Of rice and men: Land-use restrictions in Vietnam

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Abstract: Across many economic contexts, there are policies whose efficacy is undermined by endogenous responses of agents due to a misalignment of incentives. In this paper, I show that households' production responses to a food security policy in Vietnam that restricts household land to be used for rice considerably undermines the policy's purpose. I develop a model of farmer crop choice that demonstrates how divergence of interest between the farmer and commune authority, and subsistence rice production constraints for the household generate different testable predictions for the impact of restrictions at both the household and plot levels. I test these predictions using four rounds of the household and plot panels of the Vietnam Access to Resources Household Survey (VARHS) between 2006-2012. The evidence suggests that land use restrictions are largely ineffective at increasing household rice production and lower agricultural profits. This is due to the fact that households reduce rice production on their unrestricted land while complying with restrictions. Counterfactual household rice production without any such 'slippage' on unrestricted land is 12 percent higher, and I estimate that restrictions reduces household agricultural profits by 15 percent on average. Thus, the policy appears to be unsuccessful in increasing household rice production while at the same time imposing welfare costs to the household.

1 Introduction

Over the past forty years, developing countries with collective agriculture have made substantial progress towards decollectivization and stronger land rights. Communal systems were restructured so that individual households became the basic unit of agricultural production, capturing dramatic gains in agricultural productivity as a result of the improvement in incentives. In the case of Vietnam, decollectivization delivered expansive growth following the *doi moi* reforms in 1986: between 1990-2004, crop production grew annually at a rate of 5.5% (Do and Iyer, 2008). In fact, primary catalysts for the *doi moi* reforms in 1986 were food insecurity and stagnant rice production in the decade following reunification and collectivization.[1] However, the practice of land-use planning has remained somewhat common as a relic of past command-and-control practices in some transitional and rice-producing countries—including Vietnam—despite the consequences for efficiency (Giesecke et al., 2013; Nielsen, 2003; Pingali and Siamwalla, 1993). Vietnam in particular restricts land use on 35.3 percent of its agricultural land in order to limit the conversion of paddy to other uses in the name of food security. Policies controlling land-use with the objective of internalizing externalities (e.g. from environmental damage) are not limited to developing countries. However, study of such programs reveals there is risk of 'slippage' of the unwanted land-use from policy-targeted land to untargeted land due to endogenous optimization of landowners and price effects (Alix-Garcia et al., 2012; Lichtenberg and Smith-Ramirez, 2011; Wu, 2000). Instances in which endogenous household (or individual, firm, etc.) responses to a policy work against the policy's purpose span several contexts, such as when energy efficient technology increases energy consumption due to the 'rebound' effect (Borenstein, 2013). Rice production and policies that affect it have remained politically sensitive due to its continued importance: rice constitutes over 60% of the average caloric intake and 40% of the value of agricultural exports in 1997 (Minot and Goletti, 2000; Nielsen, 2003).[2]

In Vietnam, land-use plans generated at the national, provincial, district and communal levels

[1] Shortages in food production ranged from 15-20 percent and over 1 million tons a year of rice were imported, with widespread malnutrition (Pike, 1981; World Bank, 1998)

[2] In fact, rice has been the most important crop in Vietnam for thousands of years, and its production used as a measure of a kingdom's success or failure. The Ly Dynasty (1009-1225) was particularly prosperous notably because of it's investment in rice production, whereas other dynasties' collapse was precipitated by rice shortages (Vien, 1993)

culminate in area targets for rice land within communes. Commune officials must then determine how to meet the target by restricting individual parcels within its boundaries. In this paper, I use rich household and plot level panel data from Vietnam over 2006-2012 to determine whether the restriction of household land for rice cultivation increases aggregate rice output and how household behavior may thwart the policy's efforts. Communes do not generally restrict all of a single household's land, giving households the ability to endogenously adjust productive decisions on unrestricted land to reduce the utility cost of the policy. My empirical results at the household and plot levels indicate that endogenous farmer responses ultimately undermine the efficacy of the policy, and that household rice production is relatively unaffected by land-use restrictions due to changes in production on unrestricted land.

The dual panels at the household and plot levels allow me the somewhat unique opportunity to identify both the aggregate effects of the policy on household production as well as the endogenous "slippage" on households' unrestricted plots. While restrictions appear ineffective at the household level, increasing household rice production by just 3 percent for a 1SD (about 30 percent) increase in the share of restricted land, a restricted plot is 14 pp more likely to grow rice and produces 0.17 tons more rice. Yet unrestricted plots of households that face restrictions on other land are 20 pp less likely to grow rice and produce 0.14 tons less rice. This explains how restrictions may bind at the plot level and be somewhat ineffective at the household level.

A simple model of a farmer's crop choices under a subsistence constraint for rice production demonstrates how restrictions may generate this empirical pattern.According to the model, the household and plot level results depend on the divergence or convergence of interest between the farmer and commune, as well as whether the farmer faces a binding subsistence constraint. The former determines whether the farmer would rather plant restricted land with a non-rice crop, and the latter determines whether productive decisions are dependent across the farmer's land—in other words, whether restrictions will affect production on unrestricted land. The pattern of the empirical results suggest that restrictions do 'bind' at the plot level, so that restricted plots are more likely to be planted with rice and planted more intensively with rice, but also that restrictions reduce rice production on unrestricted land. With the model, I can infer from these results that there may be a divergence of interest between the commune and farmer, in addition to binding rice subsistence constraints.

The data are relatively unique to the literature in that I can utilize variation in land use restrictions while controlling for time-invariable plot characteristics. To my knowledge, only Goldstein and Udry (2008) have used a plot level panel to issues of land rights and production. The plot panel also permits a secondary analysis to predict restriction status using dynamic panel data methods and reveals the characteristics that induce cross-sectional and temporal variation in restrictions. Econometrically, the analysis is challenging due to unobserved plot-specific heterogeneity as well as possible state dependence. I address these issues by employing two different estimation strategies: first, I use Arellano and Bond's (1991) difference GMM estimator in a linear probability model, and second, I use Wooldridge's (2000) dynamic probit panel estimator that utilizes a Chamberlain-Mundlak device. Both methods yield surprisingly similar results across most covariates, including the lagged dependent variable. With these results, I show that the main drivers of restriction are time-invariant plot characteristics and observable characteristics that make land suitable for rice production, such as access to commune-managed irrigation. Since no viable instrument is available to isolate exogenous variation in plot restrictions, understanding the source of variation in restrictions is critical. My identifying assumption is that once I control for plot and year fixed effects, rice suitability, plot-, household- and commune-level shocks, household political connections, etc., the variation in restriction status is as good as randomly assigned. To support this assumption, I add more flexible time trends to test whether the effects are the result of omitted variables driving both production and restriction decisions.

The micro- and macroeconomic impacts of Vietnam's land use policy have not been studied extensively, and just three economic papers address plot restrictions explicitly. Nielsen (2003) employs the Global Trade Analysis Project (GTAP) to simulate the aggregate impact of allowing 5 percent of arable land in Vietnam to move out of rice cultivation and estimates that this relaxation actually reduces welfare.[3] In contrast, Giesecke et al. (2013) use a computable general equilibrium model to find that reduced restrictions would have positive impacts along many dimensions—annual

[3]Giesecke et al. (2013) point out that this is likely due to the fact that she neglects the effects such a shift would have on rental rates.

consumption, poverty reduction, food security and nutrition diversity. Thus, the macroeconomic insights into this policy are sensitive to assumptions and ultimately equivocal. Markussen et al. (2011) turn to microeconomic evidence and empirics to investigate the effects of land-use restrictions. The authors utilize the first two rounds of this panel to show that while restrictions increased the probability a plot was used for rice production and agricultural labor supply of the household, it did not affect household crop income. The authors hypothesize that this lack of a negative impact could be due to access to superior inputs (fertilizer, irrigation) through the commune authorities. However, they do not pursue how restrictions ultimately affect household rice production, or how household land allocation—including unrestricted land—is altered by the policy. The latter is particularly relevant to understanding household responses as well as the efficiency costs of the policy.

Other examples of agents' endogenous behavior in response to a policy or innovation undermining the intended goal span many contexts. In the study of land conservation programs, there is "slippage," in which price and substitution effects increase the undesirable activity on unenrolled land. In the U.S., Wu (2000) estimates that for every 100 acres enrolled in the Conservation Reserve Program, 20 acres of unenrolled land was converted to cropland. In a developing country context, Alix-Garcia et al. (2012) shows that a program that pays landowners for hydrological services shifts deforestation to unenrolled land in Mexico, and that this slippage is stronger in poorer *ejido* communities where landowners are credit constrained. In the study of governmental and household spending, transfers may or may not increase expenditures in a targeted category, as recipients allow the transfer to displace initial spending and respond no differently than when facing an aggregate budget increase.[4] Knight (2002) demonstrate that intergovernmental transfers as part of the Federal Highway Aid Program in the U.S. ultimately crowd state spending. Finally, the "rebound" effect in the energy economics literature describes the phenomenon in which an increase in energy efficiency of a technology may increase total energy consumption due to the lower marginal cost of use. Borenstein (2013) develops a theoretical framework for this effect, distinguishing between the income and substitution channels by which a lower cost of energy affects use, and Beltramo

[4]If spending in the targeted category is observed to increase, this is called a "flypaper" effect.

and Levine (2013) provide empirical evidence of rebound in the use of improved (fuel-efficient) cookstoves in Senegal. In each of these cases, the efficacy of the policy or innovation is weakened when its goal is not incentive compatible at the individual level.

In the next section, I describe Vietnam's long history of land reform and the policy of land use restrictions. Section 3 provides summary statistics for the household and plot level panels, and explores both compliance and the characteristics of households and plots selected for restriction. The simple model of household crop decisions is given in Section 4, empirical results are presented in Section 5, and Section 6 concludes.

2 Background

2.1 Land reform in Vietnam

Land reform has been an integral issue to the political and economic evolution of Vietnam, from French colonialism, to conflict with U.S., to post-reunification Communist rule. The incredible improvement in the agricultural sector, highlighted by Vietnam's emergence as a net rice exporter in 1989 and as the second largest exporter in 1997 after two decades of being a net importer, has long been attributed to changes made to its land policy (Marsh and MacAulay, 2002; Nielsen, 2003).

The first major departure from collectivization was in 1981, when communes began contracting individual farmers to produce a certain level of output to be delivered to the commune. All inputs necessary to meet the expected output level were provided by the commune and any excess output could be kept by the household or sold on a separate market. Short term gains were large: according to Pingali and Xuan (1992), rice yields in 1984 had increased by 32 percent and 24 percent relative to 1980 in the north and south, respectively.

In 1986, a set of economic reforms called *Doi moi* (the renovation) began Vietnam's transformation to a "socialist-oriented market economy." The waning benefits of the contract system and a massive famine in 1988 spurred further reform in agricultural and land markets. Resolution 10 passed by the Politoburo in April 1988 (Marsh and MacAulay, 2002) officially recognized the household as the main productive unit, and allocated farmers land in the commune with use rights for 10-15 year terms. In the North, the principal goal was equity amongst households in a commune, which in many cases lead to significant fragmentation as holdings were determined by both size and land quality. The South attempted to return to households land they had cultivated prior to collectivization and reunification.

The third major reform came in 1993 with the issuance of household land use rights (LUC or redbooks), covering 71 percent of households by 1998 and over 90 percent by 2000 (Do and Iyer, 2008). With LUCs, farmers were permitted to exchange, transfer, lease, inherit and mortgage land, though total holdings were still limited based on crop type (annual or perennial) and land is still officially "owned" collectively by all Vietnamese. The aim of the 1993 Land Law was to promote land investment and an efficient land allocation by reducing tenure insecurity and creating a market for land use rights.

Adjustments to the land law were made in 1998, 2001 and 2003, awarding households the right to re-lease land, to use land as joint venture capital for investment, to gift land to others, and formalizing procedures to register land related changes. The 1998 Land Law granted private ownership of input factors (machines, tools, draft animals) and released households from selling a contracted amount of output back to the commune (Nielsen, 2003). The 2001 and 2003 reforms further encouraged the exchange of LUC to form a land market, and increased the possible number of names to be listed on a LUC from one to two, in hopes that female spouses would be included as well.

2.2 Land use restrictions

Part of the motivation for such reforms to land policy and agricultural markets stemmed from Vietnam's struggle with food insecurity. Pingali and Xuan (1992) estimate that from 1950-1987, annual population growth often exceeded growth in total rice production. The decade preceeding *doi moi* saw shortages in food production ranging from 15-20 percent (Pike, 1981) and rice imports of over 1 million tons a year, with widespread malnutrition (Pike, 1981; World Bank, 1998). By 1988, 12 million people were short of food with 3 million starving (Gill et al., 2003). Thankfully, *doi moi* reforms were extremely effective in increasing rice production and efficiency: in 1994-1999, total agricultural output grew 6.7 percent annually, and remained at 4.6 percent for 2000-2003 (**?**).

Despite these large gains in food production, agricultural policies have continued to be directed towards achieving food security rather than promoting rural income growth (World Bank, 1998). With rice accounting for 50-75 percent of the average household's calorie intake (Bui, 2010), and about 40 percent of the value of agricultural exports (Nielsen, 2003), the state's particular policy interest in controlling rice markets in pursuit of food security is understandable. Important agricultural inputs including credit, extension services, and fertilizers (which are supplied by the state) are provided preferentially to rice producers (World Bank, 1998). In addition, massive irrigation efforts beginning in the 1980s doubled the size of Vietnam's irrigated area in 20 years, but focused on paddy areas: 70-90 percent of rice-growing land in the deltas was irrigated by 1998, while less than 50 percent of all annual crop land was irrigated in other areas. While this focus on rice irrigation extended the season in some areas enough to grow another crop of rice every year (Ives, 2013), it has come at the expense of neglected irrigation needs of dryland, subsidiary and cash crops, and requires significant improvements to support multi-cropping and crop diversity (Tu, 2002; World Bank, 1998). Finally, as domestic rice production increased, pushing Vietnam from a net importer to net exporter, export quotas were erected to stabilize prices and ensure sufficient domestic supply (Alavi, 2012; Nguyen and Grote, 2004; World Bank, 1998).[5].

The right to determine land use and crop choice has consistently been withheld by the state (Hung and Murata, 2001; Markussen et al., 2011; Marsh and MacAulay, 2002; World Bank, 1998) by nominally requiring any change to be consistent with existing "physical planning" (Markussen et al., 2011; Vasavakul et al., 2006) even while the 1988, 1993 and 2003 land law reforms steadily added to the list of rights farmers had over their land. Restrictions on land use existed before the major expansion of rights in 1993; Pingali and Xuan (1992) reports that the persistent top-down approaches by the State Planning Commission to determine land use and crop choice at the farmer level contributed to the erosion of benefits from the 1981 contract system. In addition to land being

[5]This quota is set annually by the Ministry of Agriculture and Rural Development, but is often adjusted in response to domestic supply situations. For example, during a drought in 1998, the government refused to authorize export contract prices to effectively reduce the export quota of 4 million tons that was set initially (CIE, 1998)

restricted to general agricultural use, individual plots may be required to grow rice in all seasons or a subset of seasons by commune authorities: Tien et al. (2006) state that "[rice] production targets are set at the local level in response to government directives and individual households may have to grow crops as directed."

These restrictions are implemented through long term (10 year) and short term (1 and 5 year) Land Use Plans (Giesecke et al., 2013; Markussen et al., 2011; Vasavakul et al., 2006) at the national, provincial, and district levels of the Ministry of Natural Resources and Environment (MONRE). National rice area and production targets are guided by considerations of projected domestic consumption, export goals and planned land conversion (from socioeconomic "Master Plans"). According to the Government's Resolution on National Food Security, 3.8 million hectares (encompassing around 90 percent of current paddy and 35 percent of cultivated land) must be reserved for rice cultivation by 2020—a reduction from the 2010 target of 4.2 million hectares (Giesecke et al., 2013). The national targets are then divided among provinces, which are then divided among districts, eventually filtering down to the commune level. Rice is a special category of land-use, and is specifically defined in all land-use plans. Unlike other higher levels, communes must produce 'detailed land-use plans' that specify land-use parcel by parcel within its boundaries from one year to the next. This spatial plan is posted at the land management office of the commune, or announced parcel-by-parcel over the commune's loudspeaker.

From the administrative side, the plans are generally rigid, as any adjustment at the commune level would require adjustment at higher levels to keep all land-use plans consistent. Communes are also required to submit land-use reports to the district multiple times a year, and district land officials unpredictably inspect commune land-use in person. The Land Administration Officer (LOA) of the commune bears the responsibility of the plan's implementation, facing political punishments for unofficial deviations from the plan. From the households' side, their land-use rights are officially conditional on their land-use being consistent with government planning. Marsh and MacAulay (2002) report that "illegally used" land can be confiscated from households who do not obey restrictions. The commune LOA monitors restricted land, and government officials anecdotally mention flooding or otherwise destruction of crops or coercion of households who do not obey restrictions.

Also, households would have significant incentive to comply with commune direction, as most inputs, credit and extension services are supplied through the state and depend on a commune's evaluation of the household.

Vietnam is not the only country to control land use in this way, particularly for maintaining or increasing rice cultivation. Myanmar similarly restricts land to be used as rice paddy, preventing conversion to non-rice or non-agricultural uses, and other rice-producing nations employ policies that either directly regulate paddy land or use financial incentives (Giesecke et al., 2013; Nielsen, 2003; Pingali and Siamwalla, 1993). Vietnam's official stated purpose of land use restrictions is food security, particularly rice self-sufficiency and price stabilization (Government of Vietnam, Hanoi 2009). However, 20 percent of domestic rice is ultimately sold in foreign markets, and a large share of agricultural exports is exported rice, suggesting that unofficial trade targets could be another justification for restricting land (Markussen et al., 2011; Nielsen, 2003).

On a more local level, there are two additional explanations for the persistence of the policy over time. First, there may be local negative externalities of land conversion that the commune uses restrictions to limit. For example, converting a plot from rice to a perennial crop such as fruit trees may result in surrounding plots being shaded by the new trees. Given the community irrigation systems in place, the irrigation of one plot may rely on particular plots being used for paddy rice. Vasavakul et al. (2006) reports that Vietnamese policy makers claim "environmental damages" as justification for placing restrictions on plot use. Note that it is not uncommon for crop choice to be restricted based on surrounding cultivation in developed contexts—to control cross-pollination, for example. Unfortunately, without knowing the locations of the plots, I am unable to determine which plots are in sensitive positions, with the potential of producing negative externalities without restrictions. Thus, this angle of plot restrictions must be left for another dataset. Second, there are reports (The Economist, 2013) of local officials strategically restricting land to seek rents from future development or infrastructure projects. An official may enforce a restriction to keep land agricultural in order to suppress property values.[6] Then once land is rezoned, they are able to extract bribes from developers to release the land from the restrictions and seize it from farmers for

[6] (which are partly determined by the state)

the purpose of 'economic development' (The Economist, 2013). Because the land was previously kept in agriculture or paddy, the compensation given to the farmer is comparatively low. However, these officials are more often exploiting restrictions concerning conversion of agricultural land to non-agricultural use, rather than conversion between crops. In addition, plots targeted in this way would not see their restriction status change over time unless they were claimed by the state for development, in which case they would fall out of the plot-level panel.

3 Data

The data used here are the Vietnam Access to Resources Household panel survey (VARHS) from 2006, 2008, 2010, and 2012, covering 12 provinces across Vietnam (see Figure 1). Initially, households were chosen from the 2002 and 2004 Vietnam Household Living Standards Survey (VHLSS), but with the purpose of supporting evaluation of Danida programs in Vietnam. Poorer regions that were targeted by these programs, such as the north west and central highlands, are consequently oversampled. I limit the sample to a panel of 2,054 households across 466 communes that own and operate at least one agricultural plot. From these households, I have a panel of 4,707 plots that were followed over time using plot maps collected each year.

In Table 1, summary statistics at the plot and household level are shown for each year of the study period. Most plots are irrigated and irrigation expands over time, increasing from 73 to 81 percent of panel plots. The proportion of plots restricted in some way is fairly constant across years, with the exception of 2010 and those plots restricted to grow rice in all seasons. Policy changes in 2010 that reduced the national target of rice paddy coupled with a drought in regions covered by the survey likely contributed to this decline. In addition to crop choice, the rights to build permanent structures or convert land out of agriculture are heavily restricted, demonstrating another dimension of land use that is controlled by the state.

Up to three seasons of rice can be cultivated in a year in Vietnam, depending on the region and irrigation structure. The average plot in this panel grows 1.3 seasons a year, making it by far the most common crop cultivated in the sample. The second most common is maize, which is grown for less than 1 season on average. Both rice and maize yields marginally increase between 2006 and

2012, averaging at 8.3 and 4 tons/ha, respectively.

Household level summary statistics by year are also included in Table 1. While the plot level panel includes only plots that the household used all years and that could be matched by the enumerators, household variables encompass all plots reported by the household each year. The land rental and sale markets are puzzlingly thin, despite the issuance of LUC and the series of reforms that came afterward to promote exchange: the average number of plots rented in or out by households over the period is never more than 0.45. Land holdings are on average very fragmented, with the average plot size below one fifth of a hectare and total holdings below one hectare. The average household cultivates rice on over 40 percent of its used land, amounting to about 5 seasons per household per year. Though the average household grows less than one season of maize per year, 32-55 percent cultivate another annual crop and 28-33 percent cultivate perennial crops.

On average, 4.5 households were sampled in each commune, with a range from 1 to 23. When a commune did restrict household land, a total of 1.3-1.8 hectares is restricted across 14.6 plots and 74 percent of sampled households. Figure 5 shows these average amounts of land by year at the commune and household levels, and the decline in restrictions in 2008 and 2010 is clearly visible. While I observe plot restrictions in every province and district sampled, not all communes restrict land use and these policies are not constant over time—at the commune, plot or household levels. I consider a unit to be never-restricted (or unrestricted) if it's recorded as unrestricted in all four years, and restricted if it's recorded as restricted at least once. For 132 communes (30 percent), I observe restricted plots in every period, and for 85 (19 percent), I don't observe any restricted plots. However, as not all households in a commune were sampled, we cannot conclude that these communes didn't impose restrictions on unsampled households and plots. There is comparable variation in the burden of plot restrictions at the household and plot levels: about 20-30 percent of households and plots are never-restricted, 15-17 percent always-restricted, with the remaining units both restricted and unrestricted in the study period. This variation in restriction does appear to have a stabilizing effect on rice production. Figure 2 fits communes' coefficients of variation of total household rice production over the four surveys to the communes' average proportion of household area restricted. There is a clear negative correlation between these two measures, indicating that the variability of rice production is lower when more land is restricted by the commune.

3.1 Explaining restrictions

It is important to understand how plot restrictions are determined, as communes select plots to be restricted based on household and plot characteristics. Thus it's useful not only to compare plots or households that are contemporaneously restricted or unrestricted, but plots or households that are *ever* restricted to those that do not face restrictions. Summary statistics are disaggregated in Tables 2 based on whether I ever observe a plot or household to be restricted or unrestricted.

Predictably, plots selected for restriction are those more suited for rice cultivation, flat with canal irrigation—both essential qualities for rice cultivation. Interestingly, they are less likely to have a male manager, though this is not predetermined with respect to restriction—it could be that women are assigned to manage plots that are restricted. The stark difference in the proportion of plots growing rice is a hint at the degree of compliance with the policy. While almost 90 percent of restricted plots grow at least one season of rice, just 30 percent of unrestricted plots do so. Unrestricted plots are twice as likely to grow maize and are about 13 times more likely to grow a perennial crop.

If negative externalities of plot conversion are more relevant or larger with higher fragmentation (and therefore more plots sharing borders), we'd expect that plots under restriction will be smaller in size. Consistent with this logic, I see that plots that are restricted are 70 percent smaller than plots that are never restricted. There is also evidence that plots are selected for their rice productivity. Restricted plots yield an additional 3.2 tons of rice per hectare than unrestricted plots on average. The fact that maize yields are also higher on restricted plots suggests that these plots aren't only particularly productive for rice. This can also be seen in Figure 3, where the yields of plots under restrictions are shifted above those of unrestricted plots. This could be due to either selection of plots into different restrictions and restriction patterns, or if the state of being restricted influences yield (through more rice seasons grown, or preferential treatment by the commune, for example).

The commune's decision to restrict a plot may also depend on household characteristics. Though household size doesn't vary significantly, unrestricted households have slightly more educated and more often female household heads. The amount of used land per household member is about 30 percent lower for restricted households, suggesting they are more land-constrained. Consistent with land fragmentation-related restrictions, households who face restrictions have about twice as many plots despite the fact their land holdings are 30 percent smaller. Whether due to the selection of productive land and farmers into restriction or selection of farmers with productive land, rice yields for household that face restrictions are 25 percent higher. Unlike the plot-level results, household level maize yields aren't significantly higher for restricted households—suggesting that restrictions target productive plot characteristics more than household ability.

3.1.1 Predicting restriction status

I also use the plot panel to predict restriction status using dynamic panel data methods. The estimation is econometrically sensitive due to the possibility of 'true' state dependence as well as 'fake' or 'spurious' state dependence. The latter is simply the time-invariant unobserved plot heterogeneity in the disturbance term—in other words, the plot fixed effect. The former describes the circumstance when the outcome variable is truly dependent over time and lagged outcomes should be included as regressors, even after controlling for other covariates and fixed effects. The distinction between fake and true state dependence is often very relevant for policy: distinguishing between a 'scarring' effect of unemployment where the current unemployed are more likely to be unemployed next period (all else constant), and the existence of people with constant characteristics that make them more likely to be unemployed in any period, has important implications for public programs to reduce short run unemployment. In this context, the extent of true state dependence in restriction status can provide insight into the commune's objective. For example, negative state dependence could suggest that communes 'rotate' the burden of restriction among households who are made to share the burden of restricted rice production.

Allowing for true state dependence introduces the 'initial conditions problem,' however. This occurs when the researcher does not observe the entire dynamic process, collecting data only after the process has started. Without the full history, it's unclear how the first *observation* of the dependent variable is influenced by either the unobserved previous value or unobserved heterogeneity.

With a continuous dependent variable or a linear probability model, this issue is resolved by transforming the data to eliminate the fixed effect and instrumenting for the lagged dependent variable to eliminate dynamic panel bias as in Arellano and Bond (1991), who suggest using lagged values of the dependent variable as instruments. In a discrete model, no transformation can eliminate the fixed effects, so the solution is more difficult. Wooldridge (2005) suggests a conditional maximum likelihood estimator that models the distribution of the unobserved heterogeneity given the covariates as well as the initial observation of the outcome. The mean of this distribution is allowed to depend on all values of the covariates, their initial values, and time-invariant covariates, thus allowing the fixed effect to be correlated with plot characteristics. The advantage of this method over others (for example Honoré and Kyriazidou (2000)) is that it can be easily implemented in standard software and it's possible to compute average partial effects, which is critical to interpretation. I include the results of both estimations mainly because they are remarkably similar despite very different underlying models, which imparts more confidence in their individual results.

Table 3 shows the results from application of Wooldridge (2005)'s model. Coefficient estimates, coefficient standard errors, and average partial effects are shown for each variable. The characteristics that determine the correlation between the fixed effect and covariates are each listed variable at each period (including 2006), as well as flexible controls for plot area, slope, distance from home, household size, way of acquiring the plot, household gender, household age, and household education. In each model, the coefficient for lagged restrictions is significant, though the largest average partial effect is just 5pp. In the last column, the degree of state dependence has fallen to 3pp. Compared to irrigation, which increases the probability of restriction by 13pp on average, state dependence seems less critical to restriction patterns. Irrigation, possession of a redbook, and political connections are the only other statistically significant, sizable effects. Notably, household size and household land holdings do not significantly affect the probability of restriction, which suggests that communes do not restrict land in order to minimize their burden. The average partial effect of the district rice price is large and positive though insignificant at 13pp. This indicates that communes restrict more land to rice when prices rice, which could indicate restrictions are used as a response to food insecurity. Finally, these results provide no evidence that previous shocks to either plot or household rice yields affect restriction status.[7]

Results of the same estimations using Arellano and Bond's (1991) method are shown in Table 4. Most surprising is the similarity between the two sets of results with full controls in the last column. State dependence is around 3pp, irrigation increases the probability of restriction by 14pp, redbook possession increases it by 13pp, and household political connections increase it by 7pp. As with the Wooldridge (1991) method results, there is a large positive estimated effect of the price of rice: if the price increased by 20 percent, the probability of restriction of any plot increases by about 3pp. The effect of growing a non-rice crop in the previous year is larger and more significant with this method, suggesting that new restrictions target plots that aren't already being used for rice. As before, there's still no evidence that restriction depends on past yield shocks or household land or labor supply. Additionally, it is only plot-level natural shocks that affect restriction status rather than household level shocks, which makes more sense if communes care more about production than household utility.

To summarize, these predictive results suggest that restrictions are mostly determined by time-invariant plot characteristics, changes in irrigation and redbook possession, as well as household political connections.

3.2 Compliance

For plot restrictions to impact farmer behavior, households must comply with restrictions, and restrictions must actually constrain plot choice (i.e. the constraint must be binding). To determine how often plots are in compliance with restrictions in a given period, I compare a plot's restriction status to it's rice cultivation status. A plot can either grow no rice, grow rice in some of the seasons for which I have data, or grow rice in all seasons for which I have data. As restrictions can require a plot grow rice in all seasons or require it to grow rice in some seasons, I consider the following to be "in compliance:"

[7] If households were playing some form of game with commune authorities and manipulating their rice production to affect their probability of restriction, we might see evidence of it here. However, the effects of lagged household and plot yields are both small and insignificant,

Rice cultivation	Restricted in all seasons	Restricted in some seasons	Unrestricted
No rice	Noncompliant	Noncompliant	Compliant
Rice in some seasons	Noncompliant	Compliant	Compliant
Rice in all seasons	Compliant	Compliant	Compliant

Figure 6 compares these at the plot level. We can see that when a plot is restricted to grow rice in all seasons, 86 percent of the time the plot is compliant and grows rice in every (non-missing) season. When a plot is restricted to grow rice in some seasons, 94 percent of the time the plot is compliant and grows rice in at least some seasons (exceeding the restriction 55 percent of the time and growing rice in all seasons). Plots that don't face restrictions are much less likely to cultivate it: while over 40 percent of plots don't grow any rice when unrestricted, less than 8 percent of restricted plots cultivate no rice. In fact, 30 percent of the time, rice is replaced with another crop as the main crop cultivated on a plot when it happens to be unrestricted. Secondary and tertiary rice crops are similarly replaced when unrestricted. However, given the degree of selection into restrictions based on plot and household characteristics, it's unwise to draw any conclusions about whether or not the policy binds from Figure 6 and such correlations.

4 Model

The following model formalizes a single household's crop choice across a continuum of land, and demonstrates how restrictions may affect decisions on both restricted and unrestricted land. It attempts to separate two conditions which influence the impact of restrictions on household production: whether restrictions require households to grow rice where they would prefer to grow a different crop, and whether production decisions are dependent across land within a household. The former is determined by the objectives of the commune and farmer, particularly whether they coincide or diverge. As previously argued, the commune likely selects land for restriction that's more suitable for rice production and has higher rice yields, whereas the farmer will incorporate the opportunity cost of rice cultivation and select land for rice based on relative profitability. If land characteristics are such that plots with the highest rice yields would be more profitably used for another crop, then the interests of the farmer and commune diverge, and land restrictions will change the use of restricted land. The latter condition is determined by the tightness of the household's subsistence production constraint. If binding, this constraint would bring land into rice production that would be more profitably allocated to another crop. Restrictions may also release such unrestricted land from subsistence rice production if restrictions cause conversion of land from non-rice to rice.

I simplify these decisions by only allowing the farmer to choose between two crops, rice and non-rice, which can be produced with standard technologies. Let $Z = [\Theta, C_\Theta, \Gamma, C_\Gamma]'$ be jointly normal across household land according to the cumulative density function F_Z, where Θ and Γ are rice and non-rice yields per unit of area, respectively, and C_Θ and C_Γ are rice and non-rice input costs per unit of area, respectively.[8] Thus $F_Z(\theta, c_\theta, \gamma, c_\gamma)$ specifies the proportion of the household's land with $\Theta \leq \theta$, $C_\Theta < c_\Theta$, $\Gamma \leq \gamma$ and $C_\Gamma \leq c_\Gamma$. Also normalize the price of rice to 1, so that non-rice profits on a unit of land with $\Gamma = \gamma$ and $C_\Gamma = c$ are given by $\pi_N = p\gamma - c$, and rice profits on a unit of land with $\Theta = \theta$ and $C_\Theta = c$ are given by $\pi_R = \theta - c$. Without any other constraint, the farmer will clearly plant with rice all land such that $\Pi = \pi_R - \pi_N \geq 0$, which will also be normally distributed as it is a linear combination of jointly normal variables. Let $F_{\Pi,\Theta}$ give the joint density of (Π, Θ) across the farmer's land with $\mu = AZ$, and $\Sigma = A\Sigma_Z A^T$, where A is the linear transformation, $(\Pi, \Theta)^T = AZ$. Thus the farmer's total area in rice, A_0, and total rice production, R_0, when unconstrained will be given by,

$$\begin{aligned} A_0 &= 1 - F_\Pi(0) \\ R_0 &= \int_{-\infty}^{\infty} \int_0^{\infty} \theta f_{\Pi,\Theta}(\pi, \theta) d\pi d\theta \end{aligned}$$

Now suppose that the farmer faces two constraints. The first is a land use restriction implemented by the commune authority. The commune must restrict a proportion of its land to be used for rice production, $\Omega \in [0, 1]$, as determined by higher levels of government, and I assume that the

[8] I assume that the mean, μ_Z, and covariance matrix, Σ_Z, are such that a value of 0 is more than two standard deviations from their means, making negative values for any of these variables very unlikely.

commune selects land for restriction based on rice suitability, represented by rice yield, Θ. Let G_Θ be the density of rice yield across all of a commune's land, so that $G_\Theta(\theta)$ gives the proportion of commune land with rice yield below θ. This restriction results in the commune's choice of $\bar{\theta}$, such that all land with $\Theta \geq \bar{\theta}$ is restricted to grow rice:

$$1 - G_\Theta(\bar{\theta}) = \int_{\bar{\theta}}^{\infty} g_\Theta(\theta) d\theta \geq \Omega$$

which implicitly defines a cutoff, $\bar{\theta}(\Omega)$, if the constraint holds with equality. Then each household will face restrictions on all of their land with $\Theta \geq \bar{\theta}(\Omega)$. Define a household's restricted area as,

$$\Omega_i = \int_{\bar{\theta}(\Omega)}^{\infty} f_\Theta(\theta) d\theta$$

In this set up, households will face different degrees of restriction on their land depending on where their land holdings fall in the distribution G_Θ.

The second is a subsistence constraint for total rice production, requiring that household rice production is above $\omega \in R_+$. Taking into account the rice production on restricted and unrestricted land, the farmer's subsistence constraint will take the form,

$$\int_{-\infty}^{\bar{\theta}(\Omega)} \int_{\bar{\pi}}^{\infty} \theta f_{\Pi,\Theta}(\pi,\theta) d\pi d\theta + \int_{\bar{\theta}(\Omega)}^{\infty} \theta f_\Theta(\theta) d\theta \geq \omega$$

which implicitly defines a second cutoff, $\bar{\pi}(\omega, \Omega)$, if the constraint holds with equality. Thus, when constrained, the farmer's total area in rice, A_1, and total rice production R_1, will be given by,

$$\begin{aligned} A_1 &= \int_{-\infty}^{\bar{\theta}(\Omega)} \int_{\min\{0,\bar{\pi}(\omega,\Omega)\}}^{\infty} f_{\Pi,\Theta}(\pi,\theta) d\pi d\theta + 1 - F_\Theta\left(\bar{\theta}(\Omega)\right) \\ R_1 &= \int_{-\infty}^{\bar{\theta}(\Omega)} \int_{\min\{0,\bar{\pi}(\omega,\Omega)\}}^{\infty} \theta f_{\Pi,\Theta}(\pi,\theta) d\pi d\theta + \int_{\bar{\theta}(\Omega)}^{\infty} \theta f_\Theta(\theta) d\theta \end{aligned}$$

Rice will be grown on unrestricted land where there are positive returns ($\Pi \geq 0$), but if $\bar{\pi}(\omega, \Omega) < 0$, the farmer will cultivate rice until $\Pi = \bar{\pi}(\omega, \Omega)$ in order to meet the subsistence constraint. Therefore, the lower bound for rice cultivation in the Π dimension on unrestricted land is instead

$\min\{0, \bar{\pi}(\omega, \Omega)\}$. For what follows, I initially assume that the subsistence constraint is binding for the farmer, $\bar{\pi}(\omega, \Omega) < 0$. The key comparative statics are $\frac{\partial A_1}{\partial \Omega}$ and $\frac{\partial R_1}{\partial \Omega}$, which give the effect of an increase in the amount of restricted land on total rice area and rice production, respectively. First, however, note that $\bar{\theta}(\Omega)$ will fall and $\bar{\pi}(\omega, \Omega)$ will rise with an increase in restricted land, Ω.[9]

$$
\begin{aligned}
\frac{\partial \bar{\theta}(\Omega)}{\partial \Omega} &= \frac{-1}{g_\Theta(\bar{\theta}(\Omega))} < 0 \\
\frac{\partial \bar{\pi}(\omega, \Omega)}{\partial \Omega} &= \frac{\frac{\partial \bar{\theta}}{\partial \Omega}\bar{\theta}(\Omega)\left(f_\Theta\left(\bar{\theta}(\Omega)\right) - \int_{\bar{\pi}}^{\infty} f_{\Pi,\Theta}\left(\pi, \bar{\theta}(\Omega)\right) d\pi\right)}{-\int_{-\infty}^{\bar{\theta}(\Omega)} \theta f_{\Pi,\Theta}\left(\bar{\pi}, \theta\right) d\theta} > 0
\end{aligned}
$$

The cutoff rice yield for land restrictions, $\bar{\theta}(\Omega)$, will fall because the commune will select land with lower yields in order to restrict more land, and the relative profit cutoff $\bar{\pi}(\omega, \Omega)$ will rise because the increase in restricted area reduces the residual subsistence constraint on unrestricted land. These cutoffs give the boundaries of rice production on the household's land, and consequently drive the impacts of restrictions on rice area and production.

When the subsistence constraint binds, the effect of restrictions on household rice area can be decomposed into two opposing effects,

$$
\frac{\partial A_1}{\partial \Omega} = -\frac{d\bar{\pi}}{d\Omega}\left[\int_{-\infty}^{\bar{\theta}(\Omega)} f_{\Pi,\Theta}\left(\bar{\pi}(\omega, \Omega), \theta\right) d\theta\right] - \frac{\partial \bar{\theta}}{\partial \Omega}\left[f_\Theta\left(\bar{\theta}(\Omega)\right) - \int_{\bar{\pi}(\omega,\Omega)}^{\infty} f_{\Pi,\Theta}\left(\pi, \bar{\theta}(\Omega)\right) d\pi\right]
$$

The first term in the above derivative gives the reduction in rice area as unrestricted land once planted with rice in order to meet the subsistence constraint is converted to non-rice; this production is effectively replaced by the increase in rice production on restricted land. The size of this effect is determined by the adjustment of the $\bar{\pi}(\omega, \Omega)$ cutoff, as well as the density of unrestricted plots along this cutoff. If the subsistence constraint was not binding, then this negative term would be dropped from the derivative, and an increase in Ω would unambiguously increase A_1 due to the remaining two terms. The sum of these two terms gives the increase in rice area simply due to the lower $\bar{\theta}(\Omega)$ cutoff, and is similarly determined by the adjustment of $\bar{\theta}(\Omega)$ and the density of plots along this cutoff. Note that land distributed around the $\bar{\theta}(\Omega)$ cutoff with $\Pi \geq \bar{\pi}(\omega, \Omega)$ is already

[9] This follows from the derivation of marginal densities from joint densities.

planted with rice by the household and so does not contribute to the derivative. Also, the density of land distributed there depends on the covariance between Π and Θ. When the covariance is negative, more land is likely to be distributed around the $\bar{\theta}(\Omega)$ cutoff with $\Pi \leq \bar{\pi}(\omega, \Omega)$, and when the covariance is positive, less land is likely to be distributed there.

The derivative for total rice production appropriately mirrors that of rice area.

$$\frac{\partial R_1}{\partial \Omega} = -\frac{d\bar{\pi}}{d\Omega}\left[\int_{-\infty}^{\bar{\theta}(\Omega)} \theta f_{\Pi,\Theta}\left(\bar{\pi}(\omega,\Omega),\theta\right) d\theta\right] - \frac{\partial \bar{\theta}}{\partial \Omega}\bar{\theta}(\Omega)\left[f_{\Theta}\left(\bar{\theta}(\Omega)\right) - \int_{\bar{\pi}(\omega,\Omega)}^{\infty} f_{\Pi,\Theta}\left(\pi,\bar{\theta}(\Omega)\right) d\pi\right]$$

The negative effect on production of conversion of land from rice to non-rice is captured by the first term; the loss in rice area represented by the first term of $\frac{\partial A_1}{\partial \Omega}$ generates this decrease in production. Likewise, the sum of the remaining terms encompasses the net impact of restricted area on rice production on restricted land: the added output from newly restricted land, ignoring the output from land that was already allocated to rice.

As previously discussed, the signs of these derivatives and thus the affect of changes in restrictions on household rice area and production are decided by the sign of $\text{Cov}(\Pi, \Theta)$, and the tightness of the subsistence constraint. The more negative the covariance between Π and Θ, the more the interests of the commune and farmer diverge, as the commune will restrict land with the highest relative non-rice profits. This positive effect may be diminished if the subsistence constraint is binding, and rice production falls on unrestricted land.

4.1 Empirical Specification

To evaluate the hypothesis of the model, I estimate fixed effect regressions at both the household and plot level. The household regressions correspond to the farmer level from the model, for which it's ambiguous how restrictions will affect aggregate rice outcomes. The household level models take the form,

$$\begin{aligned} Y_{hct} &= \beta_0 + \beta_1 Res_{hct} + \boldsymbol{\beta}\mathbf{X}_{hct} + \alpha_h + \delta_t + \varepsilon_{hct} \\ Y_{hct} &= \beta_0 + \beta_1 Res_{hct} + \boldsymbol{\beta}\mathbf{X}_{hct} + \alpha_h + \delta_{ct} + \varepsilon_{hct} \end{aligned}$$

where Y_{hct} is the outcome of interest for household h in commune c in period t, including an indicator for whether the household grows any rice, the number of seasons of rice grown across all household plots, rice output in tons, and the total area devoted to rice production. Res_{hct} is either an indicator that the household faces restrictions or a measure of the share of household land that's restricted. Instead of using the share, for which a 1 unit change is extreme, or a standardized share, for which a 1 unit change is too low[10], I simply divide the share of restricted land by the standard deviation of the shares of *restricted* households, excluding those that are unrestricted. This way, a value of 0 still indicates that the household is unrestricted, and a 1 unit increase in the variable is a reasonable change in the amount of restricted land. X_{hct} is a vector of household controls, α_h is a household fixed effect, and δ_t and δ_{ct} are year and commune-specific year fixed effects. To further examine how households respond to restrictions, I also estimate parallel models with maize outcomes, using an indicator for maize cultivation, number of maize seasons, etc.

As previously discussed, the sign and size of β_1 will depend on how farmers' and communes' choices diverge or converge about which plots to plant with rice, as well as the tightness of the households' rice production constraint. If β_1 is large and positive, it would suggest that commune and farmer interests diverge and it's likely that households do not face binding subsistence constraints. If β_1 is small in magnitude, then household level estimation will not be able to distinguish between two cases: (1) commune and farmer interests converge, and restrictions are placed where households choose to grow rice, or (2) commune and farmer interests diverge, but a binding subsistence constraint leads to 'slippage' on unrestricted land. However, these cases are distinguishable at the plot level. The former will yield no effect of restriction on plot level outcomes, and the latter will yield positive effects for restricted plots in addition to negative effects for unrestricted plots.

[10] With a standardized version, the standard deviation is calculated including observations from unrestricted households with a share of 0. This makes the standard deviation an inaccurate measure of a reasonable increase in the restricted share of land when the household is restricted.

At the plot level, I estimate models of the form,

$$
\begin{aligned}
Y_{ihct} &= \beta_0 + \beta_1 Res_{ihct} + \beta_2 OtherRes_{ihct} + \boldsymbol{\beta}\mathbf{X}_{ihct} + \alpha_i + \delta_t + \varepsilon_{ict} \\
Y_{ihct} &= \beta_0 + \beta_1 Res_{ihct} + \beta_2 OtherRes_{ihct} + \boldsymbol{\beta}\mathbf{X}_{ihct} + \alpha_i + \delta_{ct} + \varepsilon_{ict} \\
Y_{ihct} &= \beta_0 + \beta_1 Res_{ihct} + \beta_2 OtherRes_{ihct} + \boldsymbol{\beta}\mathbf{X}_{ihct} + \alpha_i + \delta_{h1} t + \delta_{h2} t^2 + \varepsilon_{ict}
\end{aligned}
$$

where Y_{ihct} is the outcome of interest for plot i in household h in commune c in period t, including an indicator that rice is grown on the plot, the number of rice seasons grown, rice output in tons, and rice yield in tons per hectare. While Res_{ihct} is an indicator that the plot is restricted to grow rice, $OtherRes_{ihct}$ is an indicator that *another* plot controlled by household h is restricted to grow rice. Together, these variables separate restricted from unrestricted land. X_{ihct} is a vector of plot and household controls, α_i is a plot fixed effect, δ_t and δ_{ct} are year and commune-specific year fixed effects, and t is a period count. Again, to further test the results, I run analogous estimations using maize outcomes. The coefficients of interest are β_1 and β_2. If commune and farmer interests converge, then $\beta_1, \beta_2 \approx 0$, but if commune and farmer interests diverge, then $\beta_1 > 0$. Finally, there is evidence of slippage and therefore a binding subsistence constraint if $\beta_1 < 0$.

5 Results

The first set of tests are at the household level, in order to evaluate the net effect land restrictions on households after they have had the opportunity optimize production. Tables 6 and 7 explore how restrictions shift the extensive and intensive margins of rice and maize production. Dependent variables are an indicator that the household grows at least one season of rice across its plots, the cumulative number of rice seasons grown by the household, and the measure of land (in hectares) of land that is planted with rice for at least one season. Regressions include controls for household size, gender of household head, whether the household reported facing a negative natural shock, total land used by the household (owned land and rented in land), district median price of rice, and the shares of household land with a redbook and with irrigation, converted to standard units. The first four columns include plot and year fixed effects, and the last four include commune-specific year dummies. Thus the results in the last four columns are robust to any commune level shocks that would affect both household rice production decisions and commune restriction decisions. Having restricted land increases a household's probability of growing rice by 5.4-8.3 pp according to results in columns 1 and 5, and increases the number of rice seasons grown by 0.2-0.25 according to columns 2 and 6. The estimated effects are statistically- but not economically significant: a 5.4 pp increase in the probability of growing rice is just 7.3 percent of the average, and an increase of 0.2 rice seasons is just 3.8 percent of the average. Statistically significant results for hectares of rice are only found in level form, where they are between 5.2-11.6 percent of the mean value. Table 7 completes a parallel analysis restriction's effect on maize production decisions. In this case, there are no statistically significant effects of restriction, and all point estimates are small relative to the averages. Overall, there is little evidence that restrictions alter household rice production at the extensive or intensive margins.

Restrictions seem to have comparably small and insignificant effects on household rice output, as shown in Tables 8 and 9. In Table 8, the dependent variables are either household rice production in tons and household rice yield in tons per hectare. In columns 1 and 4, I see that restrictions do not significantly affect rice production. In accordance with the earlier negative relationship between restriction and rice area, I see a positive effect of restriction on rice yields in the rest of the columns. Though the effects are small—none are larger than 8 percent of the mean rice yield—they are robust to the inclusion of commune-year fixed effects as well as the number of cumulative rice seasons grown by the household. As land-use restrictions specify land used for rice as well as rice seasons, if controlling for these non-predetermined household outcomes absorbs the estimated effect of restrictions, then it's less likely my results are driven by unobservables.[11] In columns 3 and 6, the addition of household rice seasons only shrinks the magnitude of the coefficient for restriction but does not totally absorb the effect. From the model, however, a persistent positive effect of restrictions on rice yields is expected if there is a divergence of interest. In this case, the commune restricts land that's highly suitable for rice that the household would rather plant with non-rice,

[11] If my results are driven by unobservable shocks that affect both restriction decisions and household production, then I might see residual effects of restrictions on household and plot outcomes even after controlling for the amount of land/seasons planted with rice.

which leaves the household with higher rice yields under restrictions.

The dependent variable of Table 9 is the log of rice output from all household rice production measured in tons. In addition to the restriction indicator, I also introduce a measure of the share of households' land under restriction, measured in standard deviations of restricted households. The discrete change from unrestricted to restricted is not significantly correlated with logged rice production. However, a 1 SD increase in the share of restricted land increases rice production by 3 percent—which is, again, statistically but not economically significant. The inclusion of rice seasons and rice area—which are not predetermined with respect to restriction status—absorbs the magnitude and significance of this effect in column 3, suggesting that way restrictions affect household rice production is entirely through changes in the amount of rice planted, as expected. With commune-specific year dummies in columns 3-6, the estimated effect of a 1 SD increase in the share of restricted land almost doubles and the effect of the restriction indicator remains insignificant. In contrast to column 3, a small positive effect of restricted share stays significant even with the addition of household production variables. Such a positive relationship could either indicate that households that experience higher than usual rice productivity in a given year are more likely to be restricted, or that households receive some beneficial treatment from the commune when restricted that is not captured by the household production variables. Yet the effect is still ultimately negligible at 1.8 percent, and in either case, we might expect for this positive shock or beneficial treatment to spill over to a household's other crops. Table 10, which performs a similar analysis for maize production, shows that this does not hold.

The remaining tables utilize the plot-level panel. With this finer unit of analysis, I can control for time-invariant, unobservable plot characteristics in addition to those of households. This analysis can also test the predictions of the model, which distinguishes between the effect of restrictions on restricted plots and the effect it may have on unrestricted plots. Tables 11 and 12 investigate the effect of restriction on the probability that rice is cultivated on a plot as well as number of seasons of rice. The first two columns of both tables include plot and year fixed effects, columns 3 and 4 include commune-specific year effects, and the last two columns control for household-specific quadratic time trends. These further controls assuage concerns about commune—and now household—level shocks as previously discussed. In contrast to the household results, at the plot level, a restriction indicator does significantly increase the probability of growing rice by 13-21 pp and increases cultivation by 0.25-0.38 seasons as seen in columns 1, 3 and 5 of Tables 11 and 12. These are relatively large effects at 17-28 percent and 18-28 percent of the average, respectively.

These effects seem incongruous with the lack of impact observed at the household level, until a control is added for whether any of the household's *other* plots face restriction, in columns 2, 4, and 6 of Tables 11 and 12.[12] This variable controls for plots that were not chosen for restriction by the commune, which, as we saw in the model of household behavior, can still affect production on such plots. While plots still grow rice more often and more seasons of it when restricted, these gains are lower when the household has other plots that are restricted, and if the plot is unrestricted while other household plots are restricted, the effect is negative. For example, a household's only restricted plot will be 28 pp more likely to grow rice and grow 0.5 more seasons if there are no other plots restricted,[13] and an unrestricted plot of a household who faces restriction will be 20 pp less likely to grow rice and grow 0.37 fewer seasons. If this pattern is driven by the fact that households are targeted for restrictions precisely when they reduce rice production on their land, then the variety of controls for temporal shocks across the columns should alter the results. Instead, they are both statistically significant and stable across these controls. These results are consistent with a divergence of interest between the farmer and commune concerning where rice should be planted and with binding subsistence constraints for households, as demonstrated by the model.

Additional support is given by Tables 13 and 14, which reveals a complementary pattern for maize production decisions. Plots that face restriction are less likely to grow maize and grow fewer seasons, but are more likely to grow maize and grow more seasons if they are unrestricted plots of a household facing restrictions on other plots. These effects are admittedly small in magnitude—a restriction decreases the probability of growing maize by 11 percent and maize seasons by about 0.18 seasons—but are very large relative to the mean. As the case with rice, they are also robust

[12]Though only a subset of a household's plots are included in the panel due to matching difficulties and gaining/losing plots over time, this variable is constructed at the household level: if a household has other restricted plots in a given year, this variable will equal 1 even if those plots are not a part of the panel of plots.

[13] If other plots are restricted, this increase is reduced to 8 pp more likely to grow rice, and 0.18 more seasons of rice.

to various controls for temporal shocks and trends at the commune and household levels. Taken together, Tables 11-14 suggest that households shift production across plots in order to comply with restrictions in a way that results in little change in rice cultivation at the level of the household.

Tables 16 and 15 show the corresponding effects on rice output measured in tons and yields measured in tons per hectare. As in earlier tables, the first two columns utilize plot and year fixed effects, and the remaining columns add more detailed temporal controls. Again, the effects of restriction and the restriction of other household plots is remarkably stable across columns 1, 3 and 5: a restricted plot produces 0.17 tons more rice and an unrestricted plot in a restricted household produces 0.14-0.17 fewer tons. If these effects are due to compliance with restrictions and a shift in cultivation across households as described before, adding controls for growing rice and number of rice seasons should eliminate the effect of restrictions. Columns 2, 4, and 6 show that this is the case.

Table 16 instead examines rice yields. When the restriction status of other household plots is not included, restriction of a plot increases its yield by about 0.8 tons per ha, an effect that's erased when growing rice and rice seasons are controlled for. As shown by column 3, this effect rises to 2.3 tons per ha (35 percent of the average yield) when other household plots are not restricted, and rice yields on unrestricted plots of restricted households fall by 1.9 tons per ha. However, that negative effect is not absorbed by controls for rice growing and rice seasons. This could either indicate that households otherwise reduce production on unrestricted plots or that commune authorities anticipate plot-level negative shocks to productivity when making restriction decisions so that plots left unrestricted have significantly worse rice yields. However, if this were the case, then we could expect to find a similarly persistent negative effect for other crops, such as maize. Plot-level maize production was not recorded in 2006, but Table 17 repeats this analysis for maize production for 2008-2012. There is no persistent negative effect of other restricted plots in the household after controlling for maize growing and maize seasons, as seen in column 4.

The empirical results discussed thus far suggest that there is a divergence of interest between the commune and farmers, such that a significant subset of restricted land would be more profitably planted with non-rice crops. Moreover, the reduction in rice production on unrestricted land suggests that households face binding subsistence constraints and the rice produced on restricted land releases a significant subset of unrestricted land from subsistence rice production. Because restrictions are effectively a distortion of households' land allocation across crops, they should also reduce household agricultural profits. In Table 18, I show that household agricultural profits fall by 450,000 2010-VND for every 1SD increase in the share of land restricted. This is a large effect, at 14 percent of the average level of agricultural profit. Table 19 decomposes this into rice profits and non-rice agricultural profit, to find the loss is due to a reduction in non-rice profit.

6 Conclusion

In Vietnam, a history of food insecurity and famines associated with both national and local rice shortages have lead to a preoccupation with rice production in agricultural policy. While all agricultural land use was once centrally planned and households were required to deliver quantities of rice to the commune for collective consumption, the latter policy was abandoned as a part of Vietnam's move toward a "socialist-oriented market economy." Land use planning, on the other hand, has persisted along with the importance of rice to the Vietnamese diet and economy.

I develop a model of crop choice that explains the patterns I observe at both the household and plot levels, depending on whether household and commune interests diverge and if the household faces a binding subsistence constraint. If household and commune interests converge, land that's restricted would've been planted with rice without any restrictions. If they diverge, the commune restricts land the household would more profitably plant with another crop. In the model, the correlation between rice yields and the relative profits of rice over a non-rice crop govern the degree of convergence. Clearly, if restrictions don't change crop choice on any household land, we shouldn't see any impacts of restriction on restricted or unrestricted land. The tightness of the household subsistence constraint determines whether changes in production on restricted land prompts adjustments in production on unrestricted land. If the constraint is binding, then the household grows rice where it would more profitably grow a non-rice crop in order to meet its subsistence constraint. Restrictions may effectively relax the subsistence constraint if they increase rice production on restricted land, which releases this land to the more profitable non-rice crop.

When interests diverge and the subsistence constraint binds, then households may increase rice on restricted land, decrease rice on unrestricted land, and see only small effects of restriction at the household level due to the offsetting effect.

The question of how restriction affects household production is clearly an empirical question. Using household survey data from Vietnam between 2006-2012, I exploit variation in household- and plot-level restrictions to estimate how restrictions affect crop choice, cropping intensity, rice production, and agricultural profits. At the household level, restrictions marginally increase the probability that the household grows rice and the number of seasons grown. I find that restrictions have no effect on household rice production levels and a 1SD increase in restricted land share increases rice production by just 6 percent among intensive rice households. However, restrictions do increase households' rice yields. In the model, this could be expected if the subsistence constraint binds even after restrictions, which require the household to meet this production on the household's 'best' land for rice. However, the effect is still small: a 1SD increase in the restricted land share increases household rice yield by 0.45 tons per hectare, which is just 7 percent of the average yield. At the plot level, I see evidence of rice production being shifted across household land as a result of restrictions. Households grow 0.6 more seasons of rice on restricted plots, but grow 0.4 fewer seasons on unrestricted plots with a parallel pattern found for maize production.

Consequently, the aggregate effect of restrictions is to shift rice production across plots, but not significantly alter the amount of rice produced due to households' endogenous responses. With the plot level estimates, I can construct counterfactual rice production in the absence of the 'slippage' on unrestricted land and find that this behavioral response reduces household rice by about 0.4 tons on average, which is about 12 percent of the average household's output. Since the household-level effect was estimated to be zero, this suggests that in the absence of 'slippage,' restrictions would have increased rice production by 12 percent for the average household. As is expected, I estimate that this distortion from household's optimal land allocation reduces agricultural profits by about 15 percent—a cost which does not seem to be justified by increased food security. Note that this likely underestimates the full cost of the restrictions, as it does not include the cost of actions taken by households in anticipation of restrictions. Just as households must re-optimize once land restrictions have been imposed on their land, they must re-optimize as well to the risk of facing restriction.

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Tables and Figures

Figure 1: Provinces included in VARHS data.

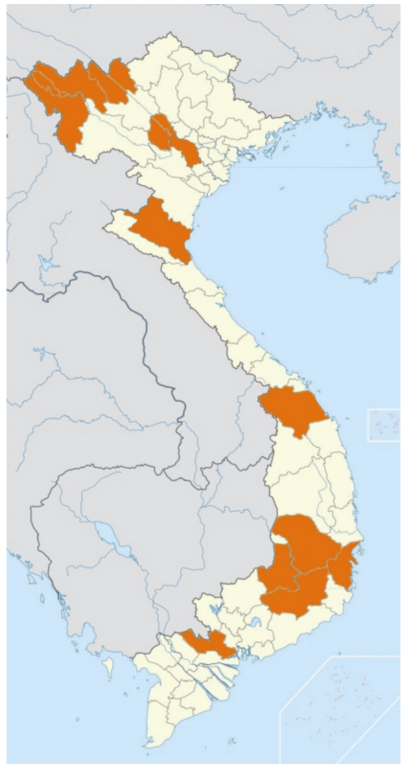

Table 1: Summary statistics by year.

	2006	2008	2010	2012	Total
Plot					
Irrigated	0.737	0.732	0.789***	0.821***	0.770
	(0.440)	(0.443)	(0.408)	(0.383)	(0.421)
Manager is head	0	0.553***	0.497***	0.508	0.390
	(0)	(0.497)	(0.500)	(0.500)	(0.488)
Restricted to grow rice in all seasons	0.200	0.230***	0.0965***	0.320***	0.212
	(0.400)	(0.421)	(0.295)	(0.467)	(0.408)
Restricted to grow rice in some seasons	0.349	0.238***	0.245	0.235	0.267
	(0.477)	(0.426)	(0.430)	(0.424)	(0.442)
Restricted to grow other crop	0.0377	0.0269***	0.0156***	0.0242***	0.0261
	(0.190)	(0.162)	(0.124)	(0.154)	(0.159)
Construction permitted	0.125	0.125	0.101***	0.209***	0.140
	(0.331)	(0.331)	(0.301)	(0.407)	(0.347)
Conversion permitted	0.120	0.122	0.108*	0.216***	0.142
	(0.325)	(0.327)	(0.311)	(0.412)	(0.349)
Rice seasons	1.342	1.351	1.374	1.383	1.362
	(0.873)	(0.874)	(0.874)	(0.876)	(0.874)
Rice yield if >0 (tons/ha)	8.109	8.289**	8.134**	8.861***	8.349
	(3.634)	(3.323)	(3.024)	(3.385)	(3.362)
Maize seasons	0.172	0.181	0.166	0.155	0.168
	(0.466)	(0.464)	(0.470)	(0.464)	(0.466)
Maize yield if >0 (tons/ha)	.	4.012	4.174	4.200	4.118
	(.)	(2.255)	(2.419)	(2.328)	(2.329)
Household					
Household size	4.585	4.558	4.317***	4.236	4.424
	(1.725)	(1.748)	(1.714)	(1.789)	(1.750)
Male head	0.808	0.791	0.789	0.782	0.792
	(0.394)	(0.407)	(0.408)	(0.413)	(0.406)
Head, years of educ.	.	7.854	7.943	7.984	7.927
	(.)	(3.323)	(3.308)	(3.289)	(3.307)
Total area used by household (ha)	0.745	0.740	0.723	0.729	0.734
	(1.201)	(1.176)	(1.192)	(1.228)	(1.199)
Size of used plot (ha)	0.169	0.169	0.171	0.174	0.171
	(0.278)	(0.282)	(0.306)	(0.307)	(0.294)
Number of owned plots	4.881	4.764	4.452***	4.321	4.605
	(3.248)	(3.092)	(2.996)	(2.844)	(3.056)
Number of plots rented in	0.339	0.392***	0.318**	0.298	0.337
	(0.885)	(1.019)	(0.881)	(0.835)	(0.908)
Number of plots rented out	0.259	0.317***	0.403**	0.458	0.359
	(1.048)	(1.129)	(1.238)	(1.386)	(1.209)
Number of plots lost/sold	0.313	0.375***	0.326	0.213***	0.307
	(0.986)	(1.384)	(1.082)	(0.781)	(1.082)
Share of land irrigated	0.583	0.575	0.616***	0.623	0.599
	(0.365)	(0.373)	(0.381)	(0.374)	(0.374)
Share of land with rice	0.465	0.453	0.433*	0.423	0.444
	(0.348)	(0.353)	(0.363)	(0.365)	(0.357)
Rice grown	0.774	0.749*	0.709	0.690	0.731
	(0.418)	(0.433)	(0.454)	(0.463)	(0.444)
Non-rice annual grown	0.658	0.527***	0.613***	0.590	0.597
	(0.475)	(0.499)	(0.487)	(0.492)	(0.491)
Perrenial grown	0.283	0.403***	0.406	0.332***	0.356
	(0.450)	(0.491)	(0.491)	(0.471)	(0.479)
District					
Price of rice (2010 1000VND per KG)	1.683	3.831***	5.335***	7.935***	4.675
	(0.295)	(0.828)	(2.160)	(1.525)	(2.659)
Price of maize (2010 1000VND per KG)	1.446	3.960***	4.603***	7.156***	3.990
	(0.301)	(0.990)	(1.424)	(1.285)	(2.371)

Standard errors in parentheses. Stars indicate statistical significant differences compared to previous year. previous year.

Table 2: Summary statistics by restriction.

	Never-restricted	Restricted
Plot		
Size (ha)	0.376	0.102***
	(0.596)	(0.295)
Irrigated	0.482	0.865***
	(0.500)	(0.342)
Canal irrigation	0.146	0.743***
	(0.353)	(0.437)
Flat	0.413	0.772***
	(0.492)	(0.419)
Male manager	0.696	0.471***
	(0.460)	(0.499)
Redbook	0.632	0.825***
	(0.482)	(0.380)
Construction permitted	0.452	0.0511***
	(0.498)	(0.220)
Conversion permitted	0.438	0.0584***
	(0.496)	(0.235)
Grows rice	0.312	0.881***
	(0.463)	(0.324)
Grows maize	0.213	0.106***
	(0.410)	(0.308)
Grows other annual	0.214	0.143***
	(0.410)	(0.350)
Grows perennial	0.310	0.0236***
	(0.463)	(0.152)
Rice yield if >0 (tons/ha)	5.539	8.577***
	(3.446)	(2.409)
Maize yield if >0 (tons/ha)	3.474	4.424***
	(2.052)	(2.110)
Household		
Household size	4.360	4.445*
	(1.773)	(1.742)
Male head	0.750	0.806***
	(0.433)	(0.395)
Head, years of educ.	8.140	7.859***
	(3.519)	(3.233)
Total area used by household	0.943	0.667***
	(1.390)	(1.123)
Total area used per capita	0.223	0.153***
	(0.353)	(0.273)
Number of plots	3.107	6.007***
	(2.286)	(3.120)
Number of restricted plots	0	2.675***
	(0)	(3.147)
Rice yield if >0 (tons/ha)	6.799	8.535***
	(3.276)	(2.469)
Maize yield if >0 (tons/ha)	4.368	4.848*
	(3.285)	(2.840)

Table 3: Wooldridge method, estimated with xtprobit.

	Restricted	Restricted	Restricted	Restricted
Plot restricted$_{t-1}$	0.204***	0.194***	0.152**	0.130*
	(0.0661)	(0.0680)	(0.0693)	(0.0700)
	[0.0547]	[0.0492]	[0.0390]	[0.0331]
Irrigated		0.452***	0.481***	0.495***
		(0.0986)	(0.0994)	(0.0983)
		[0.1167]	[0.1274]	[0.1301]
Redbook		0.460***	0.461***	0.472***
		(0.126)	(0.128)	(0.129)
		[0.1160]	[0.1187]	[0.1208]
Other Crops$_{t-1}$		0.176	0.159	0.154
		(0.123)	(0.125)	(0.126)
		[0.0426]	[0.0396]	[0.0380]
Plot RiceYield$_{t-1}$ (tons per ha)		-0.00288	-0.00361	-0.00327
		(0.00546)	(0.00515)	(0.00501)
		[-0.0012]	[-0.0016]	[-0.0015]
District rice price (log)		0.257	0.262	0.284
		(0.310)	(0.314)	(0.318)
		[0.1104]	[0.1185]	[0.1278]
Natural disaster shock, plot		0.00473	-0.0357	-0.0345
		(0.0674)	(0.0818)	(0.0822)
		[0.0012]	[-0.009]	[-0.0086]
Natural disaster shock, HH			-0.0880	-0.0753
			(0.0860)	(0.0869)
			[-0.0223]	[-0.0189]
HH labor supply			0.0172	0.0167
			(0.0646)	(0.0644)
			[0.0078]	[0.0075]
HH RiceYield$_{t-1}$			0.00329	0.00314
			(0.00565)	(0.00580)
			[0.0015]	[0.0014]
Area used by HH (log)			-0.0329	-0.0171
			(0.149)	(0.149)
			[-0.0149]	[-0.0077]
HH relative/member is gov. official				-0.263**
				(0.105)
				[-0.0665]
Year=2010	-0.503***	-0.594***	-0.617***	-0.617***
	(0.0740)	(0.110)	(0.112)	(0.113)
Year=2012	0.432***	0.247*	0.222	0.183
	(0.0679)	(0.145)	(0.146)	(0.148)
Observations	11452	11335	11071	11071
Mean DV	0.513	0.514	0.523	0.523
Sample	All	All	All	All

SEs in parentheses, APEs in brackets. Standard errors clustered at the household level. Controls for initial condition and each independent variable at each period included as specified in Wooldridge (2002). Flexible controls for plot area, slope, distance from home, household size, way of acquiring the plot, and household head's gender, age, and education level are included but not shown.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Arellano-Bond method, estimated with xtabond2

	Restricted	Restricted	Restricted	Restricted
Plot Restricted$_{t-1}$	0.0181	0.0241	0.0333**	0.0320**
	(0.0150)	(0.0153)	(0.0159)	(0.0159)
Irrigated		0.134***	0.141***	0.142***
		(0.0155)	(0.0165)	(0.0164)
Redbook		0.124***	0.128***	0.131***
		(0.0199)	(0.0209)	(0.0209)
Other Crops$_{t-1}$		0.0887***	0.0886***	0.0885***
		(0.0182)	(0.0207)	(0.0207)
Plot RiceYield$_{t-1}$ (tons per ha)		-0.00139	-0.00195	-0.00175
		(0.00115)	(0.00122)	(0.00122)
District rice price (log)		0.120***	0.139***	0.141***
		(0.0304)	(0.0359)	(0.0359)
Natural disaster shock, plot		-0.0334***	-0.0337**	-0.0344**
		(0.0108)	(0.0135)	(0.0135)
Natural disaster shock, HH			-0.00833	-0.00706
			(0.0116)	(0.0116)
HH labor supply			-0.0103	-0.0122
			(0.00778)	(0.00780)
HH RiceYield$_{t-1}$			0.00239	0.00247
			(0.00153)	(0.00158)
Area used by HH (log)			-0.0121	-0.00743
			(0.0227)	(0.0225)
HH relative/member is gov. official				-0.0668***
				(0.0136)
Year=2010	-0.105***	-0.138***	-0.156***	-0.154***
	(0.00793)	(0.0114)	(0.0131)	(0.0131)
Year=2012	0.0892***	0.0338**	0.0253	0.0188
	(0.00798)	(0.0148)	(0.0174)	(0.0173)
Observations	9414	9294	8711	8711
A-B AR(1)	-27.81	-26.79	-26.75	-26.76
Sargan	82.91	76.04	58.42	60.27
Hansen	85.96	80.41	62.22	64.12
Mean DV	0.438	0.441	0.467	0.467
Plot, Year	Yes	Yes	Yes	Yes
Sample	All	All	All	All

Standard errors in parentheses

Standard errors clustered at the plot level. GMM style instruments for lagged restriction status, two-step estimation of standard errors with the finite sample Windmeijer correction.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 2: Coefficient of variation of commune-level rice production and proportion of land under restriction.

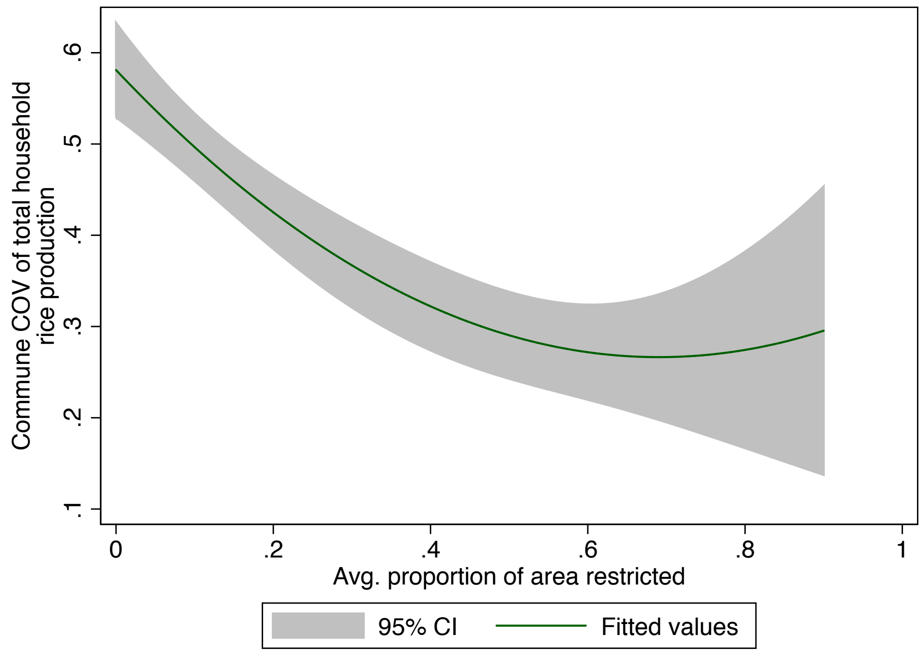

Table 5: Changes in restrictions and previous rice cultivation.

Rice_{t-1}	All→None	All→Some	Some→None	None→Some	Some→All	None→All
None	3.25	3.50	4.03	16.50	2.21	14.32
Some seasons	11.53	12.94	37.85	20.00	39.50	16.87
All seasons	85.22	83.56	58.12	63.50	58.29	68.81
N	893	371	1,041	1,000	362	901

Figure 3: Yield of rice-growing plots by restriction status.

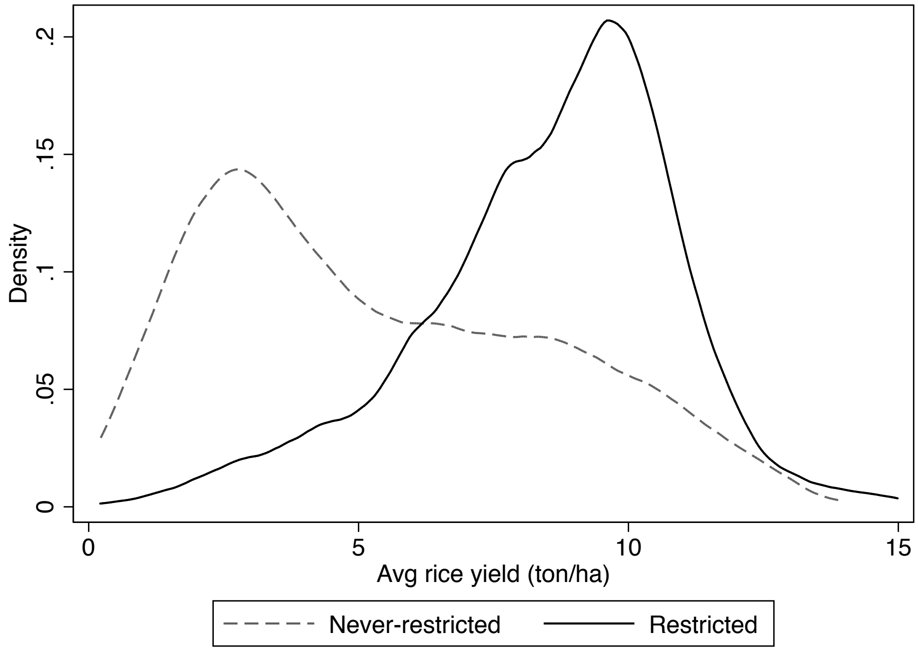

Figure 4: Yield of maize-growing plots by restriction status.

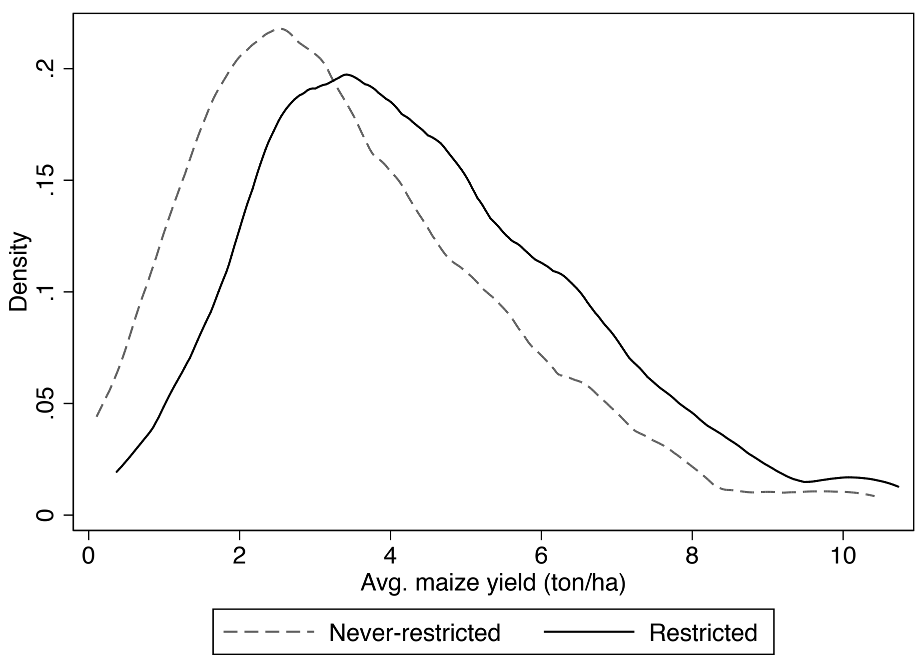

Figure 5: Total land restricted at the household and commune levels by year.

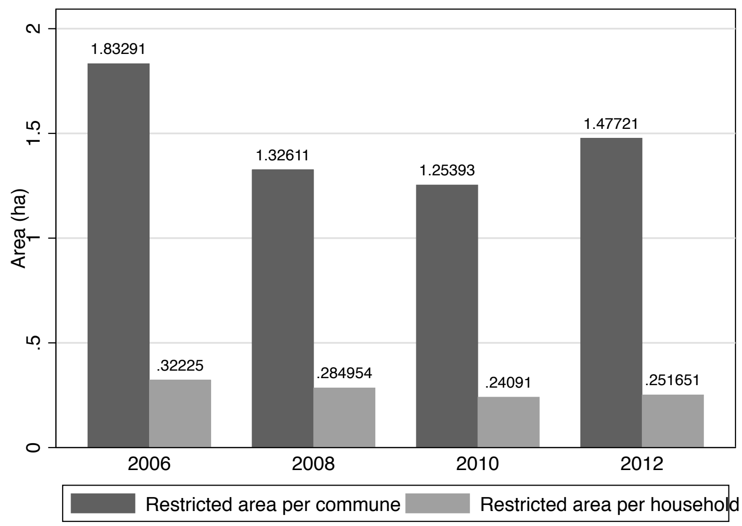

Figure 6: Compliance with plot restrictions.

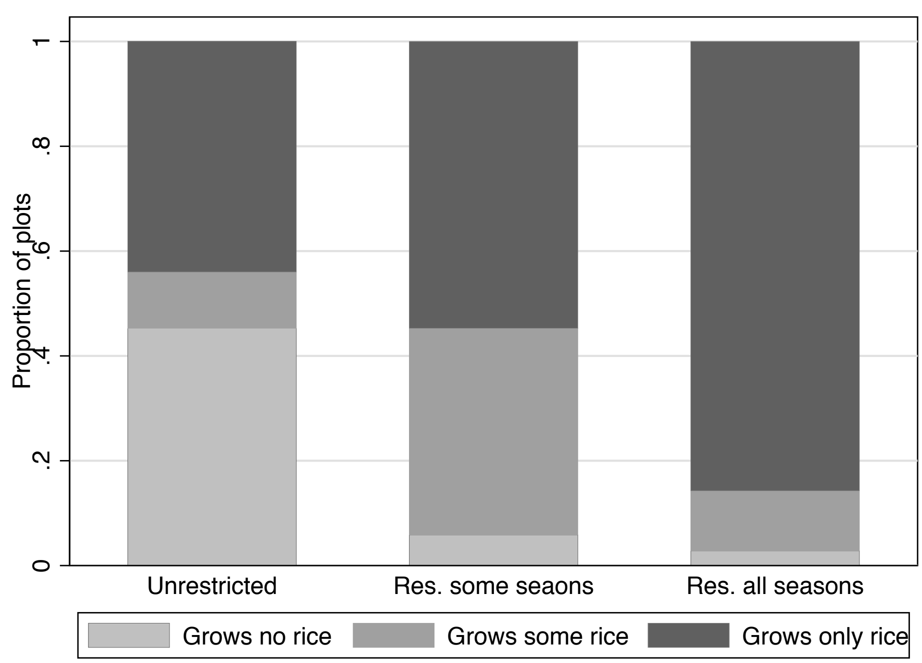

Table 6: Land restriction and the extensive margins of household rice production.

	Rice=1	RiceSeasons	RiceHa.	ln(RiceHa.)	Rice=1	RiceSeasons	RiceHa.	ln(RiceHa.)
HH Restricted	0.0543***	0.215**	-0.0159	-0.0186	0.0826***	0.252**	-0.0347**	0.00143
	(0.00873)	(0.0989)	(0.00996)	(0.0140)	(0.0117)	(0.119)	(0.0154)	(0.0186)
Total used land, ha. (log)	0.189***	1.785***	0.143***	0.683***	0.184***	1.666***	0.136***	0.699***
	(0.0139)	(0.178)	(0.0206)	(0.0459)	(0.0144)	(0.176)	(0.0214)	(0.0472)
Irrigated land share (std)	0.0419***	0.455***	0.0336***	0.128***	0.0453***	0.398***	0.0369***	0.158***
	(0.00744)	(0.0806)	(0.00656)	(0.0168)	(0.00642)	(0.0730)	(0.00832)	(0.0183)
Redbook land share (std)	0.00332	0.0551	-0.00273	0.00621	0.00643	0.0539	0.00238	0.00488
	(0.00480)	(0.0696)	(0.00557)	(0.0117)	(0.00530)	(0.0507)	(0.00569)	(0.0128)
HH size	0.00594	0.280***	0.00774	0.0238***	0.00528	0.284***	0.00688	0.0261***
	(0.00405)	(0.0556)	(0.00545)	(0.00783)	(0.00417)	(0.0613)	(0.00554)	(0.00876)
Male household head	-0.0181	-0.161	0.00884	0.0164	-0.0141	-0.0528	0.0101	-0.0152
	(0.0226)	(0.268)	(0.0197)	(0.0338)	(0.0228)	(0.258)	(0.0216)	(0.0419)
Natural disaster	0.0211***	0.126	-0.00503	0.00414	0.0180**	0.163	0.0137	0.0265
	(0.00643)	(0.0809)	(0.00986)	(0.0131)	(0.00842)	(0.102)	(0.0128)	(0.0169)
Rice price (log)	-0.00794	-0.317	-0.0852	-0.113				
	(0.0280)	(0.311)	(0.0633)	(0.0887)				
Observations	7960	7960	7960	5152	8032	8032	8032	4808
Mean DV	0.747	5.235	0.303	-1.431	0.734	5.147	0.298	-1.421
HH, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	No	No	Yes	Yes	Yes	Yes
Sample	All	All	All	AlwaysRice	All	All	All	AlwaysRice

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Land restriction and households' decision to grow maize.

	Maize=1	MaizeSeasons	MaizeHa.	Maize=1	MaizeSeasons	MaizeHa.
HH Restricted	-0.0133	0.0338	0.00426	-0.0305**	0.0126	-0.00128
	(0.0142)	(0.0618)	(0.00728)	(0.0135)	(0.0589)	(0.00598)
Total used land, ha. (log)	-0.0238	0.224***	0.0353***	-0.0458***	0.136***	0.0234***
	(0.0178)	(0.0446)	(0.00725)	(0.0123)	(0.0337)	(0.00565)
Irrigated land share (std)	-0.0670***	-0.0814***	-0.0145**	-0.0672***	-0.0474**	-0.0141**
	(0.00984)	(0.0259)	(0.00572)	(0.00939)	(0.0210)	(0.00559)
Redbook land share (std)	-0.0193**	-0.0309	-0.00213	-0.0131	0.00744	0.000429
	(0.00927)	(0.0325)	(0.00518)	(0.00839)	(0.0137)	(0.00355)
HH size	0.0179***	0.0881***	0.00756***	0.0112*	0.0483***	0.00538**
	(0.00654)	(0.0214)	(0.00275)	(0.00573)	(0.0168)	(0.00209)
Male household head	0.0225	-0.123	-0.0153	0.00418	-0.149	-0.00752
	(0.0439)	(0.173)	(0.0114)	(0.0377)	(0.102)	(0.00817)
Natural disaster	-0.0103	0.0343	-0.00706	-0.0247	-0.0137	-0.00528
	(0.0139)	(0.0492)	(0.00833)	(0.0159)	(0.0606)	(0.00653)
Maize price (log)	-0.0201	0.0429	-0.00781			
	(0.0475)	(0.135)	(0.0119)			
Observations	5940	5940	5940	8032	8032	8032
Mean DV	0.438	0.886	0.0951	0.354	0.663	0.0706
Plot, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	No	Yes	Yes	Yes
Sample	All	All	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Land restriction and household rice production.

	RiceProd	RiceYield	RiceYield	RiceProd	RiceYield	RiceYield
Restricted land share (in Std.Dev.)	-0.103	0.376***	0.287***	-0.0911	0.541***	0.447***
	(0.0906)	(0.0677)	(0.0658)	(0.101)	(0.0786)	(0.0745)
Irrig. land share (std)	0.264***	0.459***	0.358***	0.249***	0.373***	0.298***
	(0.0568)	(0.0907)	(0.0777)	(0.0628)	(0.0725)	(0.0669)
Redbook land share (std)	-0.00387	0.0177	0.00606	0.00488	-0.0566	-0.0621
	(0.0373)	(0.0638)	(0.0601)	(0.0341)	(0.0678)	(0.0665)
Total used land (log)	0.996***	1.378***	0.963***	0.988***	1.381***	1.036***
	(0.195)	(0.141)	(0.123)	(0.210)	(0.135)	(0.127)
HH size	0.108**	0.115**	0.0450	0.102***	0.0706	0.00867
	(0.0504)	(0.0534)	(0.0510)	(0.0343)	(0.0549)	(0.0522)
Male household head	-0.0325	-0.346	-0.296	-0.120	-0.344	-0.328
	(0.125)	(0.261)	(0.255)	(0.174)	(0.277)	(0.274)
Natural disaster	-0.122	-0.350***	-0.377***	-0.0386	-0.271**	-0.305**
	(0.0769)	(0.108)	(0.108)	(0.109)	(0.134)	(0.134)
Price of rice (log)	-0.617	-0.0924	-0.00891			
	(0.674)	(0.427)	(0.404)			
# Rice Seasons			0.240***			0.213***
			(0.0332)			(0.0297)
Observations	7652	7652	7652	7696	7696	7696
Mean DV	2.290	6.164	6.164	2.252	6.046	6.046
HH, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	No	Yes	Yes	Yes
Sample	All	All	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Land restriction and household rice production.

	ln(Output)	ln(Output)	ln(Output)	ln(Output)	ln(Output)	ln(Output)
HH Restricted	-0.0124			0.0233		
	(0.0186)			(0.0219)		
Restricted land share (in Std.Dev.)		0.0313***	0.00139		0.0596***	0.0184**
		(0.00879)	(0.00756)		(0.0102)	(0.00861)
Total used land (log)	0.559***	0.562***	0.115***	0.601***	0.606***	0.131***
	(0.0437)	(0.0433)	(0.0310)	(0.0484)	(0.0468)	(0.0364)
Irrig. land share (std)	0.154***	0.150***	0.0689***	0.134***	0.126***	0.0252**
	(0.0164)	(0.0161)	(0.0134)	(0.0149)	(0.0144)	(0.0122)
Redbook land share (std)	0.0158	0.0133	0.00730	-0.00406	-0.00706	-0.00892
	(0.0110)	(0.0111)	(0.00895)	(0.0131)	(0.0129)	(0.0104)
HH size	0.0461***	0.0465***	0.0241***	0.0395***	0.0390***	0.0175***
	(0.00814)	(0.00813)	(0.00621)	(0.00803)	(0.00790)	(0.00580)
Male household head	0.0155	0.0110	0.00941	-0.0189	-0.0279	0.00226
	(0.0435)	(0.0425)	(0.0360)	(0.0448)	(0.0430)	(0.0345)
Natural disaster	-0.0797***	-0.0793***	-0.0825***	-0.0511***	-0.0503***	-0.0602***
	(0.0160)	(0.0160)	(0.0144)	(0.0173)	(0.0174)	(0.0145)
Price of rice (log)	-0.0235	-0.0324	0.0100			
	(0.0802)	(0.0817)	(0.0704)			
# Rice Seasons			0.0387***			0.0359***
			(0.00414)			(0.00412)
Rice area (log)			0.485***			0.499***
			(0.0387)			(0.0480)
Observations	4920	4920	4920	4548	4548	4548
Mean DV	0.587	0.587	0.587	0.595	0.595	0.595
HH, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	No	Yes	Yes	Yes
Sample	AlwaysRice	AlwaysRice	AlwaysRice	AlwaysRice	AlwaysRice	AlwaysRice

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Land restriction and household maize production.

	MaizeOutput	MaizeOutput	MaizeOutput	MaizeOutput	MaizeOutput	MaizeOutput
HH Restricted	0.0118			-0.0229		
	(0.0341)			(0.0240)		
Restricted land share (in Std.Dev.)		-0.00639	-0.000453		-0.0167*	-0.00746
		(0.0124)	(0.00972)		(0.00970)	(0.00715)
HH size	0.0205*	0.0203*	-0.00489	0.0207**	0.0208**	0.00446
	(0.0121)	(0.0121)	(0.0105)	(0.00848)	(0.00850)	(0.00748)
Irrigated land share (std)	-0.0359*	-0.0352*	-0.00355	-0.0450**	-0.0430**	-0.0127
	(0.0206)	(0.0203)	(0.0165)	(0.0194)	(0.0190)	(0.0129)
Redbook land share (std)	-0.00629	-0.00551	0.00166	0.0160	0.0164	0.0151
	(0.0238)	(0.0239)	(0.0179)	(0.0181)	(0.0182)	(0.0149)
Total used land, ha. (log)	0.148***	0.149***	0.0276	0.106***	0.108***	0.0329*
	(0.0334)	(0.0337)	(0.0232)	(0.0286)	(0.0288)	(0.0185)
Natural disaster=1	-0.0358	-0.0360	-0.0301	0.00809	0.00823	0.0191
	(0.0371)	(0.0370)	(0.0310)	(0.0299)	(0.0298)	(0.0228)
Maize price (log)	0.00159	0.00313	0.00889			
	(0.0849)	(0.0848)	(0.0741)			
MaizeSeasons			0.120***			0.106***
			(0.0242)			(0.0206)
Maize area			1.709***			1.804***
			(0.375)			(0.357)
Observations	5488	5488	5488	7300	7300	7300
Mean DV	0.413	0.413	0.413	0.312	0.312	0.312
Plot, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	No	Yes	Yes	Yes
Sample	All	All	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Plot restrictions and household decision to grow rice.

	Rice=1	Rice=1	Rice=1	Rice=1	Rice=1	Rice=1
Plot Restricted	0.129***	0.283***	0.192***	0.301***	0.207***	0.304***
	(0.0135)	(0.0188)	(0.0166)	(0.0191)	(0.0202)	(0.0219)
Other HH plot restricted		-0.204***		-0.193***		-0.202***
		(0.0151)		(0.0156)		(0.0186)
Irrigated	0.250***	0.221***	0.280***	0.254***	0.305***	0.276***
	(0.0227)	(0.0225)	(0.0239)	(0.0235)	(0.0261)	(0.0273)
Redbook	0.0188	0.0194*	0.0308*	0.0263	0.0274	0.0345
	(0.0118)	(0.0113)	(0.0157)	(0.0160)	(0.0214)	(0.0212)
Household size	0.00391	0.00326	0.00277	0.00260	0.00511	0.00269
	(0.00284)	(0.00290)	(0.00364)	(0.00351)	(0.00700)	(0.00610)
Male household head	-0.0306	-0.0295	-0.00881	-0.00756	-0.0256	-0.0188
	(0.0239)	(0.0263)	(0.0234)	(0.0283)	(0.0569)	(0.0563)
Natural disaster, HH	0.00273	0.000185	0.0159*	0.0116	0.00160	0.00431
	(0.00639)	(0.00667)	(0.00867)	(0.00867)	(0.0101)	(0.0114)
Rice price (log)	-0.0514*	-0.0504*				
	(0.0308)	(0.0290)				
Observations	18032	18032	18024	18024	18160	18160
Mean DV	0.746	0.746	0.742	0.742	0.740	0.740
Plot, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	Yes	Yes	No	No
HH quadratic trend	No	No	No	No	Yes	Yes
Sample	All	All	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Plot restrictions and household decision to grow rice.

	RiceSeasons	RiceSeasons	RiceSeasons	RiceSeasons	RiceSeasons	RiceSeasons
Plot Restricted	0.254***	0.535***	0.364***	0.568***	0.374***	0.570***
	(0.0260)	(0.0341)	(0.0311)	(0.0356)	(0.0401)	(0.0425)
Other HH plot restricted		-0.371***		-0.362***		-0.413***
		(0.0279)		(0.0300)		(0.0365)
Irrigated	0.517***	0.464***	0.551***	0.502***	0.594***	0.536***
	(0.0423)	(0.0414)	(0.0421)	(0.0408)	(0.0442)	(0.0463)
Redbook	0.0256	0.0267	0.0295	0.0211	0.0126	0.0271
	(0.0202)	(0.0200)	(0.0247)	(0.0252)	(0.0339)	(0.0327)
Household size	0.00567	0.00449	0.00215	0.00182	0.000843	-0.00411
	(0.00488)	(0.00484)	(0.00622)	(0.00585)	(0.0139)	(0.0125)
Male household head	-0.0504	-0.0485	-0.0166	-0.0143	-0.0119	0.00183
	(0.0484)	(0.0547)	(0.0454)	(0.0561)	(0.102)	(0.103)
Natural disaster, HH	0.00177	-0.00285	0.0170	0.00893	-0.00826	-0.00270
	(0.0132)	(0.0141)	(0.0197)	(0.0203)	(0.0218)	(0.0245)
Rice price (log)	-0.108	-0.106				
	(0.0677)	(0.0653)				
Observations	18032	18032	18024	18024	18160	18160
Mean DV	1.372	1.372	1.365	1.365	1.362	1.362
Plot, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	Yes	Yes	No	No
HH quadratic trend	No	No	No	No	Yes	Yes
Sample	All	All	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: Plot restrictions and households' decision to grow maize.

	Maize=1	Maize=1	Maize=1	Maize=1	Maize=1	Maize=1
Plot Restricted	-0.0474***	-0.113***	-0.0591***	-0.102***	-0.0591***	-0.111***
	(0.0143)	(0.0202)	(0.0147)	(0.0192)	(0.0211)	(0.0244)
Other HH plot restricted		0.0889***		0.0757***		0.103***
		(0.0156)		(0.0134)		(0.0194)
Irrigated	-0.103***	-0.0903***	-0.109***	-0.0986***	-0.115***	-0.0995***
	(0.0166)	(0.0163)	(0.0156)	(0.0153)	(0.0183)	(0.0181)
Redbook	-0.00381	-0.00457	-0.00826	-0.00648	-0.0186	-0.0246
	(0.0123)	(0.0124)	(0.0131)	(0.0130)	(0.0159)	(0.0156)
Household size	0.00833	0.00875*	0.00280	0.00287	0.00670	0.00676
	(0.00506)	(0.00500)	(0.00417)	(0.00408)	(0.0105)	(0.0100)
Male household head	-0.0114	-0.0118	-0.0136	-0.0140	0.00740	0.00882
	(0.0490)	(0.0466)	(0.0321)	(0.0302)	(0.0487)	(0.0472)
Natural disaster, HH	-0.00504	-0.00437	-0.0179	-0.0162	-0.00567	-0.00875
	(0.0106)	(0.0109)	(0.0150)	(0.0151)	(0.0128)	(0.0132)
Maize price (log)	0.0183	0.0151				
	(0.0328)	(0.0331)				
Observations	14600	14600	18024	18024	18160	18160
Mean DV	0.163	0.163	0.133	0.133	0.133	0.133
Plot, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	Yes	Yes	No	No
Household quadratic trend	No	No	No	No	Yes	Yes
Sample	All	All	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Plot restrictions and households' decision to grow maize.

	MaizeSeasons	MaizeSeasons	MaizeSeasons	MaizeSeasons	MaizeSeasons	MaizeSeasons
Plot Restricted	-0.0889***	-0.191***	-0.111***	-0.179***	-0.125***	-0.198***
	(0.0214)	(0.0341)	(0.0248)	(0.0339)	(0.0314)	(0.0420)
Other HH plot restricted		0.138***		0.121***		0.154***
		(0.0258)		(0.0230)		(0.0320)
Irrigated	-0.143***	-0.124***	-0.145***	-0.129***	-0.153***	-0.131***
	(0.0251)	(0.0240)	(0.0241)	(0.0234)	(0.0275)	(0.0265)
Redbook	0.00640	0.00523	-0.00529	-0.00246	-0.0136	-0.0190
	(0.0178)	(0.0181)	(0.0155)	(0.0155)	(0.0188)	(0.0184)
Household size	0.00909	0.00974	-0.000826	-0.000719	-0.000915	0.000931
	(0.00608)	(0.00605)	(0.00526)	(0.00510)	(0.0113)	(0.0106)
Male household head	-0.00788	-0.00848	-0.0190	-0.0198	0.0466	0.0415
	(0.0555)	(0.0512)	(0.0400)	(0.0362)	(0.0655)	(0.0629)
Natural disaster, HH	0.000288	0.00133	-0.0163	-0.0136	-0.00322	-0.00529
	(0.0137)	(0.0141)	(0.0203)	(0.0203)	(0.0168)	(0.0171)
Maize price (log)	0.00517	0.000220				
	(0.0416)	(0.0421)				
Observations	14600	14600	18024	18024	18160	18160
Mean DV	0.206	0.206	0.169	0.169	0.168	0.168
Plot, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	Yes	Yes	No	No
Household quadratic trend	No	No	No	No	Yes	Yes
Sample	All	All	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Plot restrictions and plot rice output.

	RiceOutput	RiceOutput	RiceOutput	RiceOutput	RiceOutput	RiceOutput
Plot Restricted	0.164***	-0.0501	0.190***	-0.0192	0.157***	-0.0329
	(0.0339)	(0.0348)	(0.0387)	(0.0354)	(0.0310)	(0.0350)
Other HH plot restricted	-0.201***	-0.0473	-0.210***	-0.0686	-0.198***	-0.0524
	(0.0527)	(0.0447)	(0.0610)	(0.0546)	(0.0391)	(0.0387)
Irrigated	0.187***	0.00414	0.198***	0.0209	0.202***	0.0295
	(0.0333)	(0.0261)	(0.0341)	(0.0251)	(0.0440)	(0.0329)
Redbook	0.0320*	0.0269*	0.0241	0.0258	0.0263	0.0250
	(0.0171)	(0.0147)	(0.0211)	(0.0184)	(0.0269)	(0.0236)
Household size	0.0137	0.0123	0.0112	0.0109	0.000174	-0.00131
	(0.00939)	(0.00920)	(0.00822)	(0.00800)	(0.0143)	(0.0143)
Male household head	-0.0413	-0.00838	-0.0406	-0.0204	0.0566	0.0564
	(0.0386)	(0.0356)	(0.0468)	(0.0444)	(0.0691)	(0.0635)
Natural disaster, HH	-0.0254	-0.0223	-0.0258	-0.0277	-0.0346	-0.0319
	(0.0227)	(0.0218)	(0.0308)	(0.0300)	(0.0260)	(0.0249)
Rice price (log)	-0.186	-0.147				
	(0.148)	(0.139)				
# Rice seasons		0.502***		0.395***		0.291***
		(0.0981)		(0.0777)		(0.0535)
Rice=1		-0.181		-0.0502		0.0831
		(0.144)		(0.106)		(0.0759)
Observations	16180	16180	16152	16152	16296	16296
Mean DV	0.668	0.668	0.656	0.656	0.664	0.664
Plot, Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	Yes	Yes	No	No
HH quadratic trend	No	No	No	No	Yes	Yes
Sample	All	All	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Plot restrictions and plot rice yield.

	RiceYield	RiceYield	RiceYield	RiceYield
Plot Restricted	0.820***	-0.183	2.294***	0.0762
	(0.162)	(0.116)	(0.200)	(0.123)
Other HH plot restricted			-1.926***	-0.325***
			(0.158)	(0.0755)
Irrigated	2.311***	0.207*	2.044***	0.184*
	(0.175)	(0.112)	(0.163)	(0.111)
Redbook	0.0114	-0.0449	0.0206	-0.0424
	(0.136)	(0.0908)	(0.136)	(0.0911)
Household size	0.0858**	0.0661**	0.0820**	0.0657**
	(0.0388)	(0.0300)	(0.0382)	(0.0300)
Male household head	-0.134	0.194	-0.160	0.186
	(0.312)	(0.231)	(0.316)	(0.232)
Natural disaster, HH	-0.349***	-0.338***	-0.370***	-0.342***
	(0.0919)	(0.0751)	(0.0966)	(0.0752)
Rice price (log)	-0.212	0.177	-0.239	0.168
	(0.484)	(0.371)	(0.475)	(0.370)
# Rice seasons		4.352***		4.332***
		(0.123)		(0.122)
Rice=1		-0.169		-0.220
		(0.204)		(0.202)
Observations	16180	16180	16180	16180
Mean DV	6.463	6.463	6.463	6.463
Plot, Year FE	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	No	No
HH quadratic trend	No	No	No	No
Sample	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Plot restrictions and maize yields.

	MaizeYield	MaizeYield	MaizeYield	MaizeYield
Plot Restricted	-0.201**	-0.00814	-0.549***	-0.00310
	(0.0796)	(0.0305)	(0.155)	(0.0564)
Other HH plot restricted			0.451***	-0.00648
			(0.141)	(0.0532)
Irrigated	-0.420***	0.0671	-0.360***	0.0663
	(0.116)	(0.0490)	(0.108)	(0.0498)
Redbook	-0.0939	0.00265	-0.103	0.00279
	(0.0862)	(0.0444)	(0.0852)	(0.0443)
Household size	0.0103	-0.00538	0.0114	-0.00539
	(0.0283)	(0.0129)	(0.0278)	(0.0129)
Male household head	-0.126	-0.146*	-0.114	-0.146*
	(0.219)	(0.0871)	(0.201)	(0.0872)
Natural disaster, HH	0.0264	0.00957	0.0256	0.00958
	(0.0635)	(0.0280)	(0.0645)	(0.0281)
Maize price (log)	0.0793	-0.0615	0.0501	-0.0611
	(0.218)	(0.0846)	(0.217)	(0.0845)
# Maize seasons		3.140***		3.140***
		(0.193)		(0.193)
Maize=1		0.463**		0.463**
		(0.233)		(0.233)
Observations	9936	9936	9936	9936
Mean DV	0.622	0.622	0.622	0.622
Plot, Year FE	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	No	No
Household quadratic trend	No	No	No	No
Sample	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Land restriction and household agricultural profit.

	AgProfit	AgProfit	AgProfit	AgProfit
Restricted land share (in Std.Dev.)	-557.5***	-526.9***	-521.2***	-450.0**
	(151.0)	(153.8)	(190.6)	(191.8)
Ag. labor supplied (days)	1.471	1.745	1.593	1.894
	(2.037)	(2.022)	(2.482)	(2.466)
# Crop seasons	106.2**	198.3***	83.90*	194.0***
	(41.82)	(52.93)	(50.59)	(61.35)
Total used land (log)	240.8	445.6	460.6	930.9
	(447.2)	(495.5)	(555.0)	(627.2)
Redbook land share (std)	-494.6**	-488.7**	-142.2	-143.6
	(210.3)	(209.4)	(259.4)	(259.8)
Irrig. land share (std)	241.8	317.9	224.5	359.8
	(220.5)	(217.9)	(277.7)	(276.8)
Perennial share of land (std)	733.5**	632.2**	980.0***	742.0**
	(322.2)	(286.7)	(322.1)	(307.5)
Distance to nearest road (km)	-111.7*	-109.2*	-12.39	-12.86
	(65.44)	(65.24)	(101.6)	(101.7)
Natural disaster	-1276.7***	-1275.3***	-741.6*	-739.7*
	(386.5)	(385.0)	(439.5)	(434.4)
HH grows rice		99.12		-1765.2*
		(1178.2)		(1043.3)
# Rice seasons		-183.3**		-168.0**
		(73.42)		(77.43)
Rice area (ha)		-595.9		-1224.9
		(1356.6)		(1344.7)
Year=2008	790.5*	916.3**		
	(419.7)	(415.5)		
Year=2010	-867.1	-745.2		
	(556.7)	(554.7)		
Year=2012	168.6	295.9		
	(578.2)	(568.8)		
Observations	5756	5756	5404	5404
Mean DV	3146.3	3146.3	3164.9	3164.9
HH, Year FE	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	Yes	Yes
Sample	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 19: Land restriction and household agricultural profit.

	RiceProfit	NonRiceProfit	RiceProfit	NonRiceProfit
Restricted land share (in Std.Dev.)	-459.8**	-115.9	-53.05	-463.8**
	(199.3)	(244.6)	(145.0)	(209.4)
HH grows rice	1739.7***		349.0	
	(618.7)		(693.9)	
Rice labor supplied (days)	1.375		3.085	
	(3.742)		(4.509)	
# Rice seasons	316.1***		291.0***	
	(70.64)		(54.72)	
Rice area (ha)	6978.6***		6331.6***	
	(2156.1)		(1778.7)	
HH grows non-rice		2400.2***		1505.6**
		(840.1)		(663.8)
Non-rice labor supplied (days)		0.942		7.869**
		(3.787)		(3.862)
# Non-rice seasons		504.9***		506.4***
		(97.65)		(90.48)
Non-rice area (ha)		1920.8*		1241.4
		(1122.4)		(1027.8)
Total used land (log)	500.5	-2329.2***	992.0***	-2155.9***
	(356.0)	(795.9)	(367.6)	(817.3)
Redbook land share (std)	30.23	-491.9**	25.82	-183.7
	(155.6)	(222.2)	(181.9)	(243.2)
Irrig. land share (std)	281.4	-249.1	336.9**	-289.4
	(189.4)	(284.0)	(162.8)	(303.6)
Natural disaster	-847.7***	-358.2	-396.6	-364.6
	(309.3)	(462.5)	(266.9)	(532.9)
Distance to nearest road (km)	-0.229	-101.8	78.23	-72.23
	(152.8)	(184.1)	(65.85)	(129.1)
# Crop seasons	78.07**	-466.4***	-9.928	-351.2***
	(38.30)	(96.49)	(36.93)	(77.86)
Perennial share of land (std)	-576.6**	1210.9***	-15.56	1058.5***
	(286.0)	(418.6)	(184.8)	(349.2)
Year=2008	3946.9***	-2991.2***		
	(397.4)	(680.8)		
Year=2010	4381.8***	-5041.4***		
	(442.2)	(853.1)		
Year=2012	8547.0***	-8109.2***		
	(901.9)	(1307.2)		
Observations	5756	5756	5404	5404
Mean DV	5848.2	-2708.1	5924.6	-2763.1
HH, Year FE	Yes	Yes	Yes	Yes
Commune-Year FE	No	No	Yes	Yes
Sample	All	All	All	All

Standard errors in parentheses. Standard errors clustered at the commune level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$