact of titling on the share of the sown area to total cultivated for each crop. Results reported in column 4 of Table 7 shows a 4 percent decrease in the share relative to the control despite increases in yields. The disaggregation of the land use by crops could shed some light on the reallocation of land between crops. The area under cotton significantly increased by 10 percent relative to the control group because of land titling. This area increase is drawn partly from the decline in the share of the area by 8 percent under paddy. Overall, the estimates for the titling impact shows evidence of land use change and changing cropping pattern, which can be attributed to the profitability of the cotton crop from greater yields, the higher average price received and hence, larger returns (Table 6).

We next examine the titling impact on the cultivated area and the owned area under fallow in each of the three agricultural seasons. Table 8 columns 1 to 3 reports results for the share of cultivated to the total owned area. The overall impact on land use from land titling, as reported in columns 1, remains statistically insignificant across the seasons. It shows that no new land through purchase, rent or sharecropping is brought into cultivation. However, results reported in column 5 shows that land titling brought 9 percent of the fallow land into cultivation but only in the rabi season. Previously we showed the increase in the share of the cotton area, part of which resulted from the decrease in the area under paddy. This decrease in the area of paddy is for the farmers who cultivated only kharif-paddy and could not cultivate paddy in the rabi season due to water shortage. Hence, adoption of the long duration cotton crop resulted in the cultivation of these plots that generally remained fallow in the rabi season. Cotton can be grown under both irrigated and unirrigated conditions. Bringing in these additional land could have contributed to the yield increase in the cotton crop. Some paddy farmers who have irrigation only for the kharif season stands to gain from this shift to cotton.

3.3. Impact of land titling on credit

We now examine the well-known idea of de Soto (2000) that the lack of formal titling prevents the use of the property as collateral, and hence inhibits the capital embedded in these assets from being "unlocked". Farmers without secure landownership face constraint in gaining access to low-cost credit. With credit constraint on the working capital, cultivation could shift to crops that require smaller outlays of cash. Similarly, constraints on credit may bar farmers from using expensive inputs.

The dependent variable in columns 1 to 3 in Table 9 is a dummy 1 if the household received credit from any source. Results across the columns show that land titling has no impact on access to credit for the treated farmers relative to control. Credit here includes both institutional credit and non-institutional credit. Institutional lenders in the formal sector include cooperative societies, state-owned and private banks, while non-institutional lenders, who are part of the informal sector, comprise of friends, relatives, moneylenders, traders, and rich farmers. Given that non-institutional lenders do not require collateral, access to credit in the informal sector is the same across both treated and control groups. Possession of land titles essentially diminishes the constraints only on accessing institutional credit.

Though no collateral is required for non-institutional credit, the interest charged is usually very high.[7] Despite exorbitantly high-interest rates, there is greater reliance on the informal sources of borrowing in Karnataka (Bhende 2000). This is also reflected across India with only 15.6 percent of the farmers borrowing from institutional lenders as reported using the 1991-92 data from the National Sample Survey Organisation (Kalavakonda and Mahul 2005). The primary reason for the low penetration of credit, among others, is the key requirement that land titles are not in the name of the applicant. Despite RBI classifying agriculture as a priority sector with the stipulation that 18 percent of all lending should be directed towards this sector, lack of land titles prohibits rural households from accessing institutional lending.[8]

Since crop loans are disbursed based on the type of crop and nature of risk, we next examine the access to crop-loan for each of the crops. While results for paddy are less statistically precise, columns 4 and 5 show a significant positive impact of land titling relative to the control group. With land titles, farmers are able to receive institutional credit (crop loan), which requires land ownership proofs (records of rights or revenue receipts). However, some control farmers where the land title holder is alive and lived within the household did manage to get

[7] The interest rate is about 3 to 5 percent per month in rural Karnataka (Kalavakonda and Mahul 2005).
[8] Other reasons for low penetration of crop credit in Karnataka are inadequate loan amounts and poor loan recovery.

access to institutional credit with documents signed by the title holder. But for others accessing institutional loan is impossible without the land titles. With land titling access to institutional credit increases by 22 percent relative to the control group. If growing cotton, the change in land title increases access to crop loan by 27 percent relative to the control group without land titles. Overall, our results show that access to credit via the land titling channel finance into more profitable investment.

The access to additional credit is used in purchasing more and better inputs. Table 10 shows three of the key inputs used in cotton and paddy. The use of fertilizer increased by 11 percent for the treated relative to the control. Though cotton shows no significant increase in fertiliser application, treated paddy farmers significantly increased fertiliser application by 18 percent relative to the control. This may be the normal tendency, as is in the region and also across India, to apply more fertiliser to paddy in the hope for a greater yield with increased access to cash. Results reported in columns 4 to 6 shows increased application of insecticide to both cotton and paddy among the treated farmers. Results for micronutrient application show a huge increase among the few farmers growing cotton.

3.4. Impact of land titling on household welfare

Did land titling affect household-level consumption? If better land rights result in efficient allocation of land and labor, then this could translate into increased consumption. To examine this, we use consumption modules from all four rounds of the household surveys. A timeline of the surveys is provided in Table 1. Since the surveys were carried out between 2012 and 2017, it essentially captures the short-term effects of land titling on food and non-food consumption. Each survey has a detailed consumption module recording one month of price and quantity of food for thirty-eight items consumed by households. The non-food consumption includes eighteen items collected for annual household consumption.

Before examining the impact of titling on consumption, we aggregate all the loans received at the household level from different sources for any purpose (production or consumption) to see if the results replicate previously presented in Table 9. The estimates presented in Table 11 column 1 shows what was observed for loans from all sources for crop cultivation. Land titling is unlikely to improve access to credit for households from non-institutional sources. However, aggregating crop loans household-wise received for the different land parcels owned shows that land titling increases access to institutional credit by 15 percent for the treated relative to the control. Owning more than one parcel of land gives access to several crop loans where

households can borrow against each land title for every parcel of land. These estimates are much lower than previously observed. It may be due to the fact that some households cultivate just paddy.

We next examine the disaggregate impact of access to institutional credit on food and nonfood. Results presented in Table 11 column 3 show that, although modest, overall household consumption increases by 6 percent relative to the control group as a result of land titling. The land titling impact for consumption of food is slightly higher at 7 percent while for non-food it is almost double at 10 percent for the treated relative to control. The disaggregation presented in Table 12 gives a dramatic picture. While consumption of cereals, fruits and vegetables, and other food increases by just over 9 percent for the treated relative to the control, meat consumption though eaten by fewer households' increases by 24 percent. The consumption of non-food is greater than 12 percent for the treated relative to the control.

In interpreting these coefficients, it is helpful to highlight that the household-level results suggest both an impact to consumption – as new land titles with collateral seeking crop loan to smooth consumption – and an income induced consumption, as collateral can increase productive investment and boost incomes. Although both channels are possible, we examine here the first channel as this is more direct and easy to interpret. Results reported in Table 13 show that credit taken increase total consumption by 2 percent. This increase in consumption from access to institutional credit is wholly consistent with previous literature: Kalavakonda and Mahul (2005) report that most of the credit given to farmers by formal financial institutions as short-term crop (production) loan is widely used mainly to pay for consumption, particularly following drought years. However, it is important to note that the regression results are not a causal relationship because access to credit is not exogenous and causation could run in either direction. Hence, a note of caution in interpreting the results.

We next examine the disaggregate impact of access to institutional credit on food and nonfood. Though the impact on aggregate food is insignificant, the consumption of wheat increases by 11 percent. Households with access to institutional credit also increase their consumption of fruits and vegetables and meat and meat products. The consumption of non-food increases by 4 percent that includes expenditure on clothing and education.

4. Conclusion

Property rights institutions are central to sustainable development. The significance of land titling on agriculture productivity can hardly be overstated and has implications for income

growth and poverty reduction. Land titling has the potential to reduce poverty and contribute to sustainable development by enhancing agriculture productivity. Worldwide, several countries have attempted to improve these rights with land titling programs to alleviate poverty and improve welfare. Though land titling can ensure property rights over land, its implication in encouraging investment and stimulating agricultural productivity is theoretically ambiguous and empirically unclear. The main identification challenge is to isolate the impact of land titling from spurious effect caused by selection into the tenure security. Since institutions coevolve with other potential determinants of economic development, isolating the impact of land titling program can be challenging.

We conduct a randomized experiment that generates exogenous variation in the access to information on the significance of land titling among Indian farmers. The setting of the experiment is ideal in which to study the implications of property right institutions. Over 60 percent of the population is in the agriculture sector, and land distribution is mostly governed by customary law. As in the rest of the developing world, land rights are weak and informally determined. Combined with detailed survey data, we causally identify the impact of land titling "nudge" on farmers' investment behavior, consumption pattern and production outcomes. Our results show that simple "nudges" can increase agriculture productivity by up to 11 percent for treatment farmers relative to the control group. While these investments are financed by credit, the household borrowings can also result in unintended investment in consumption smoothing.

Our results relate to several papers that span the institution and economic performance literature. The evidence from these studies is mixed, though it is not clear whether this is due to variation in programs offered, or methodological challenges associated with evaluating programs without plausibly exogenous variation. We directly confront the selection issue through random assignment and measurement of property rights by exogenously varying the nudge to obtain land titles. To the best of our knowledge, our study is the first rigorous experimental evaluation to test the significance of institutions on economic outcomes in general, and land rights in particular.

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Table 1: Survey timeline

Survey timeline	Reference year	
	Farm survey	Household survey
Baseline round 0	June 2012 - May 2013	June 2012 - May 2013
Follow-up round 1	June 2013 - Sep 2013	July 2013 - May 2014
Follow-up round 2	Oct 2013 - Jan 2014	June 2015 - May 2016
Follow-up round 3	Feb 2014 - May 2014	June 2016 - May 2017
Follow-up round 4	June 2015 - Sep 2015	
Follow-up round 5	Oct 2015 - Jan 2016	
Follow-up round 6	Feb 2016 - May 2016	
Follow-up round 7	June 2016 - Sep 2016	
Follow-up round 8	Oct 2016 - Jan 2017	
Follow-up round 9	Feb 2017 - May 2017	

Table 2: Sample and take-up statistics

Year	Original samples	Samples dropped	Replacement samples	Total samples	All samples included in the analysis
	(1)	(2)	(3)	(4)	(5)
2012-2013	660	0	0	660	660
2013-2014	660	0	0	660	660
2015-2016	607	53	53	660	713
2016-2017	607	7	0	653	706
Statistic					
Farmers total					706
Treatment farmers					313
Take-up farmers					220
Mean output conditional on take-up (kg/acre)					144.7
Std. dev. of output conditional on take-up					350.8
Attrition rate in year 3 (percent)					8
Attrition rate in year 4 (percent)					1

Note: Attrition rate is calculated as samples dropped divided by total sample in the previous period. The attrition rate does not vary between treatment and control groups in year 3 (8%). In year 4, the attrition rate is 0.2% for treatment group and 1% for control group.

Table 3: Variable definition in regression analysis

Variable name	**Definition**
Treatment (T)	Dummy =1 for household that was randomly assigned to the group intended to be treated, and 0 otherwise.
Land title (L)	Dummy =1 for change of land title to owner-cultivator's name, and value 0 otherwise.
Education	Category based on number of years of education [between 0 & 6; 6 &10; 10 & 16 and greater than16].
Crop experience	Category based on number of years of crop experience [between 0 &16; 16 & 30; 30 & 45 and greater than 45.
Caste	Category based on household that belongs to four caste [1= general, 2= schedule caste, 3= schedule tribe, 4= backward caste].
Gender	Dummy =1 for male household members, and value 0 otherwise.
Religion	Dummy =1 for Hindu religion, and value 0 otherwise.
Family size	Number of members within household using the same kitchen
Age	Number of years
Chilly yield	Chilli production divided by area under chilli cultivation.
Cotton yield	Cotton production divided by area under cotton cultivation.
Paddy yield	Paddy production divided by area under paddy cultivation.
Crop yield	Yield for all 34 crops grown by the farmers
Total land owned	Log of farm land owned in acres.
Total cultivated land	Owned land in acres cultivated that excludes land rented and leased out, given under sharecropping or rent, fallow and pasture land. Includes land taken on sharecropping, rent and leased.
Total irrigated land	Cultivated land that received water for irrigation in acres
Share of crop area cultivated	Ratio of area under each crop to total cultivated area
Food consumption	Monthly consumption of cereals, pulses, vegetables, fruits, meat, spices, all food eaten outside and sugar.
Non-food consumption	Annual consumption of non-food items such as clothing and footwear, medicine and health costs, ceremonies, education, etc.
Total consumption	All food and non-food consumed annually.
Credit received	Dummy = 1 if household received credit, and value 0 otherwise.

Table 4. Control and Treatment Households – Baseline Balance Check - 2013

Variable	Total observations	Control group mean	Difference in treatment	P-value
Panel A: Household Characteristics				
Gender	4543	0.52	-0.0131	0.3957
			(0.0150)	
Illiterate?	4543	0.57	-0.0435	0.1222
			(0.0267	
Age in number of years	4543	27.57	0.0656	0.9351
			(0.7932)	
Farmer cropping experience (number of years in crop farming)	660	21.06	0.9117	0.5314
			(1.4250)	
Caste	660	0.72	0.2861	0.1234
			(0.1759)	
Religion	660	0.95	-0.0167	0.4733
			(0.0227)	
Family Size (number of members)	660	7.31	0.9350	0.0255*
			(0.3797)	
Food consumption monthly	660	7169	539.5156	0.2738
			(476.0408)	
Non-food consumption annual	660	110428	-5.8e+03	0.6478
			(1.3e+04)	
Total consumption annual	660	189286	104.2656	0.9944
			(1.5e+04)	
Panel B: Farm Characteristics				
Total Land owned (acre)	660	8.04	-1.8198	0.1729
			(1.2756)	
Total Land cultivated (acre)	660	9.36	-1.7889	0.1454
			(1.1687)	
Total irrigated Land (acre)	660	5.40	-1.5804	0.4123
			(1.8774)	
Credit received	660	0.58	0.0200	0.8712
			(0.1214)	
Crop yield (quintals per acre)	1289	15.08	1.3718	0.6702
			(3.1618)	
Crop output (quintal)	1291	108.22	2.4426	0.9543
			(41.9952)	
Share of crop area cultivated	1290	0.70	0.0713	0.5575
			(0.1191)	

Table 5: Impact of intervention on land ownership change

	Land title change
Titling intervention	0.706***
	(0.013)
Constant	0.022
	(0.015)
R-squared	0.570
Observations	2673

Table 6: Dominant crops, yields and prices

Crop name	Share of cultivated total area (percentage)	Mean yield (quintals per acre)	Average price (Rupees per quintal)	Percentage of farmers growing
	(1)	(2)	(3)	(4)
Paddy	50.29	24.68	1800	79
Cotton	23.93	5.94	4500	57
Jowar	5.99	7.66	2500	20
Chilli	4.55	10.23	13000	13

Notes: The above figures are pooled across all four years. Both paddy and jowar are short duration crops that are grown twice a year. Cotton and chilli are long duration crops cultivated once a year. There are 30 other crops grown that includes Bengal gram, horse gram, maize, redgram, sugarcane, sunflower, cowpea, barley, groundnut, castor, greengram, and a combination of several crops raised together.

Table 7: Land titling and crop yield

Dep. variable:	Crop-wise plot level					
	Log of crop yield			Log of share of crop area to total area cultivated		
	All crops	Cotton	Paddy	All crops	Cotton	Paddy
	(1)	(2)	(3)	(4)	(5)	(6)
Titling treatment	0.109***	0.128**	0.063***	-0.043**	0.105***	-0.089***
	(0.031)	(0.055)	(0.022)	(0.020)	(0.042)	(0.024)
Constant	0.420***	0.660***	1.522***	-0.074***	-0.276***	-0.033**
	(0.057)	(0.094)	(0.132)	(0.016)	(0.042)	(0.017)
Control mean (in levels)	17.418	7.209	22.396	0.790	0.752	0.848
GP FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES	YES
R-squared	0.768	0.482	0.418	0.627	0.608	0.601
Observations	2295	614	1593	2507	618	1791

Table 8: Land titling, fallow land and cultivated area

Dep. variable:	Household level land holding by agricultural season					
	Log of share of cultivated area to total owned			Log of share of fallow area to total owned		
	Kharif	Rabi	Summer	Kharif	Rabi	Summer
	(1)	(2)	(3)	(4)	(5)	(6)
Titling treatment	0.008	-0.000	0.028	0.033	-0.088***	-0.018
	(0.044)	(0.044)	(0.055)	(0.107)	(0.036)	(0.039)
Constant	0.027	0.082	-0.062	-0.504***	-0.173	-0.024
	(0.046)	(0.055)	(0.058)	(0.214)	(0.061)	(0.041)
Control mean (in levels)	0.790	0.752	0.848	17.418	7.209	22.396
GP FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES	YES
R-squared	0.603	0.557	0.832	0.768	0.432	0.237
Observations	2475	1183	395	69	820	1828

Table 9: Land titling and access to credit

Dep. variable:	Credit taken from all sources (value 1 if credit taken from any source)			Log of crop loan (amount in Rupees)		
	All crops	Cotton	Paddy	All crops	Cotton	Paddy
	(1)	(2)	(3)	(4)	(5)	(6)
Titling treatment	0.007	0.000	0.019	0.224***	0.274***	0.099
	(0.018)	(0.031)	(0.022)	(0.059)	(0.088)	(0.078)
Constant	0.375***	0.361***	0.399***	4.698***	4.759***	4.518***
	(0.020)	(0.032)	(0.023)	(0.293)	(0.677)	(0.360)
Control mean (in levels)	0.748	0.725	0.763	146613	129897	153061
GP FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES	YES
R-squared	0.256	0.279	0.259	0.416	0.390	0.470
Observations	4093	1197	2495	2049	585	1258

Table 10: Land titling and input costs

	Log of fertilizer cost			Log of insecticide cost			Log of micronutrient cost		
	All crops	Cotton	Paddy	All crops	Cotton	Paddy	All crops	Cotton	Paddy
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Titling treatment	0.109**	0.073	0.185***	0.142***	0.184***	0.118***	0.031	0.445*	0.097
	(0.053)	(0.077)	(0.066)	(0.048)	(0.067)	(0.057)	(0.102)	(0.234)	(0.084)
Constant	3.656***	3.072***	3.790***	2.867***	2.966***	2.838***	2.181***	1.169	2.120***
	(0.183)	(0.301)	(0.210)	(0.165)	(0.298)	(0.194)	(0.291)	(0.723)	(0.286)
Control mean (in levels)	41100.04	35070.73	46854.36	10962.54	9847.492	12074.13	1814.005	626.473	2599.671
GP FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.519	0.595	0.489	0.535	0.540	0.539	0.597	0.745	0.574
Observations	2456	606	1764	2356	594	1675	722	56	663

Table 11: Credit access, aggregate household consumption and land titling

Dep. Var.:	Credit		Log of per capita total consumption (annual)	Log of per capita food consumption (monthly)	Log of per capita non-food consumption (annual)
	Loan from all source	Log of Crop loan			
	(1)	(2)	(3)	(4)	(5)
Titling treatment	0.019	0.149***	0.059***	0.070***	0.098***
	(0.018)	(0.062)	(0.021)	(0.026)	(0.024)
Constant	0.239***	3.113***	3.072***	2.377***	2.926***
	(0.018)	(0.325)	(0.164)	(0.109)	(0.146)
Control mean (in levels)	0.696	124691	26085	895	14568
GP FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES
R-squared	0.435	0.599	0.610	0.561	0.577
Observations	2522	1284	2524	2524	2523

Table 12: Land titling and household consumption

Dep. Var.:	Food consumption per capita (Monthly)					Non-food consumption per capita (Annual)			
	Log of Cereals	Log of Pulses	Log of Meat	Log of Fruits and Vegetables	Log of Other food	Log of Ceremonies	Log of Clothing	Log of Education	Log of household items
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Titling treatment	0.095***	0.118***	0.245***	0.087***	0.097***	0.120***	0.155***	0.123***	0.130***
	(0.040)	(0.027)	(0.040)	(0.032)	(0.027)	(0.046)	(0.029)	(0.048)	(0.038)
Constant	1.991***	1.933***	1.469***	1.914***	1.912***	3.165***	2.755***	2.301***	2.272***
	(0.092)	(0.073)	(0.113)	(0.070)	(0.081)	(0.150)	(0.102)	(0.105)	(0.094)
Control mean (in levels)	1582	156	98	158	263	1582	1514	2694	2810
GP FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.490	0.440	0.450	0.590	0.557	0.498	0.431	0.600	0.418
Observations	2520	2493	1314	2508	2523	2474	2516	1746	2303

Notes: Control mean of Dep. Var is the monthly mean of the dependent variable for the control group.

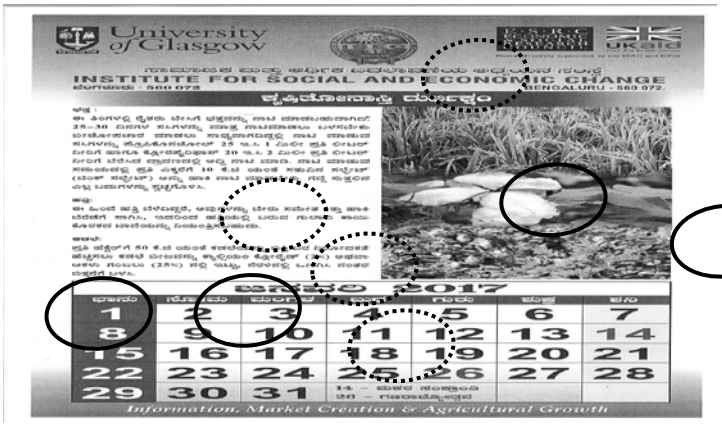
Table 13: Household consumption and crop loan

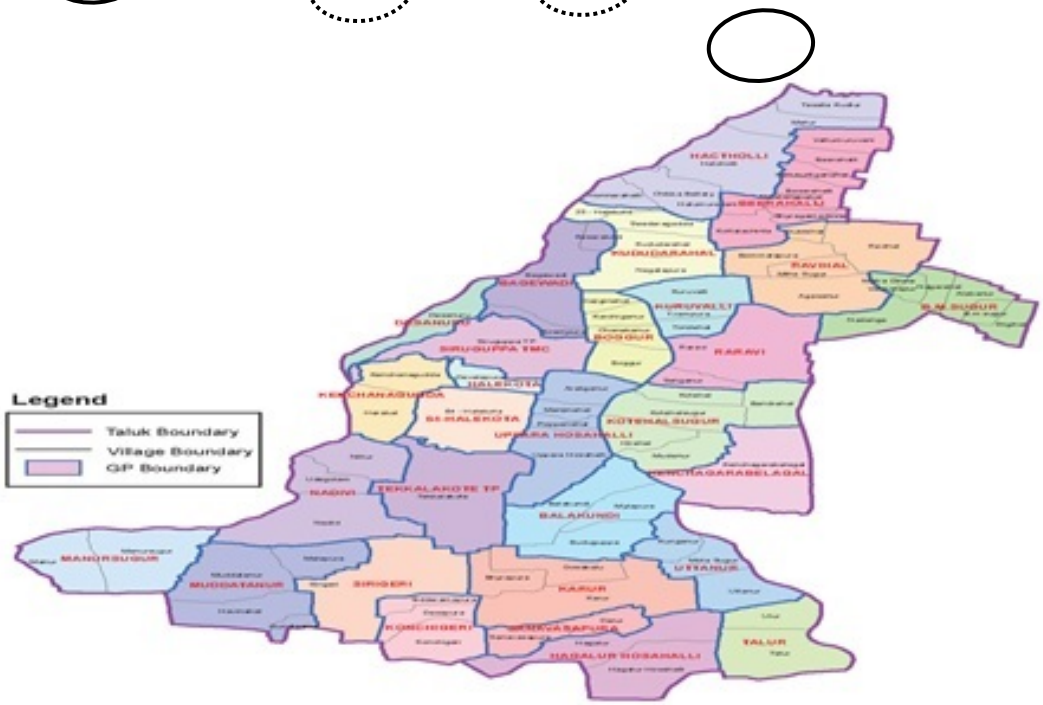
Dep. Var.:	Total expenditure (Annual)	Food consumption per capita (Monthly)				Non-food consumption per capita (Annual)		
	Log of Total	Log of Total	Log of Wheat	Log of Fruits and Vegetables	Log of Meat	Log of Total	Log of Clothing	Log of Education
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of crop loan	0.021**	-0.003	0.108***	0.021*	0.053**	0.037***	0.027**	0.063**
	(0.009)	(0.008)	(0.032)	(0.012)	(0.026)	(0.013)	(0.013)	(0.029)
Constant	3.562***	3.066***	-0.184	2.134***	1.532***	3.205***	3.645***	2.016***
	(0.212)	(0.171)	(0.390)	(0.181)	(0.360)	(0.224)	(0.237)	(0.335)
Control mean (in levels)	26085	895	16	158	97	14568	1518	2705
GP FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES	YES	YES	YES
R-squared	0.599	0.515	0.406	0.559	0.346	0.563	0.392	0.571
Observations	1696	1696	1090	1684	833	1696	1691	1190

Figure 1: Map of Karnataka, India

(a) District map

(b) Map of Siriguppa taluk in Bellary district





Notes: Continues circles show the control gram panchayats (GP) and dotted circles show the treatment GPs.

Figure 2: Example of leaflet and calendar

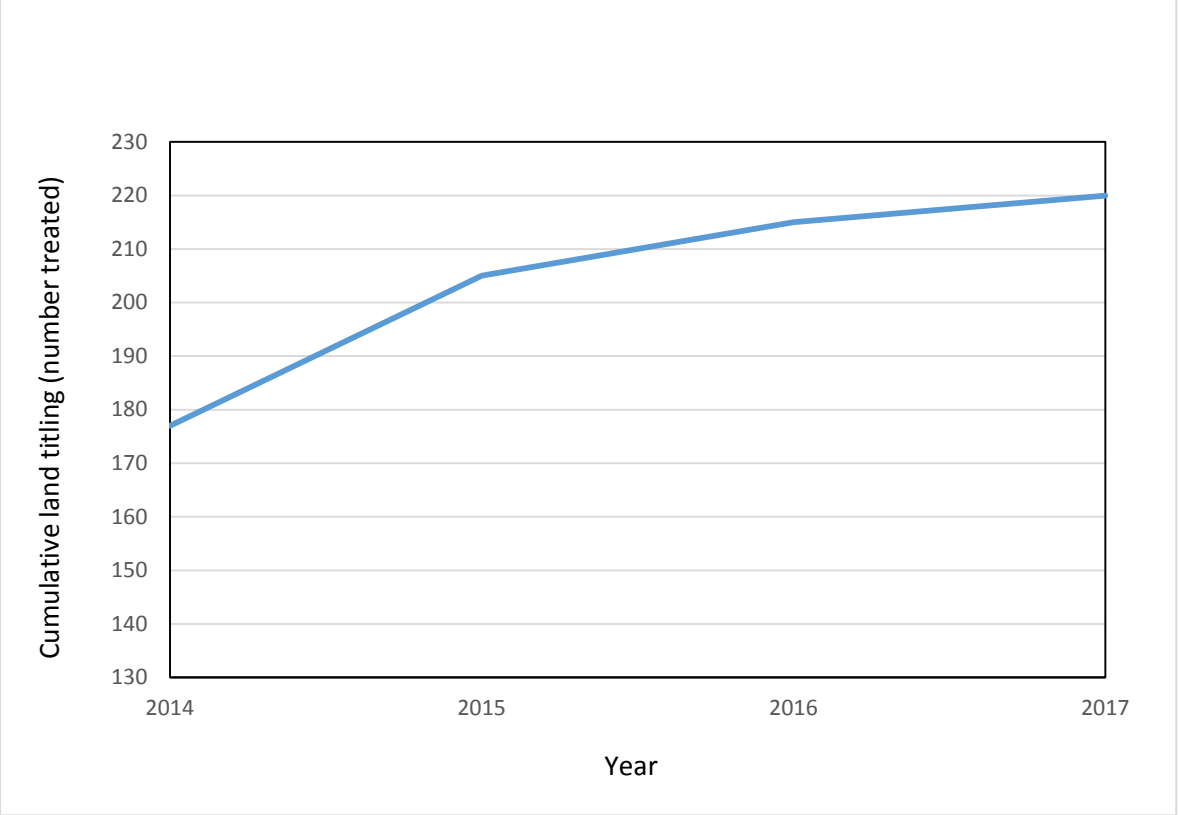


Figure 3: Cumulative land titling